



**Victoria**

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The first part of this chapter provides **contextual information** on Victoria, including basic information about its climate, geography, land use and population. It also provides an outline of the bushfire regimes, historically important bushfire events, and an overview of fire services in Victoria. The second part represents an **analysis of data** provided by the Metropolitan Fire and Emergency Services Board, the Country Fire Authority and the Department of Sustainability and the Environment. Although data supplied for the Metropolitan Fire and Emergency Services Board included all categories of fires, this analysis exclusively refers to vegetation fires, unless otherwise indicated.

For an explanation of the key terms, limitations and methodology refer to the introduction, glossary and methodology chapters.

## Introduction

Victoria is in southeastern mainland Australia (Figure 1), bordered by New South Wales to the north and South Australia to the west. It is Australia's smallest mainland state, covering an area of 237,629 square kilometres.

## Geography

Victoria is topographically, geologically and climatically diverse. The Great Dividing Range, which stretches along Australia's east coast, forms the prominent geographical feature, rising to almost 2,000 metres at Mount Bogong and terminating to the west of Ballarat (Figure 1). The range effectively divides the state into three climatic zones: southern and coastal areas, alpine areas, and semi-arid plains to the west and northwest. Coastal regions are temperate and cool, and comparatively wet, whereas the northwest (Mallee and Upper Wimmera) can be hot and dry owing to the hot winds that blow from the nearby deserts. The Alps are cool to cold, with the highest parts averaging below 0°C in winter. The Alps are the site of some of Australia's premier ski resorts.

**Figure 1: Map of Victoria**



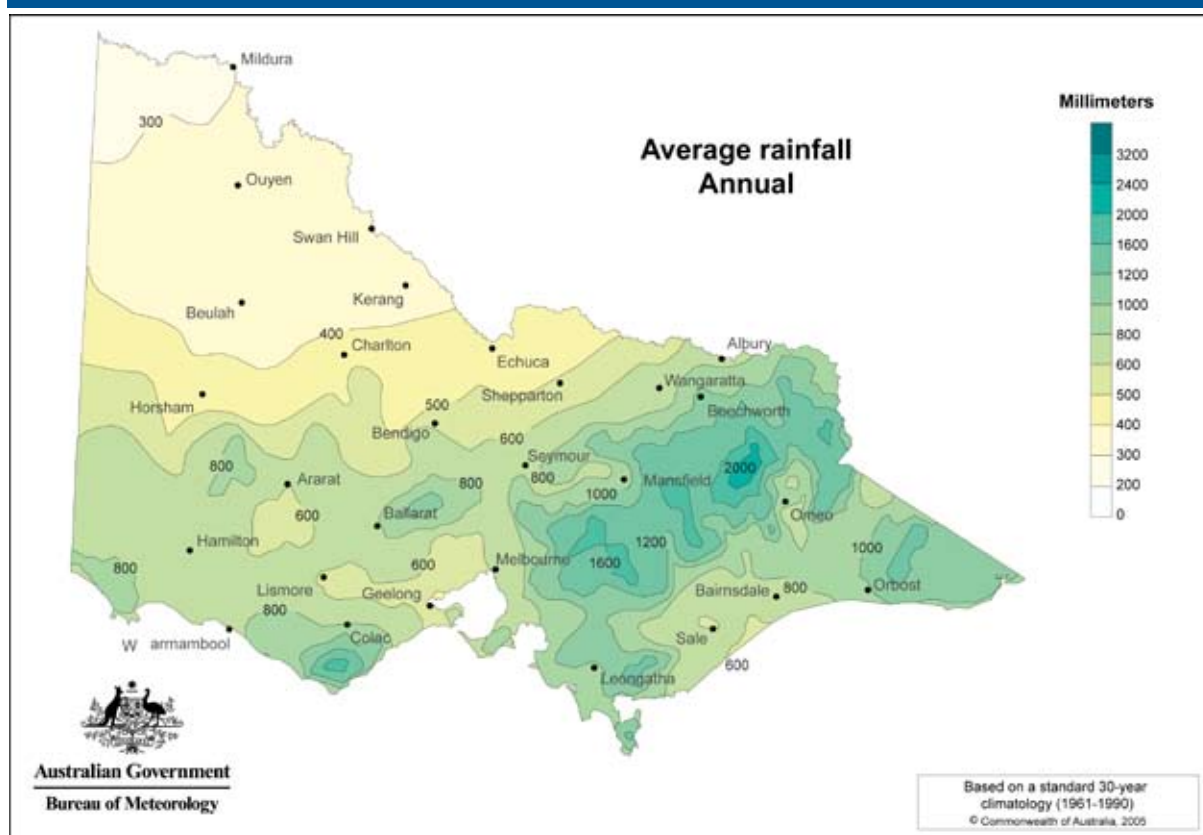
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## Climate

Victoria is the wettest state in Australia after Tasmania, but rainfall is highly variable across the state. Overall, precipitation increases from north to south, with the highest falls occurring at high altitudes. Some parts of the northeast record more than 1,800 mm of precipitation per year (Figure 2). In most of the state, precipitation principally falls as rain, whereas snow is common along the Alps in winter.

Rainfall principally occurs in winter, being associated with the movement of moisture-laden air in cold fronts, from the Southern Ocean. The most reliable rainfall occurs close to the coast, in the Gippsland and Western regions, making these the richest agricultural lands. In contrast, parts of the northwest, in the Mallee and to a lesser extent Wimmera, receive less than 250 mm (Australian Bureau of Meteorology 2007).

**Figure 2: Annual average rainfall for Victoria**

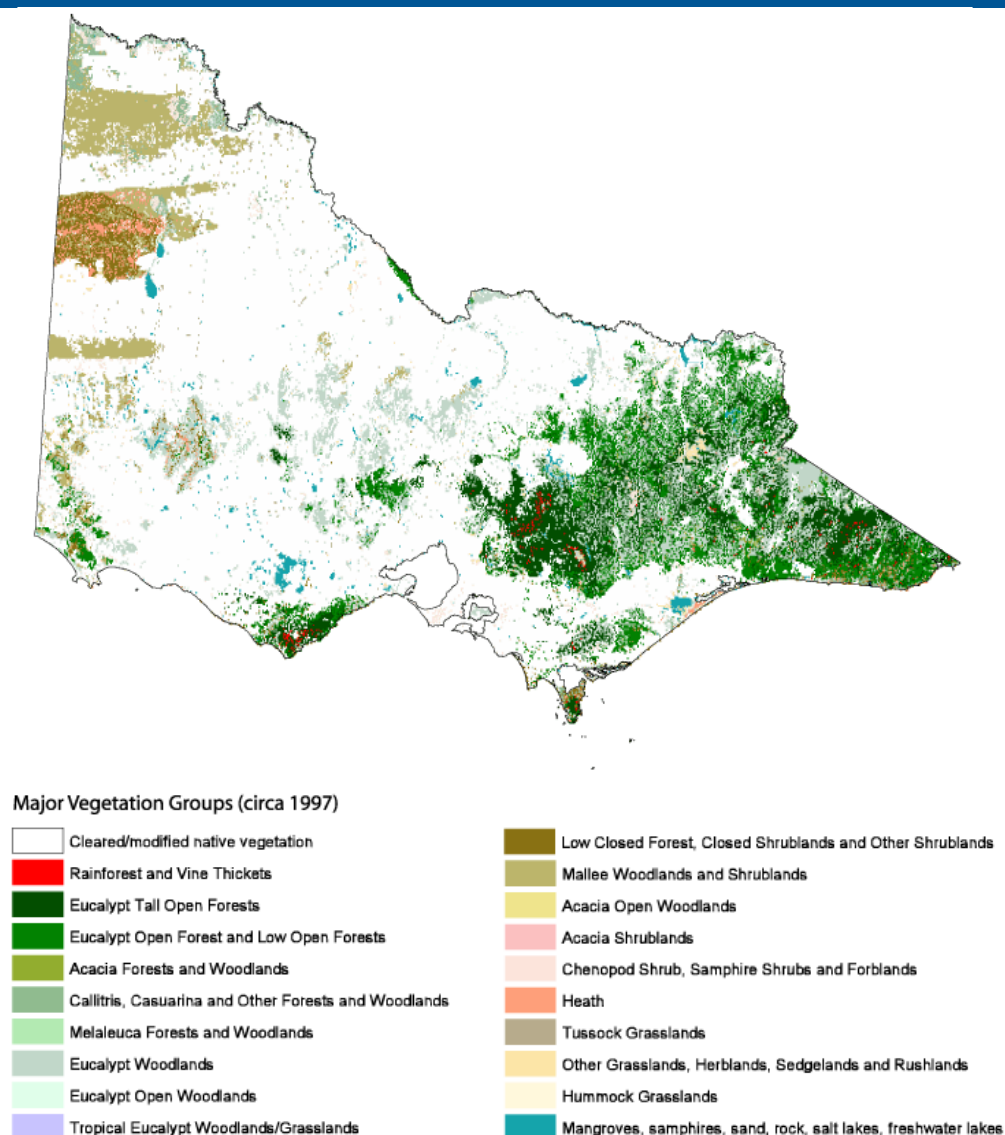


Source: Australian Bureau of Meteorology 2007  
© Australian Bureau of Meteorology

## Native vegetation

Much of Victoria's native vegetation has either been cleared or markedly modified to make way for agriculture (Figure 3). The remainder is highly diverse. The highest density of native vegetation occurs in the mountain ranges and nearby coastal plains of the northeast. There are extensive eucalypt tall open forests (trees rising to 90 m high), eucalypt open forest and low open forest in the southern ranges and plateaus. Eucalypt woodlands dominate the hot, dry plains. In the arid northwest, mallee eucalypt woodlands and shrublands dominate. There are also extensive coastal heaths and wetlands. Alpine herb fields and bogs covered by winter snows occur in the highest reaches of the Great Dividing Range, in the northeast. Small pockets of rainforest are dispersed among the eucalypt forests of the northeast and southern Victoria (Australia. Department of Environment and Heritage 2001b).

**Figure 3: Native vegetation groups (c. 1997)**



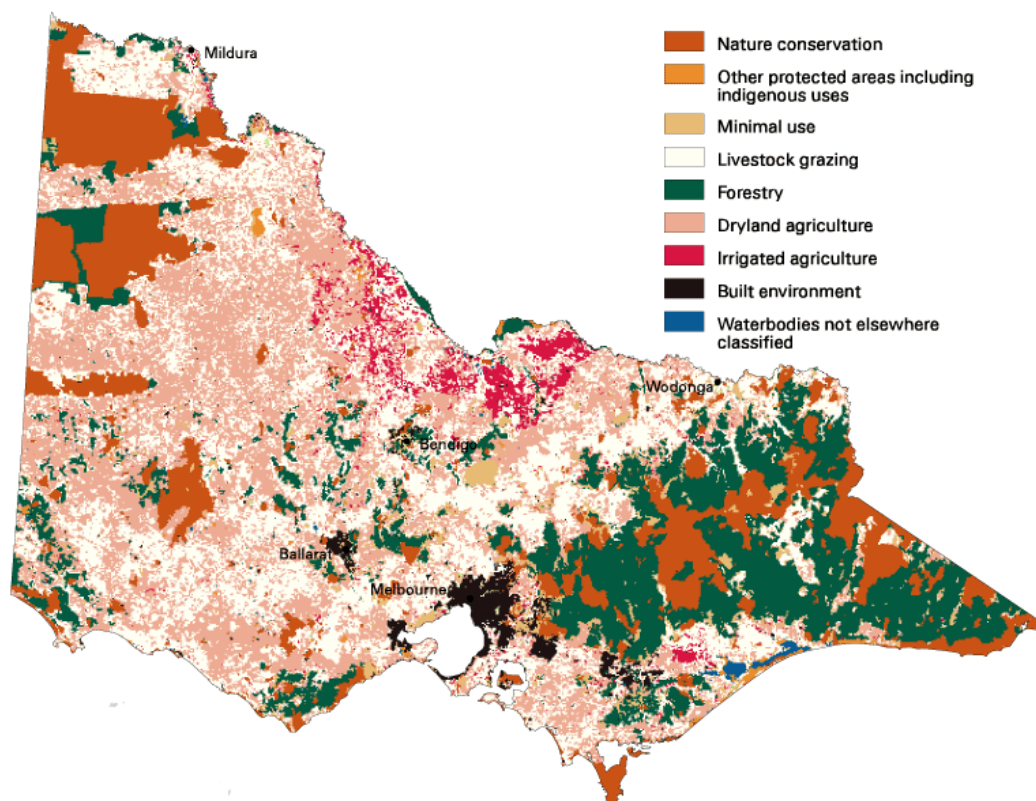
Source: Australia. Department of Environment and Heritage 2001b  
© Department of Environment and Heritage

## Land use

In 1996–97, agricultural activity accounted for 61 percent of the state's land use. Livestock grazing is commonly interspersed with dryland farming along much of the southern coast, and in central and western Victoria (Figure 4). Irrigated agriculture principally occurs in central northern Victoria, using waters from the Murray River, which defines the northern border of the state. The principal agricultural products of Victoria include wool, lamb/mutton, beef, wheat, oats, barley, maize, tobacco, hops and fodder crops, citrus, grapes, apples, stone fruits, vegetables and dairy products.

Forestry, which is concentrated in the state's northeast, accounted for nearly 17 percent of the total area in 1996–97, with a further 15 percent reserved for nature conservation (Australia. Department of Environment and Heritage 2001a).



**Figure 4: Land use (c. 1996–97)**

Source: Department of Environment and Australia. 2001a  
 © Department of Environment and Heritage

## Population

Victoria is the most densely populated and urbanised state in Australia. Although the state is geographically small, in June 2006 the residential population was estimated to be 5,091,666; 24.7 percent of Australia's population (ABS 2006). Nearly 90 percent of people live in cities or towns. Almost three-quarters (72% in 2005) live in the capital, Melbourne. Other important regional urban centres include Geelong, Ballarat, Bendigo, Shepparton, Mildura, and Warrnambool. Approximately 72 percent of Victoria's population was born in Australia, with less than one percent identifying as Indigenous. People who were not born in Australia commonly came from the United Kingdom, Italy, Vietnam, Greece or New Zealand.

The median age of Victoria's population was 36.8 years in 2005, compared with the national average of 36.6. The median age in the Melbourne statistical division (SD) was 36.0 years whereas the median age in regional Victoria (all SDs excluding Melbourne) was 39.1 years (ABS 2005a).

Children aged 0 to 14 years comprised 19.1 percent of Victoria's population in June 2005, compared with the national average of 19.6 percent. Despite a lower median age, children 0 to 14 years comprised 18.6 percent of the Melbourne SD population, but 20.3 percent of the population of the remainder of state. The highest proportion of children (0 to 14 years) occurred in the Mallee (21.7%), Goulburn (21.2%) and Western District (21.2%) SDs (ABS 2005a).

## Bushfire regimes

The bushfire season in Victoria normally extends from November to April, coinciding with hot and dry conditions that dominate the summer months across much of the state. The extent and severity of bushfires are highly variable from year to year.

## Bushfire history

Victoria has been subjected to some of the most devastating bushfires in Australia's history, in terms of both area burned during a single fire event, and loss of property and life. More than 300 people have died in Victorian bushfires, more than the loss of life in all other states and territories combined. Major bushfire events are listed in Table 1, with selected bushfires discussed in detail below.

**1851: Black Thursday, 6–10 February** – This fire, which is captured in an oil painting by William Strutt, was the largest (in terms of area burned) recorded in Victoria's history. Unofficial records indicate temperatures in Melbourne on 6 February had reached 47°C by 11 am. The bushfires consumed five million hectares (50,000 square kilometres) or nearly one-quarter of the state's land area, burning bush from Barwon Heads to Mount Gambier in South Australia, affecting Portland, Plenty Ranges, Westernport, the Wimmera and Dandenong. Emergency Management Australia's records indicate that 15 people died and 150 were injured, 1,300 buildings were destroyed and 1.1 million livestock died (EMA 2006a).

**1939: Black Friday, (13 January), December 1938 to January 1939** – The bushfire that culminated in Black Friday was the worst in Victoria's history in terms of loss of life. The summer of 1938–39 was hot and dry, and by early January several fires were burning. Northeasterly winds associated with dry, heat wave conditions caused several fires to combine into a single massive front. The effects of fire were widespread. The most damage was in the alpine areas, and in the Otway and Yarra Ranges, with the Acheron, Tanjil and Thomson Valleys, and the Grampians also hit. The townships of Narbethong, Nayook West, Noojee and Woods Point were all destroyed and not rebuilt; Omeo, Pomonal, Warrandyte and Yarra Glen were all badly damaged. The confluence of two fire fronts near Warrandyte put suburban Melbourne under threat. The Royal Commissioner leading an investigation after the fires noted that 'it appeared the whole state was alight on Friday, 13 January 1939'. The fires burned between 1.5 and 2 million hectares, including 800,000 hectares of protected forest, 600,000 hectares of reserved forest and 4,000 hectares of plantations; and they destroyed 1,300 buildings, including more than 650 homes, shops, 69 timber mills, and hospitals. The fires resulted in the deaths of 71 people and the loss of huge numbers of stock. After the Royal Commission, Judge Stretton said in his report '... it will appear that no one cause may properly be said to have been the sole cause ...', but human actions played an important role. Burning off for land clearing and grass growth, lighting campfires, inappropriate sawmill operations and domestic fires, by landowners, graziers, miners, forest workers and campers before the fires had all played a part (DSE 2007c, EMA 2006b).

**1943–44: late December to mid February** – Numerous fires occurred, particularly around the western, central and southern portions of the state. On 22 December, hundreds of hectares of grassland burned near Wangaratta, killing 10 people. Other fires occurred at Beaumauris (Melbourne), and in the Gippsland region (Morwell and Yallourn). The fires of 1943–44 resulted in the deaths of 51 people, loss of 58 homes and over 600 other buildings, as well as major stock losses (EMA 2006c).

**1969: 8 to 9 January** – Fires in central and southern Victoria killed 23 people and injured a further 100. The worst hit area was at Lara, where an enormous, fast-moving grassfire approached the four-lane Melbourne–Geelong Expressway. The dense smoke caused some motorists to halt; those who stayed in their cars with the windows closed were able to leave when the smoke became less dense. Six people who did this were known to have survived, however, 17 people who abandoned their cars and attempted



to outrun the fire, died; eight at the scene, two on the way to hospital, and seven in hospital. Fires also resulted in deaths north of the Great Dividing Range. Other fires affected Daylesford, Bulgana, Yea, Darraweit, Kangaroo Flat and Korongvale. The bushfire resulted in the loss of 230 homes and 21 schools/churches/halls. Approximately 250,000 ha were burned and 12,000 stock were lost (EMA 2006d).

**1983: Ash Wednesday – 16–18 February** – An El Niño event led to a severe drought over much of Australia during 1982–83, with Victoria recording little rainfall in the previous 10 months. Summer rainfall for Victoria was up to 75 percent less than in previous years. Large fires started in late November, and in early January and February. Movement of a cold front in South Australia forced hot air from central Australia into Victoria, generating hot conditions with low humidity. On the preceding day winds had whipped up huge dust storms. At this point, the fires moved along in narrow tongues. However, with a wind change, these fires suddenly spread, burning across a wide front and resulting in large loss of life and property across many parts of Victoria (see also South Australian Ash Wednesday fires). The most severely affected areas in Victoria included Cudgee–Ballangeich, East Trentham–Mount Macedon, Otway Ranges, Belgrave Heights–Upper Beaconsfield, Cockatoo, Monivae, Branhholme, and Warburton. Approximately 210,000 hectares burned, 47 lives were lost, and 2,080 homes burned; there were also losses of businesses, stores, equipment, machinery, stock and other private assets. Property damage resulted in losses of over \$200 million. Approximately \$50 million was lost in timber resources. The fires were attributed to numerous causes, including power lines and deliberate actions (DSE 2007b, EMA 2006e).

**2002–03:** – Thunderstorm activity on 7–8 January started a series of fires in Victoria, before moving into and triggering devastating fires in southern New South Wales and the Australian Capital Territory. In Victoria, the fires were principally in Gippsland and the northeast. The alpine fires continued over 59 days, burning one million hectares of public land and 100,000 ha of private land; they destroyed 41 houses, 213 other structures, 3,000 km of fencing, and resulted in the loss of more than 9,000 head of stock. A further 181,400 ha burned in the Big Desert fires (17 to 25 December) in the state's northwest. One firefighter died in that fire, although it was not the direct result of firefighting (Ellis, Kanowski & Whelan 2004).

**2006–07:** Approximately, 1,000,000 ha in the northeast and Gippsland were burned in December and January; in many cases in areas already affected by the 2002–03 fires.

**Table 1: Fire history in Victoria**

Date	Deaths	Area of fire (ha)	Losses	Location(s)
1851 February (Black Thursday)	Approx. 12	5,000,000; one-quarter of Victoria	1 million sheep, thousands of cattle	Wimmera, Portland, Gippsland, Plenty Ranges, Westernport, Dandenong district, Heidelberg
1898 February (Red Tuesday)	12	260,000	2,000 buildings	South Gippsland
Early 1900s (esp. 1905, 1906, 1912, 1914)		Varied (100,000 in 1914)		Gippsland, Grampians, Otway Ranges
1926	60		Many farms and homes	Noojee, Kinglake, Warburton, Erica, Dandenong Ranges
1932	9			Many districts across Victoria, particularly Gippsland
1938–1939 (December–January (incl. Black Friday))	71	1,520,000	>650 homes and shops, 69 timber mills	Large areas of the northeast and Gippsland, the Otway and Grampian Ranges, and the towns of Rubicon, Woods Point, Warrandyte, Noojee, Ormeo, Mansfield, Dromana, Yarra Glen, Warburton, Erica
1942 March	1		100 sheep, 2 farms, >20 homes	Hamilton, South Gippsland – Yarram (burning on a 96 km front)

**Table 1: Fire history in Victoria (continued)**

Date	Deaths	Area of fire (ha)	Losses	Location(s)
1943 December	10			Wangaratta
1944 January	49	>1,000,000	500 homes, huge stock losses	Central and Western Districts
1944 February			Plant works, open-cut mine and buildings	Morwell, Yallourn
1952 February	Several	100,000		Benalla area
1962 January	>8		454 homes	The Basin, Christmas Hills, Kinglake, St Andrews, Hurstbridge, Warrandyte, Mitcham
1965 January	7		6 homes	Longwood
1965 February–March		300,000 forest 6,070 grassland	>60 homes and shops >4,000 stock	Gippsland
1968 February		1,920	64 homes and other buildings	Dandenong Ranges, The Basin, Upwey
1969 January	22	250,000	230 homes, 21 schools/church/hall, >12 000 stock	280 fires broke out, affecting Lara, Daylesford, Bulgana, Yea, Darraweit, Kangaroo Flat, Korongvale
1972 December		12,140		Mount Buffalo
1977 February	4	103,000	More than 100 houses and shops, approx. 200,000 stock	Penshurst, Tatyoon, Streatham, Creswick, Pura Pura, Werneth, Cressy, Rokewood, Beeac, Mingay, Lismore, Little River
1978 January	2		1 house; 6,500 stock	Bairnsdale
1980–81 January–December		119,000		Sunset Country and the Big Desert
1983 January – February <sup>a</sup>	47	461,864	47 people died; >27,000 stock lost; 1,719 houses, 82 commercial properties, and 23 dairies burned; 1,238 farms damaged	Cann River, Mount Macedon, Monivae, Branhholme, Cockatoo, East Trentham, Otway Ranges, Belgrave Heights, Warburton, Cudgee, Upper Beaconsfield, Framlingham
1985 January	3	50,800	182 homes, 400 farms, 46,000 stock	Avoca–Maryborough, Little River, Springfield, Melton
1990 December	1		17 homes >12,000 stock	Strathbogie
1995 February		10,000 (mostly forest)		Berringa
1997 January	3	400	41 houses	Dandenong Ranges, Creswick, Heathcote, Teddywaddy, Gough's Bay
1997–98 December–January		32,000		Caledonia River area of Alpine National Park, Carey River State Forest
1998 December	5 (CFA firefighters)	780	1 CFA tanker	Linton
2000 December		29,000		Dadswells Bridge
2002 December		181,400	1 abandoned house	Big Desert
2003 January–March	1 indirectly	1,100,000	41 houses; 9,000 livestock	Over 80 fires started by lightning; northeast Victoria, Gippsland

a: losses derived from EMA 2006e

Source: Ellis, Kanowski &amp; Whelan 2004

## Fire services

Three major agencies provide fire services in Victoria. They are the Metropolitan Fire and Emergency Services Board, the Department of Sustainability and the Environment and the Country Fire Authority.

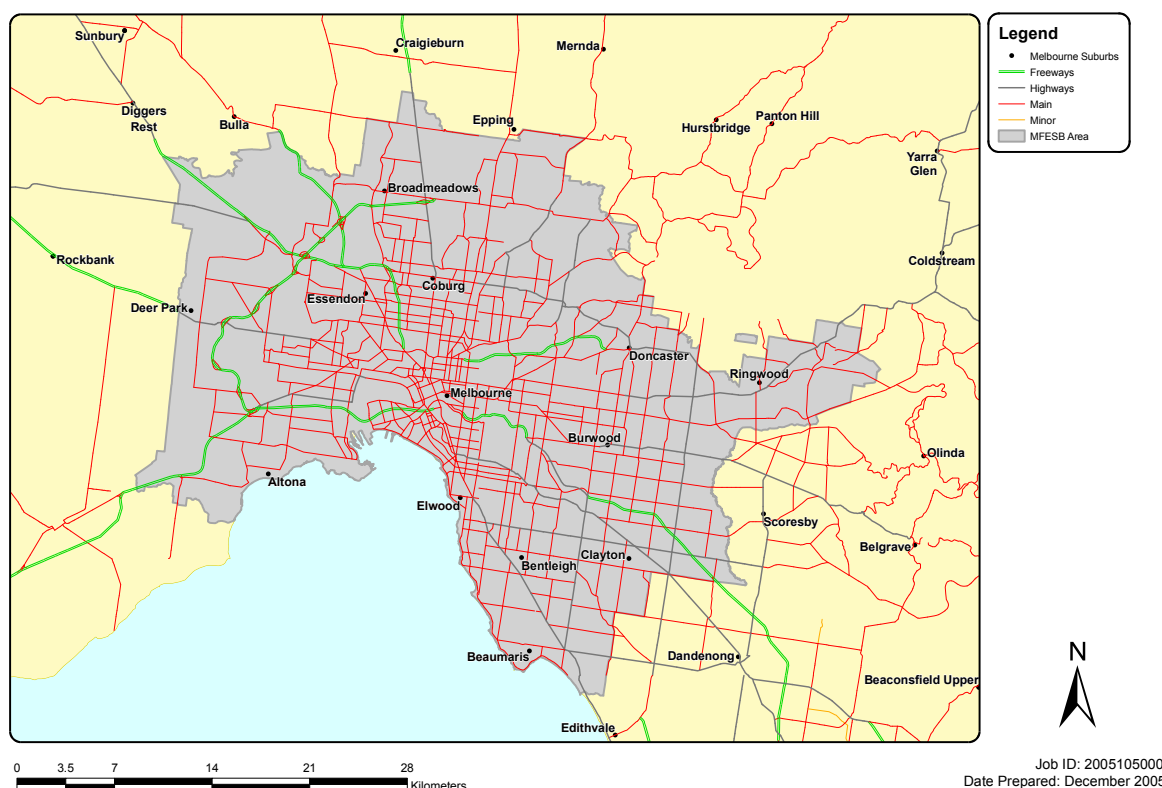
The **Metropolitan Fire and Emergency Services Board (MFB)** provides emergency response for all types of fire, urban search and rescue, high angle and road accident rescue, industrial accidents and hazardous materials incidents/handling, among other tasks, to the vast majority of the Melbourne metropolitan area (Figure 5). It employs 1,600 career firefighters, working from 47 stations (MFB 2007). The MFB data used in this analysis were sourced from the Australian Fire Authorities Council's (AFAC's) Australian Incident Reporting System (AIRS) database, and span 1997–98 to 2001–02. Further information about the MFB can be found at <http://www.mfb.vic.gov.au>.

The **Department of Sustainability and the Environment (DSE)** attends fires on public land and adjacent private property where fires threaten public land. Land under DSE jurisdiction is largely denoted as forestry and nature conservation in Figure 4. The DSE data analysed in this report is principally from 1993–94 to 2003–04, but where possible includes data from previous studies to extend the study from 1975–76 to January 2005. Further information about the DSE can be found at <http://www.dse.vic.gov.au>.

The **Country Fire Authority (CFA)** has responsibility for all fires (structural, bushfire/vegetation, vehicle fires etc.), as well as incidents involving hazardous materials, and road accident rescue that occur in urban and rural areas outside MFB and DSE jurisdiction; that is, in outer metropolitan Melbourne, regional urban centres and rural areas. The CFA may attend fires within DSE and, to a lesser extent, MFB jurisdictions, and visa versa. Further information can be found at <http://www.cfa.vic.gov.au>.

In instances where more than one fire agency attends a single fire, that fire would normally be recorded in each agency's database. This is most likely for large fires, and within the CFA and DSE datasets. It is unlikely to markedly affect the total number of fires recorded for a particularly period but will strongly affect the total area burned.

**Figure 5: Jurisdiction of the Metropolitan Fire and Emergency Services Board and the Country Fire Authority in the Melbourne metropolitan region**



Source: CFA 2007  
© Victorian Country Fire Authority

## Metropolitan Fire and Emergency Services Board

### Background information about the MFB dataset and its analysis

Important information about the MFB dataset and the methodology employed to analyse it is summarised as:

- The data were sourced from Australasian Fire Authorities Council (AFAC).
- The dataset provided included all fires (structural, vehicle, vegetation, other fires); vegetation fires (AIRS wildfires; incident code 160 to 179) were extracted from this dataset. Hence, all references to 'fire' or 'fires' in this analysis refer to vegetation fires unless otherwise indicated.
- The dataset included fires from 1997–98 to 2001–02; the 1997–98 data were, however, incomplete, with vegetation fires having only been recorded from mid November (week 46) onwards.
- The database used AIRS classification codes.
- The cause was based on the ignition factor variable.
- Deliberate vegetation fires refer to all vegetation fires classified as incendiary (AIRS ignition factor code = 110 or 120) or suspicious (AIRS ignition factor code = 210 or 220).

- Natural vegetation fires refer to all fires where the ignition factor codes were 800 to 890, which incorporate any fire resulting from a natural condition or event. For the MFB the breakdown of specific causes of natural fires was; high wind 17.6 percent, lightning 11.8 percent, high water (including flood) 3.3 percent, and any other natural condition (not classified [NC]/insufficient information to classify further [IO]) 67.2 percent.
- Information about form of heat of ignition was supplied.
- Smoking-related vegetation fires were classified on the basis of:  
Form of heat of ignition = 'Heat from smokers' materials' (AIRS codes 300 to 390); the causal classification of smoking-related vegetation fires was 90 percent accidental, 0.3 percent incendiary, seven percent suspicious and two percent unknown.
- All vegetation fires attributed to children and discussed in the text were classified accidental in origin; deliberate vegetation fires started by children were classified as incendiary or possibly suspicious and therefore cannot be delineated from other incendiary or suspicious fires. Some information about the age of children was supplied but was incomplete.
- The dataset included information about 'type of incident'.
- The regions used in the MFB analysis (pertinent to the combined MFB–CFA analysis only) were based on the tourism regions defined by the Australian Bureau of Statistics (2005b). Assignment to regions was based on the postcode variable provided. There was not an exact concordance between the postcode and tourism regions. The ABS defines tourism regions based on smaller statistical areas. Hence, ABS tourism regions potentially crosscut suburbs and postcodes. In this study, assignment was based on the highest levels of concordance between postcodes and tourism regions. Hence, there is not an exact correspondence between tourism regions used in this analysis and ABS tourism regions.
- Statistical local areas (SLA) were generated using the greatest levels of concordance between postcodes and SLAs (ABS 2001b). Statistical subdivisions (SSD) were generated from these SLAs using the ABS, Australian Standard Geographical Classification (ABS 2001a). Again, there was not an exact correspondence between SLAs, SSDs used in this analysis, and those defined by the ABS.
- The dataset included information about the area burned.
- Information was available about fire restrictions or fire danger index.

For more detail about these methodologies see the methodology chapter.

## Overview

Fires the MFB attended can be summarised as follows:

- The MFB attended 9,543 vegetation fires between 1997–98 and 2001–02, representing an average of 1,909 vegetation fires per year (sd=375) and approximately one-quarter of all vegetation fires attended by fire agencies in Victoria each year. The number of vegetation fires varied from a low of 1,427 in 1998–99 to a high of 2,482 in 2000–01 (Figure 6).
- Vegetation fires were exclusively in metropolitan Melbourne; that is, they are largely urban vegetation fires – 63 percent were classified as small vegetation fires, 18 percent as grassfires, nine percent as mixed scrub/bush/grass fires, and nine percent as other vegetation/outside fires that were not classified/insufficient information to classify. These types of incidents are likely to include fires in the local parks or reserves, fires along roadways, rivers and creeks, pockets of remnant vegetation within and between suburbs. However, they may also include hedge fires, single tree/bush fires, fires on the local oval etc.

- A total of 5,800 ha was burned in metropolitan Melbourne in five years.
- Deliberate causes were responsible for 22.9 percent of fires (31% of known causes), and almost half of the total area burned.

## Cause

Almost half of all vegetation fires in the Melbourne metropolitan district were attributed to accidental causes (Figure 7). Around twenty-three percent were deliberate, 1.5 percent incendiary and 21.4 percent suspicious. Natural causes were responsible for just 0.5 percent of fires. The cause of fires was unknown in around one-quarter of all cases (Figure 7). Deliberate causes accounted for 30.7 percent of known causes.

Annual variations in the number and proportion of deliberate fires were small (Figure 6). The number of deliberate vegetation fires ranged from a minimum of 300 in 1998–99 up to a maximum of 531 in 2000–01. Overall, there was a strong correlation between the number of deliberate vegetation fires and the total number of vegetation fires in a given year ( $r = .87$ ), with the percentage of deliberate fires ranging from 21 percent in 1998–99 to 2000–01 to 26 percent in 2001–02. No net increase in the number or proportion of deliberate fires was evident over the interval examined. Similarly, the proportions of other fire causes remained consistent throughout the observation period (Figure 8).

## Specific ignition factors

**Form of heat of ignition:** Open flames were found to be responsible for starting 31 percent of all vegetation fires, with a further 34 percent being smoking-related (cigarettes, cigars, etc.; Figure 9). Other known forms of heat of ignition comprised just 6.6 percent of cases. Of these, electrical equipment and a hot object/friction were the principal contributors.

Heat from an open flame contributed to both deliberate and non-deliberate vegetation fires, but accounted for a higher proportion of deliberate ones (Figure 10). More than three-quarters of all vegetation fires from an open flame were documented to have involved use of matches, with a further 7.8 percent involving use of a lighter (Figure 11). Fourteen percent of vegetation fires within the open flame category related to other (unspecified) causes. Burn offs, rubbish and campfires accounted for less than 1.5 percent.

**Fires started by children:** Children 16 years and younger were implicated in accidentally lighting 15.5 percent of vegetation fires in the Melbourne metropolitan area (Note: no information is available about the number of deliberate [incendiary and suspicious] vegetation fires started by children). In two-thirds of cases, the age of the child was unknown. Of the remaining one-third, the proportion of fires attributed to each age group increased with age; children 0 to 5 years, 6 to 12 and 13 to 16 years old accounted for 0.6, 10 and 25 percent of all child vegetation fires respectively (Figure 12). The number of fires started by children peaked in 2000–01, coinciding with the peak in MFB-attended vegetation fires generally. Overall, there was a significant correlation ( $r=.89$ ;  $p<.01$ ) between the number of vegetation fires lit by children and the total number of vegetation fires each year.

The majority of fires lit by children were started using the heat from an open flame. This occurred irrespective of the age group (Figure 13). However, for older age groups, additional factors like smoking-related materials and fireworks contributed to a higher proportion of fires. It was somewhat surprising that the highest proportion of smoking-related fires occurred for 6–12 year olds. Nevertheless, the greatest total number of smoking-related fires occurred for the 13–16 year age group. Of those fires started by open flames, the majority resulted from the use of matches and cigarette lighters, although lighters comprised a smaller proportion of accidental fires started by older children than for 0 to 5 year olds.

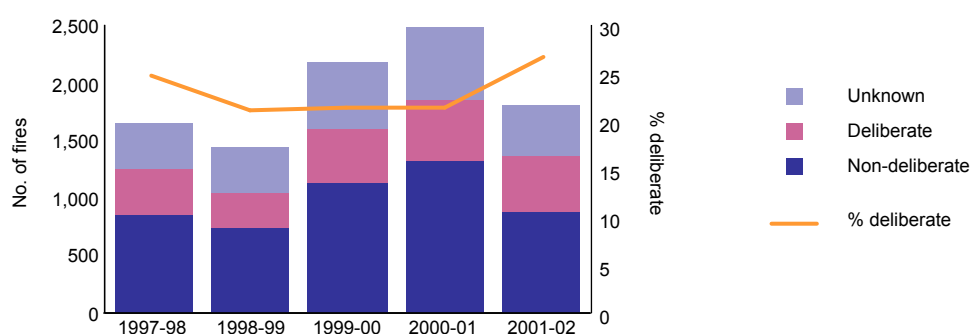


**Smoking-related fires:** Nearly one-third of all vegetation fires (31%; n=2922) the MFB attended were smoking-related (Figure 9). In this instance, smoking-related materials included cigarettes, cigars, pipes, and unspecified, other, or undetermined smoking materials. The numbers of smoking-related vegetation fires varied from 406 in 1998–99 to 767 in 2000–01 (Figure 14). The number of smoking-related vegetation fires was significantly positively correlated with the total number of vegetation fires each year ( $r=.94$ ;  $p<.01$ ). The proportion of smoking-related vegetation fires each year remained constant at 28 to 33 percent (Figure 14).

The MFB reported the highest proportion of smoking-related vegetation fires of any jurisdiction or agency in Australia. Several interconnected factors may affect this observation. First, the total frequency of vegetation fires, and the proportion of deliberate vegetation fires in the Melbourne metropolitan region is comparatively low. If the proportion of other causes is low, the proportion of smoking-related vegetation fires will necessarily be higher. Second, the restricted (metropolitan) jurisdiction of the MFB. The observation from other jurisdictions is that inner metropolitan areas are characterised by comparatively low rates of vegetation fires, lower proportions of deliberate vegetation fires, and higher rates of smoking-related fires. The proportions of deliberate and smoking-related vegetation fires are affected by the proportion of the jurisdiction that lies within an inner city, versus an interface-zone (I-zone), environment. Third, the MFB is the only agency in Australia restricted to a metropolitan area; most other agencies attend vegetation fires in all major regional urban centres, and in some cases, bushfires in more rural areas as well. Moreover, in Melbourne, many of the more distant locations closer to the I-zone fall within the Country Fire Authority's (CFA) jurisdiction. The proportion of smoking-related vegetation fires the MFB attended is comparable with the rate reported for Inner Perth.

There was a flow-on effect of high rates of smoking-related vegetation fires to causal classification schemes. In most instances, smoking-related fires were not labelled incendiary or suspicious within the ignition factor variable. Hence, the majority of smoking-related fires (90%; Figure 14) fall within the non-deliberate category based on the ignition factor code. Although technically they may have not been deliberately lit, it does not mean these fires were either legal or unavoidable. This needs to be considered when interpreting the MFB data. The issue of smoking-related fires needs to be addressed alongside deliberate causes to reduce the number of human-caused vegetation fires in metropolitan Melbourne.

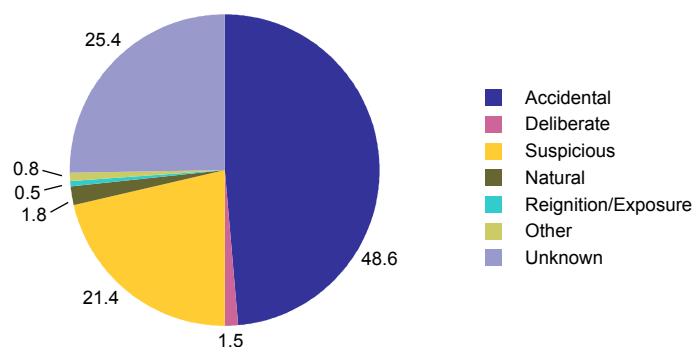
**Figure 6: Cause of vegetation fires, by year<sup>a</sup>**



a: 1997–98 data in this and all subsequent figures is incomplete

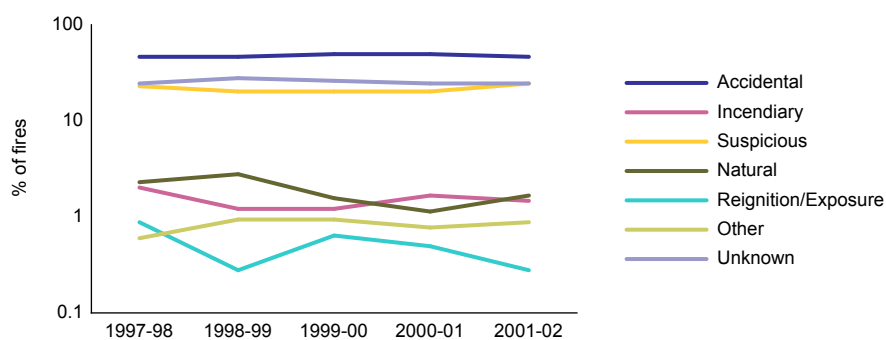
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 7: Cause of fire (percent)**



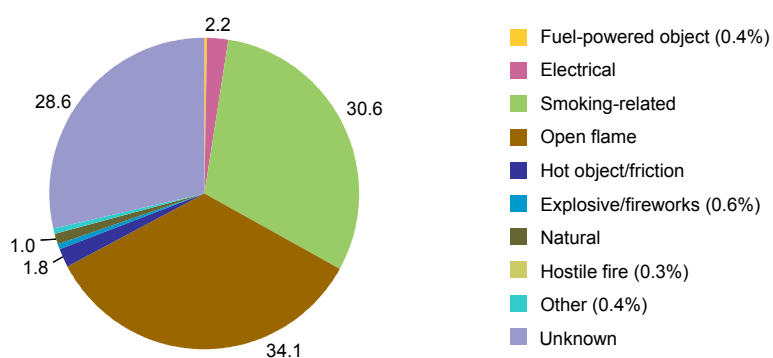
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 8: Cause of fire, by year (percent)**

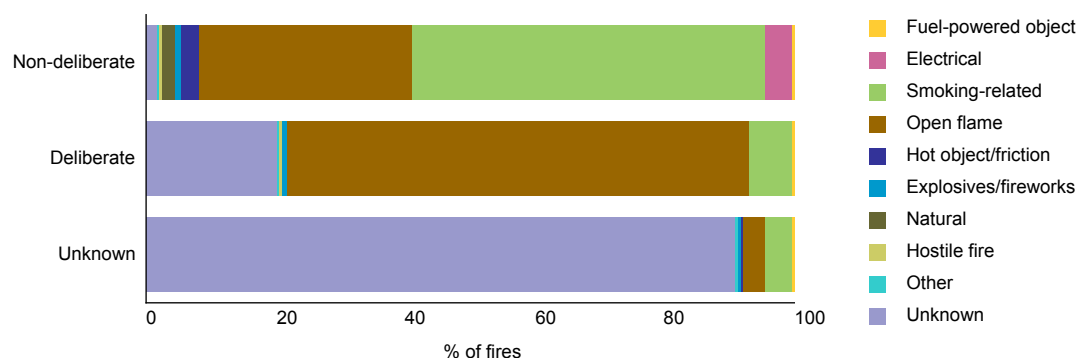


Source: MFB 1997–98 to 2001–02 [computer file]

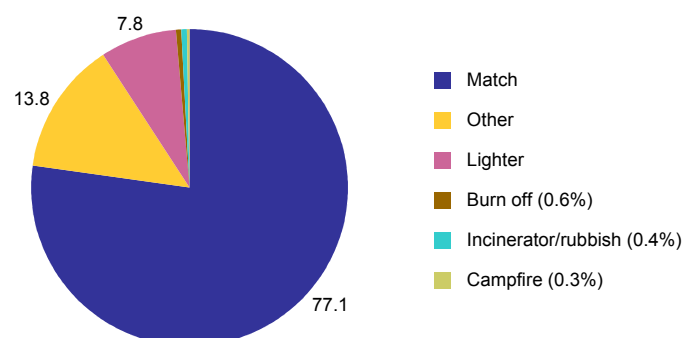
**Figure 9: Form of heat of ignition (summarised; percent)**



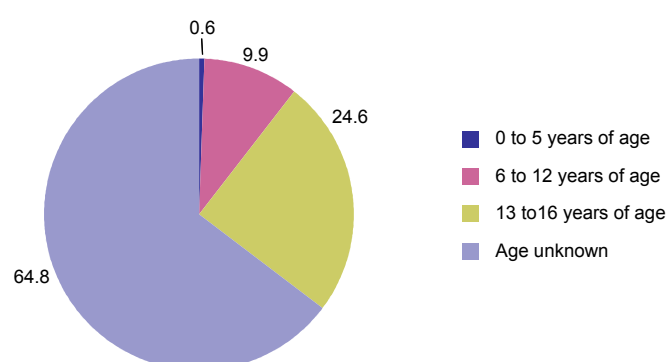
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 10: Fire cause, by form of heat of ignition (percent)**


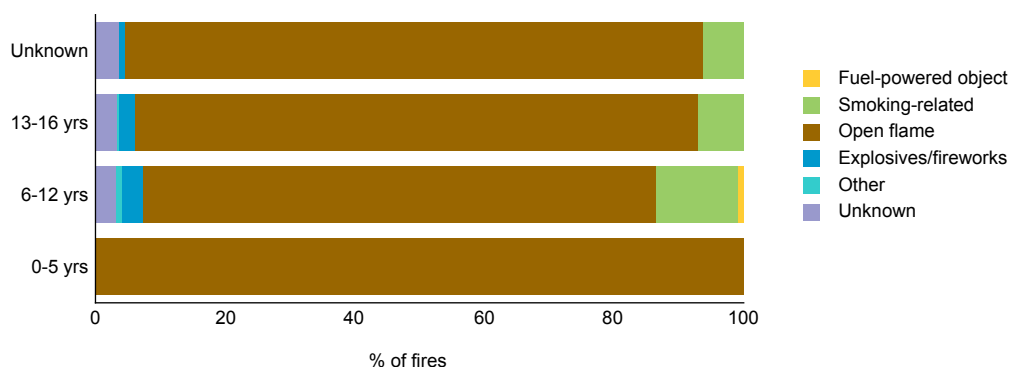
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 11: Specific form of heat of ignition for fires involving an open flame or spark (percent)**


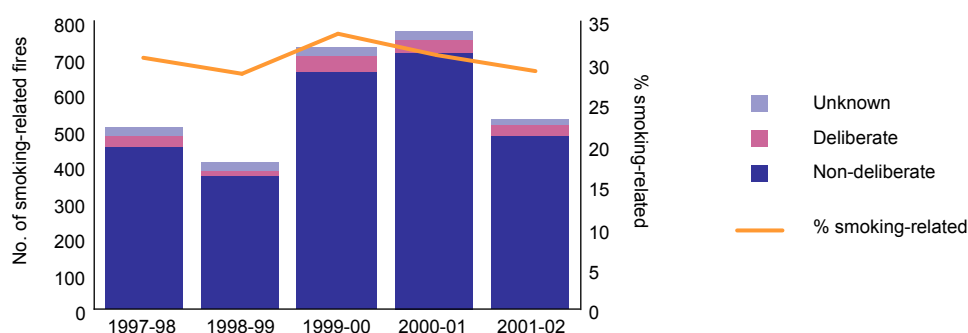
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 12: Non-deliberate child fires, by age (percent)**


Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 13: Non-deliberate child fires, by age, and by form of heat of ignition (percent)**


Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 14: Smoking-related vegetation fires, by year**


Source: MFB 1997–98 to 2001–02 [computer file]

## Location

The location of fires the MFB attended was analysed at a statistical subdivision (SSD) scale, with the distribution of fires also being examined relative to the population densities within individual postcodes, and by the type of complex or use of the property where a fire occurred.

### Statistical subdivision

Most MFB-attended vegetation fires occurred in the northern and western portions of the city, within the Western Melbourne, Northern Middle Melbourne, Hume City, and Northern Outer Melbourne SSDs (Figure 15). However, no postcodes in the Melbourne metropolitan area recorded more than 100 vegetation fires per year. The highest number of vegetation fires was recorded for one postcode in the Hume City SSD ( $n=474$  in five years). Three of the six postcodes recording the highest number of vegetation fires, and two of the top three, occurred in the neighbouring Western Melbourne SSD. The highest proportion of deliberate vegetation fires (incendiary and suspicious fires combined) occurred in the Hume City (30%) and Moreland City (25%) SSDs.

The MFB attended comparatively few vegetation fires in the Yarra Ranges Shire and Greater Dandenong City SSD, as these areas principally lie within CFA jurisdiction. Hence, the low rates of deliberate vegetation fires the MFB recorded in these areas are not likely to have been representative. However, other areas in eastern Melbourne, including Eastern Middle and Eastern Outer Melbourne SSD also

recorded comparatively low percentages of deliberate vegetation fires (typically 15 to 17%), as did the Inner Melbourne SSD (12%).

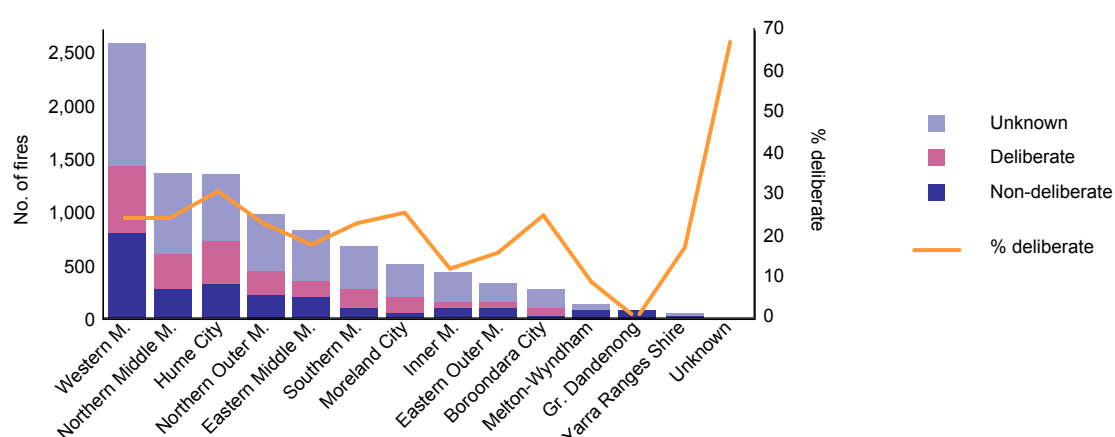
The proportion of deliberate vegetation fires was highly variable at a postcode level; deliberate causes accounted for 0 to 53 percent of vegetation fires in any postcode. The greatest heterogeneity was evident for postcodes with low total vegetation fire frequencies (fewer than 10 per year). At greater frequencies, where sampling errors were less likely to be of importance, there was a tendency for the proportion of deliberate vegetation fires in a postcode to increase with the total number of vegetation fires (Figure 16).

The greatest number of non-deliberate child fires occurred in the Hume City, Western Melbourne, Northern Outer Melbourne and Northern Middle Melbourne SSDs; that is, in areas with the highest number of vegetation fires generally (Figure 17). Between 27 and 31 percent of vegetation fires in the Northern Outer Melbourne, Hume City and Moreland City SSDs were classified non-deliberate fires lit by children. In contrast, only three percent of vegetation fires in the Inner and Southern Melbourne SSDs were non-deliberate child fires (Figure 17).

Overall, the number of non-deliberate child fires was significantly correlated with the total number of vegetation fires within SSDs ( $r=.81$ , significant at  $p<0.001$ ), although some scatter was evident (Figure 18). Numbers of non-deliberate child vegetation fires, like vegetation fires generally, were heterogeneously distributed within each SSD, with a high proportion occurring within a small number of postcodes (Figure 19). The demographic structure of suburbs (such as age distribution) was likely to have played a significant role in the number of fires started by children.

The greatest number of smoking-related fires occurred in the Western Melbourne (SSD, followed by the Northern Melbourne and Eastern Middle Melbourne SSDs (Figure 20). There was significant correlation ( $r=.94$ ;  $p<.001$ ) between the number of smoking-related vegetation fires and the total number of vegetation fires within each SSD, although some dispersion in the data was evident at moderately high frequencies. Smoking-related fires accounted for the highest percentage of all vegetation fires in the Inner Melbourne (53%), Boroondara City (43%), and the Southern, Eastern Middle and Northern Middle Melbourne (37 to 40%) SSDs. That is, smoking-related fires accounted for a higher proportion of fires in more centrally located metropolitan areas (Figure 20).

**Figure 15: Deliberate vegetation fires, by SSD<sup>a, b</sup>**

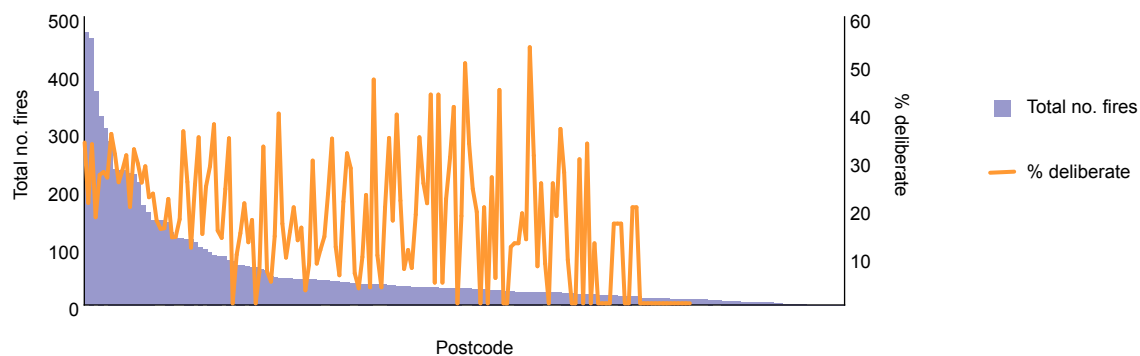


a: M. = Melbourne, Gr. = Greater

b: in many instances the CFA attended vegetation fires in the same SSD

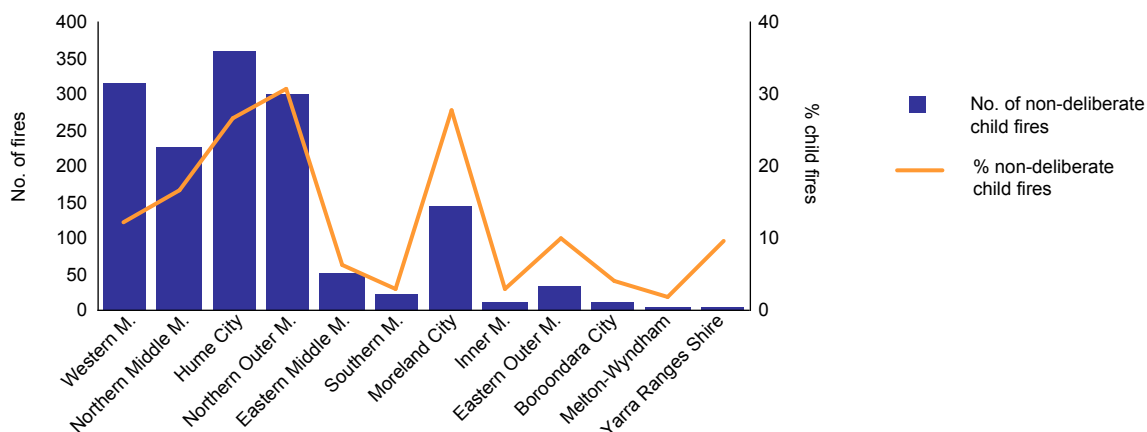
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 16: Total and deliberate fires in individual postcodes<sup>a</sup>**



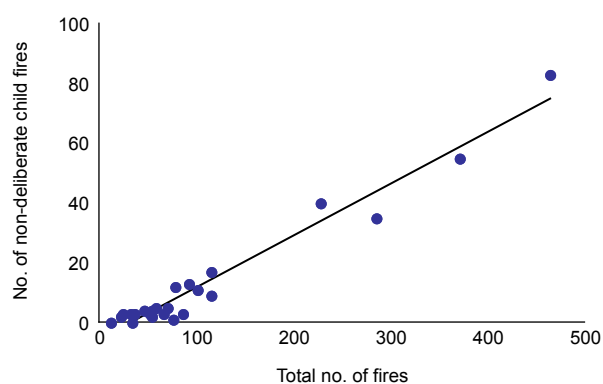
a: postcode identification has been removed to preserve the anonymity of those postcodes; fire agencies may source this information from the author  
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 17: Non-deliberate child fires, by SSD**



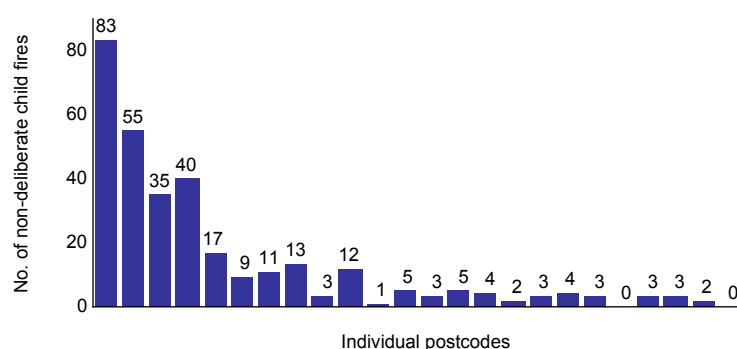
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 18: Non-deliberate child fires and total fire numbers, by postcode (number)**

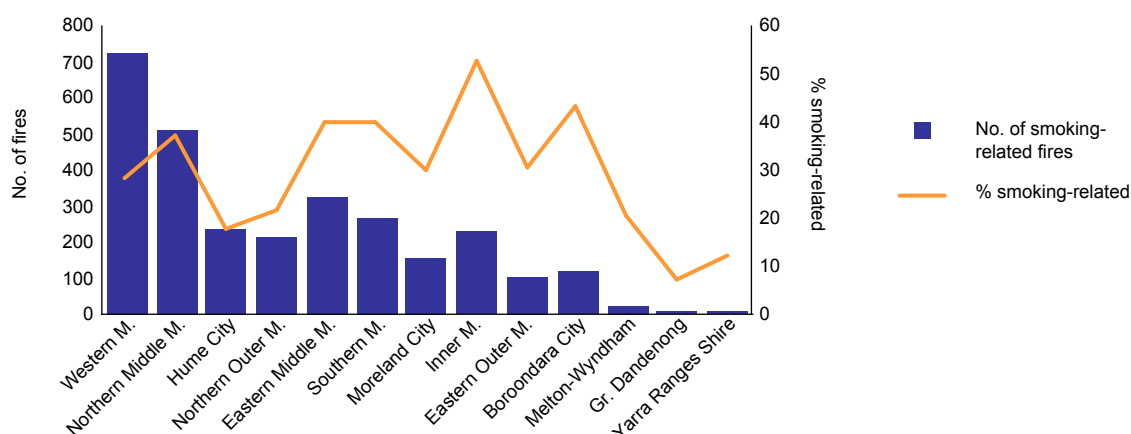


Source: MFB 1997–98 to 2001–02 [computer file]



**Figure 19: Non-deliberate child, by postcode<sup>a</sup> in the Western Melbourne postcode SSDs (number)**

a: postcode identification has been removed to preserve the anonymity of those postcodes; fire agencies may source this information from the author  
 Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 20: Smoking-related vegetation fires, by Melbourne SSDs**

Source: MFB 1997–98 to 2001–02 [computer file]

## Population analysis

There was a broad tendency for the total number of vegetation fires to increase with increasing population ( $r=.41$ ;  $p<.001$ ), although considerable variability exists in detail (Figure 21). There are a number of possible reasons for this variability, including:

- genuine variations in the total number of vegetation fires
- the Victorian Country Fire Authority may have attended fires within the same postcode, consequently the data the MFB provided do not give an adequate overview for all postcodes, particularly in eastern and southern Melbourne and Melton–Wyndham SSDs
- some postcodes may have had a low residential population but were areas that received a higher influx of visitors from other regions.

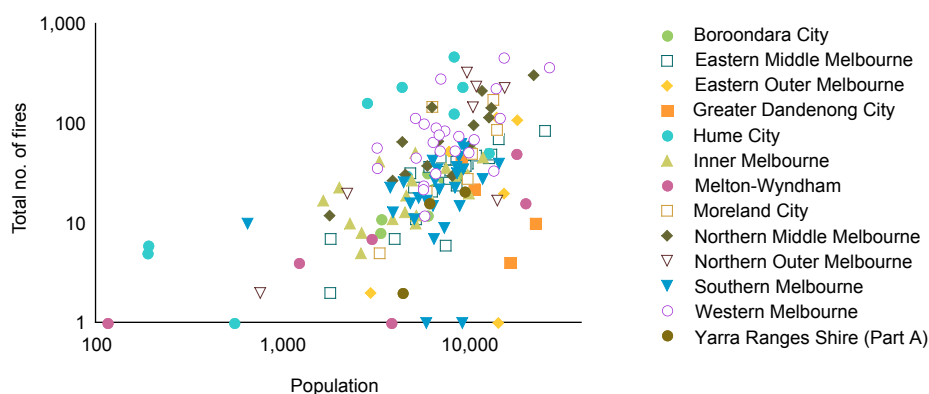
**All vegetation fires:** Based on the MFB data only, postcodes in metropolitan Melbourne experienced between three and 100 vegetation fires per 10,000 people per year (Figure 22). The rate for the Melbourne metropolitan area was on the low side when compared with some other Australian state and

territory metropolitan cities. The lowest observed rates of fires occurred in the eastern and southeast areas of the metropolitan area, including Eastern Outer Melbourne and Southern Melbourne SSDs. Low rates in the Greater Dandenong City SSD almost certainly reflected the low level of coverage the MFB provided in this area. The highest rates occurred in those SSDs that recorded the highest total number of vegetation fires, namely Western Melbourne, Northern Outer Melbourne and Hume City (Figure 22).

**Deliberate vegetation fires:** Between 0.2 and 38 deliberate vegetation fires per 10,000 people per year occurred in metropolitan Melbourne postcodes (based on MFB data only; see below for combined MFB and CFA analysis) during the observation period. Large fluctuations were evident for postcodes within SSDs, and broad differences were evident between postcodes from different SSDs. The lowest rates of deliberate fires per person generally occurred in those areas experiencing lower overall vegetation fire frequencies, namely, Inner Melbourne, Eastern Middle Melbourne, Eastern Outer Melbourne and Southern Melbourne SSDs (Figure 23). Insufficient data were available within the MFB database alone to determine rates of deliberate vegetation fires in most postcodes in the Greater Dandenong and Yarra Ranges Shire SSDs. Even considering population differences, the highest rates of deliberate vegetation fires occurred in the Hume, Western, Northern Outer Melbourne and to a lesser extent Northern Middle Melbourne SSDs; that is, in those areas that experienced the highest total and deliberate vegetation fire frequencies.

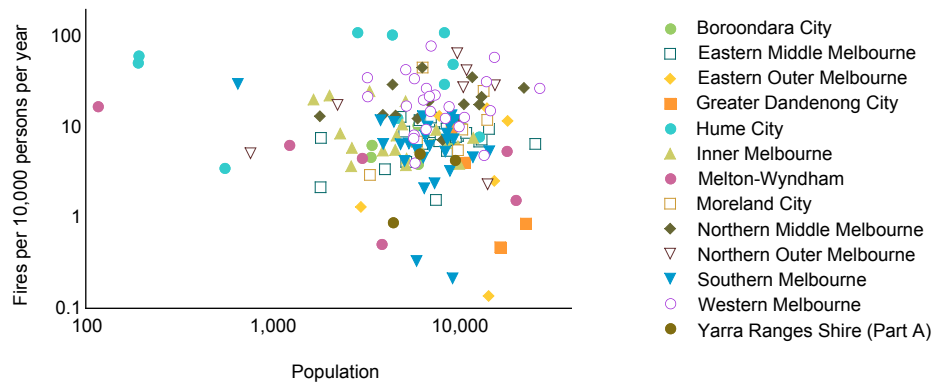
**Smoking-related vegetation fires:** One postcode recorded almost 30 smoking-related vegetation fires per year, 11 had 10 to 20, and 30 had five to 10. In contrast to both total and deliberate vegetation fires, there was comparatively little regional variation in the rate of smoking-related vegetation fires (Figure 24). Overall, individual postcodes recorded between 0.2 and 25 smoking-related vegetation fires per year: four postcodes had 20 to 25, 14 had 10 to 20, and 34 had five to 10 per 10,000 people.

**Figure 21: Vegetation fires and population by postcode, for individual SSD (number)**



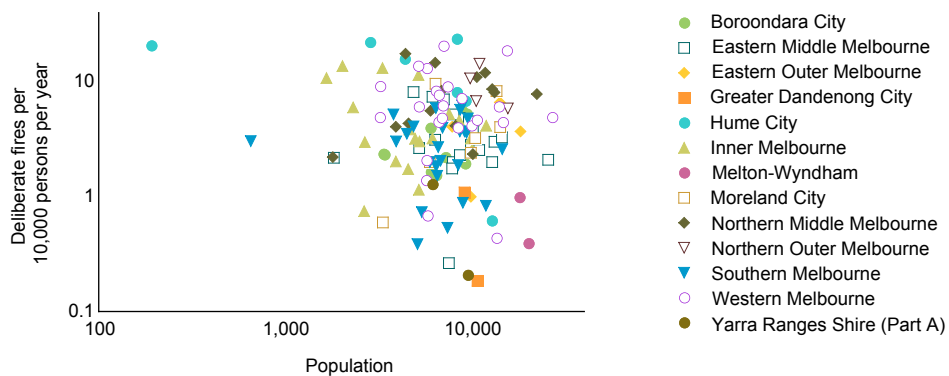
Source: MFB 1997–98 to 2001–02 [computer file]; ABS 2004. Population by post office area, 2001 [computer file]

**Figure 22: Vegetation fires per 10,000 people year, for individual postcodes, by SSDs (number)**



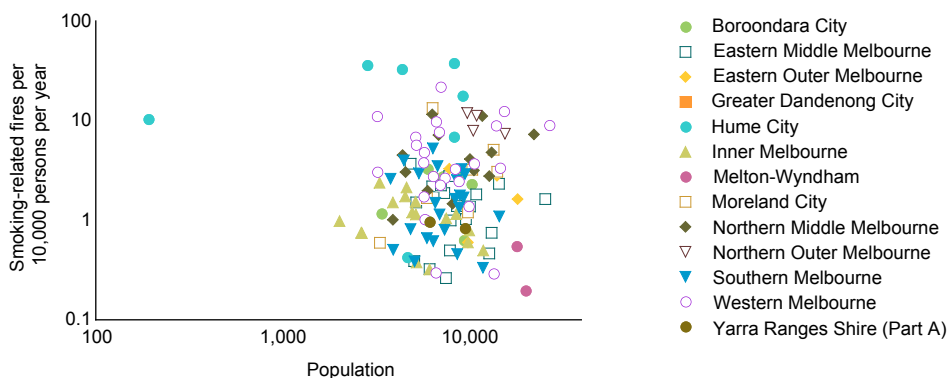
Source: MFB 1997–98 to 2001–02 [computer file]; ABS 2004. Population by post office area, 2001 [computer file]

**Figure 23: Deliberate vegetation fires per 10,000 people, for individual postcodes, by SSD (number)**



Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 24: Smoking-related vegetation fires, for individual postcodes, by SSD (number)**



Source: MFB 1997–98 to 2001–02 [computer file]; ABS 2004. Population by post office area, 2001 [computer file]

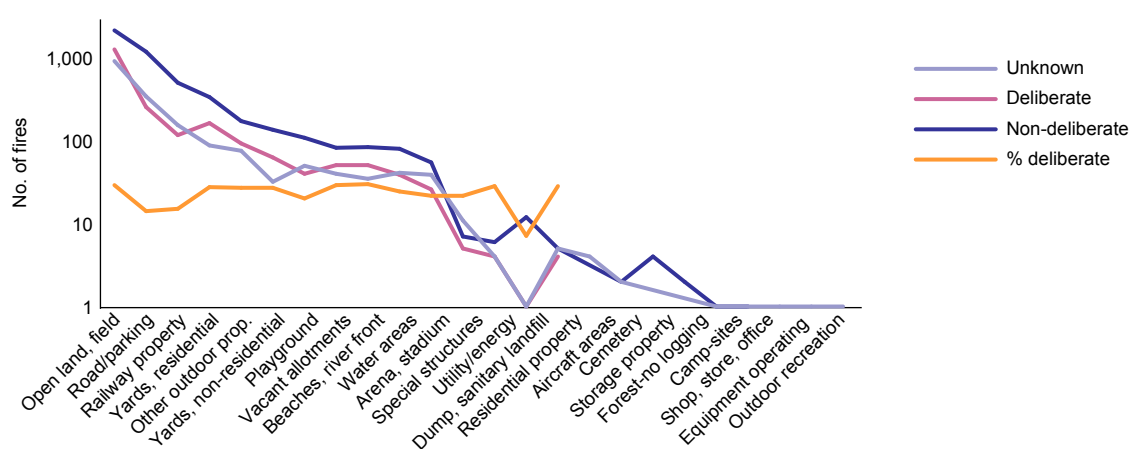
## Property use/complex

The following analysis examines the property use for fires generally and type of complex (grouping based on principal property use; see glossary for definition) where non-deliberate child fires occurred. These location details derive from existing categories with AIRS variables of the same name.

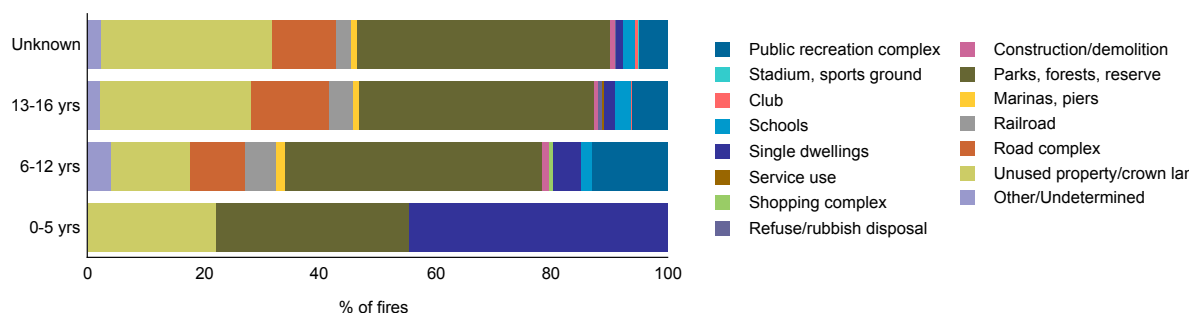
Most vegetation fires in the Melbourne metropolitan area occurred on open land and fields (35%), roads/parking complexes (31%) and railway property (12%; Figure 25). This general distribution was evident irrespective of cause. The percentage of deliberate vegetation fires was comparatively uniform (25 to 30%) across most areas that experienced more than 10 vegetation fires in five years, although somewhat lower rates occurred for roads/parking lots and on railway property, owing to higher contributions from accidental causes.

There was increasing complexity, with age, in the types of locations where children accidentally caused a vegetation fire. Notably, most fires lit by children in the 0 to 5 year age group occurred around homes (single dwellings), in parks, forests or reserves, and on unused property and Crown land (Figure 26). The proportions of vegetation fires lit at single dwellings decreased for older children. However, the proportion of non-deliberate child vegetation fires that occurred in parks, forests or reserves and on unused property and Crown land remained relatively stable. Six to 12 year olds in the Melbourne metropolitan district set a higher proportion of fires around public recreation complexes than did 13 to 16 year olds, but both groups lit more vegetation fires in that location than around a school. Unused property and Crown land featured more in fires lit by 13 to 16 year olds than for 6 to 12 year olds.

**Figure 25: Property use, by cause**



Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 26: Non-deliberate child fires, by age and, by complex<sup>a</sup> (percent)**

a: other/unknown includes fires lit at the following complexes care facility (1), religious use (3), communication (1), judicial/archival (1), child day care (1), apartments (4), military (1), industrial/manufacture (1), and warehouse/storage (1)

Source: MFB 1997–98 to 2001–02 [computer file]

## Timing

The timing of fires the MFB attended was examined by week of the year, day of the week, and time of the day.

### Week of the year

Most vegetation fires in the Melbourne metropolitan area occurred between mid November and late March, with the greatest numbers occurring near Christmas (Figure 27). This general pattern was present for both non-deliberate and deliberate fires. However, the temporal distribution of vegetation fires varied between bushfire danger seasons.

Typically, the number of vegetation fires peaked in early summer (near Christmas–New Year) and subsequently decreased over the remainder of summer and early autumn. In contrast, an unusually high number of vegetation fires occurred during late summer and autumn in 2000–01 (Figure 28). The peak number was also slightly later in 1998–99.

Overall, non-deliberate child vegetation fires defined three peaks in activity (Figure 29); one coincident with Christmas–New Year, one at week five (coincident with the start of the school year), and another at roughly week 10 (principally in 2001). No significant differences were evident between the timing of fires attributed to children of different ages, although there was a large increase in fires coincident with the start of the new school year for 13 to 16 year olds.

### Day of the week

Some 29 to 34 percent more incendiary and suspicious fires occurred on Saturdays or Sundays than on weekdays in metropolitan Melbourne, with marginally more fires occurring on Sundays than Saturdays (Figure 30). Approximately 10 percent more non-deliberate fires occurred on Saturdays than other weekdays.

Overall, children lit 10 percent more non-deliberate fires on Sunday and 22 percent more on Saturday than on other weekdays, but this relationship was not systematic. For example, the total number of non-deliberate child fires lit on Mondays was comparable to those lit on Sundays. The highest percentage of weekend fires occurred for the 13 to 16 year olds, with the number of fires on Sunday and Saturday

being 20 and 37 percent greater than on the average weekday (Figure 31). However, this group was also associated with a high number of fires on Wednesdays and to a lesser extent Tuesdays.

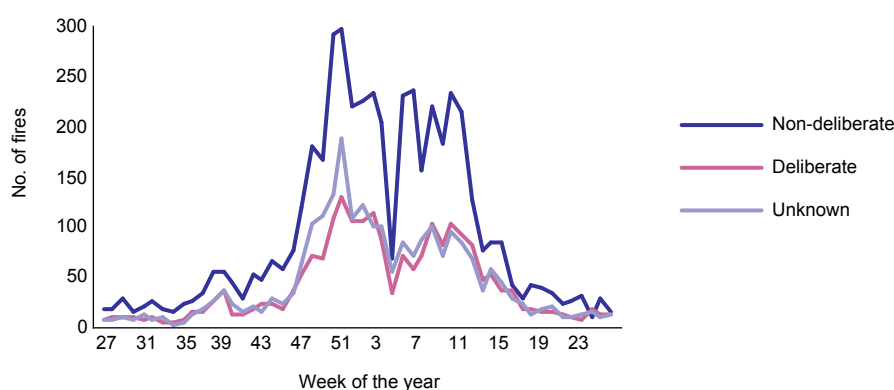
### Time of day

The time at which the alarm was raised was available for approximately 60 percent of MFB-attended vegetation fires. Most vegetation fires occurred during daylight hours, but markedly different distributions were evident for non-deliberate and deliberate vegetation fires. The peak in accidental vegetation fires occurred between 4 and 5 pm (Figure 32), somewhat later than in other jurisdictions. The distribution of deliberate fires was also unique. The frequency of deliberate fires increased from late morning onwards, reaching a maximum at around 5 to 6 pm, somewhat later than some other metropolitan centres. Also in contrast with other jurisdictions, the number of deliberately lit fires remained elevated until midnight, only decreasing in the early hours of the morning. Almost 60 percent of deliberately lit vegetation fires in the Melbourne metropolitan area occurred after 6 pm and before 6 am. The high proportion of fires lit between 6 pm and midnight, in particular, may relate to extended daylight during the summer months, including daylight saving.

A high number of vegetation fires in the Melbourne metropolitan area occurred between 6 pm and 6 am irrespective of the night of the week (Figure 33). The only notable differences between weekdays and weekends pertained to a greater number of vegetation fires between midnight and 4 am on Saturday and Sunday mornings, a finding consistent with that observed in most other metropolitan areas. Extended daylight hours may enable people to be outside in their neighbourhood to later hours, irrespective of the day of the week, thus reducing the distinction between weekends and weekdays. Alternatively, they may simply reflect social patterns that are specific to Melbourne and unrelated to such physical parameters.

The available data imply some differences in the timing of vegetation fires lit by children based on age (Figure 34), although some caution is needed in this interpretation due to the low proportion of cases where the age of the child was known. The vast majority of vegetation fires lit by children aged six to 12 occurred between midday and 10 pm, during daylight hours during summer, with the greatest number occurring between 4 and 6 pm. The number of vegetation fires occurring between 10 pm and 6 am was comparatively low. In contrast, the pattern for 13 to 16 year olds was remarkably similar to that for deliberate vegetation fires in general – fire numbers increased slowly from midday, reaching a maximum at roughly 6 pm, plateaued until midnight, and subsequently decreased. About 65 percent of all vegetation fires lit by 13 to 16 year olds occurred between 6 pm and 6 am, again similar to the general pattern. However, only 11 percent occurred between midnight and 6 am.

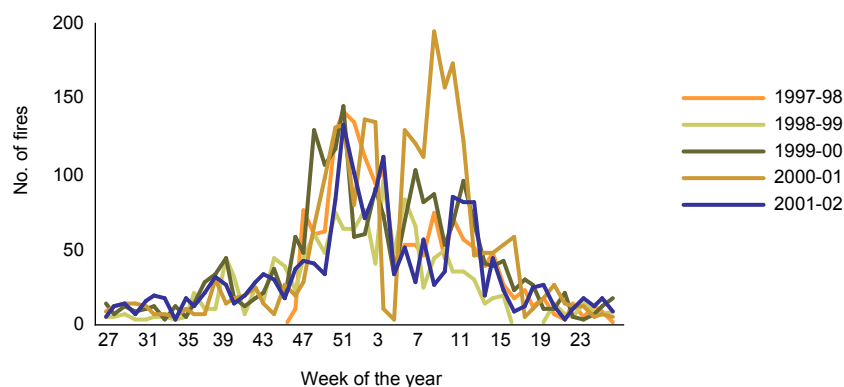
**Figure 27: Week<sup>a</sup> of the year, by fire cause (number)**



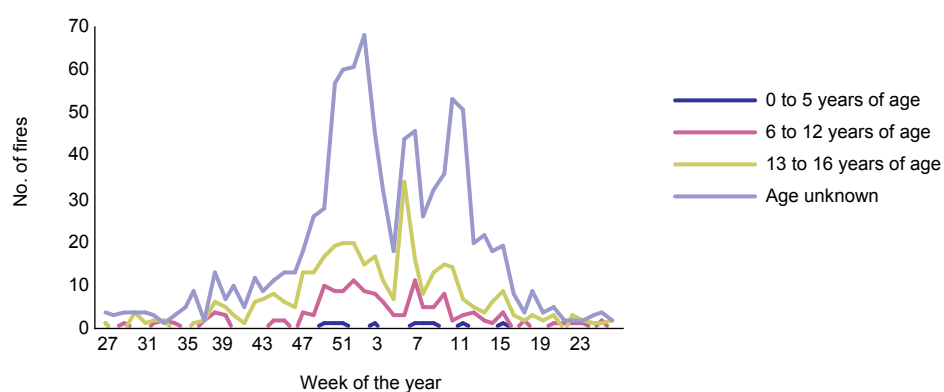
a: Week 1 = first week of January

Source: MFB 1997–98 to 2001–02 [computer file]

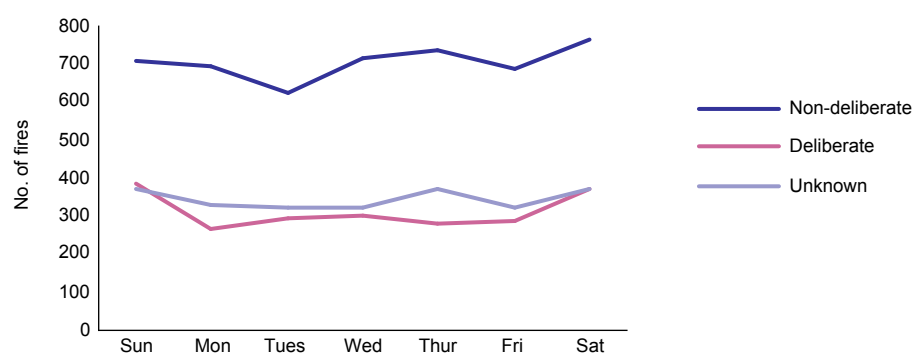


**Figure 28: All vegetation fires, by week of the year, for each year (number)**


Source: MFB 1997-98 to 2001-02 [computer file]

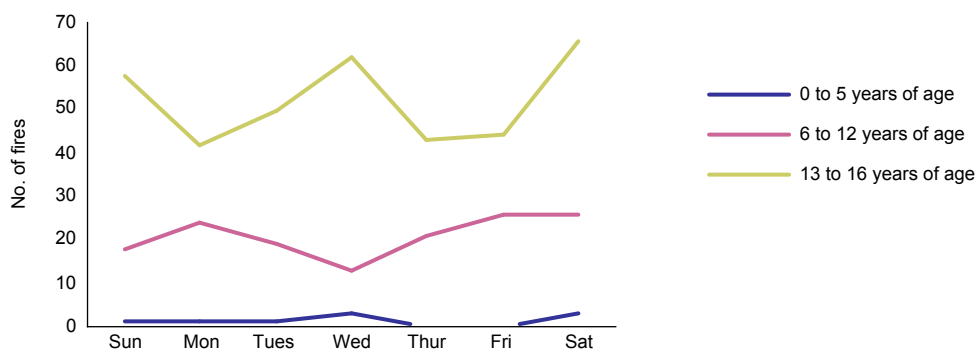
**Figure 29: Non-deliberate child fires lit, by week of the year, for individual age groups (number)**


Source: MFB 1997-98 to 2001-02 [computer file]

**Figure 30: Day of occurrence, by cause (number)**


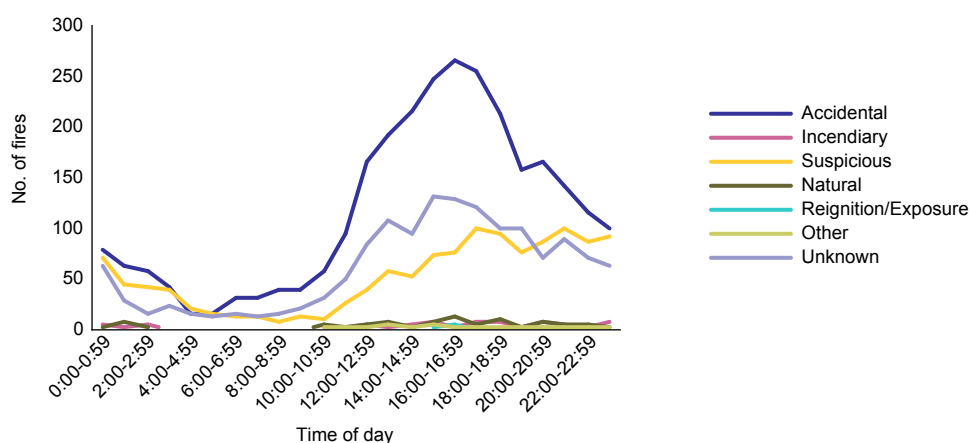
Source: MFB 1997-98 to 2001-02 [computer file]

**Figure 31: Day of occurrence of non-deliberate child fires (number)**



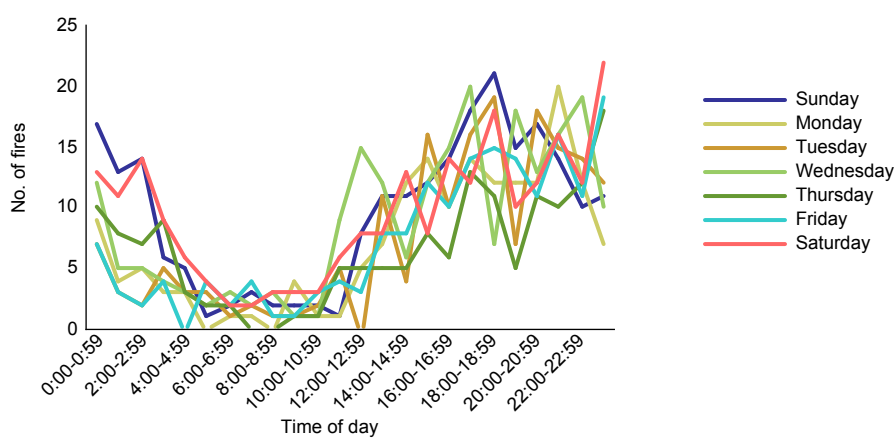
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 32: Time of day of alarm, by cause (number)**

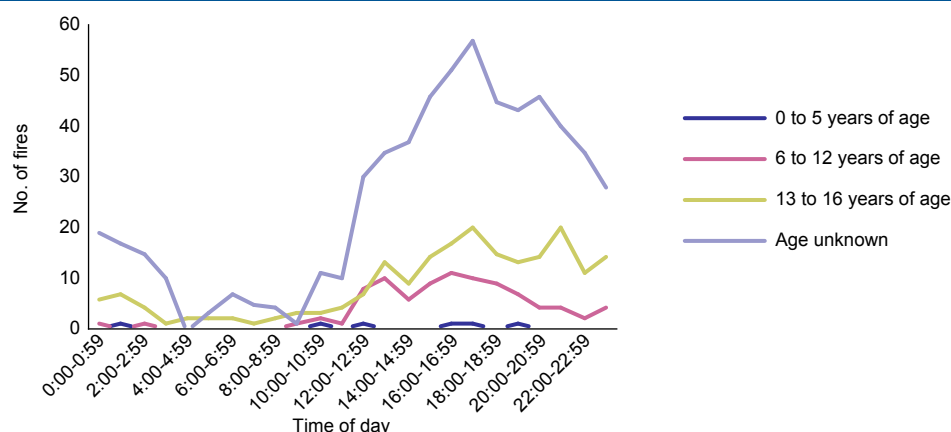


Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 33: Time of day of deliberate fires, each day (number)**



Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 34: Time of the day of non-deliberate child fires, by age group (number)**

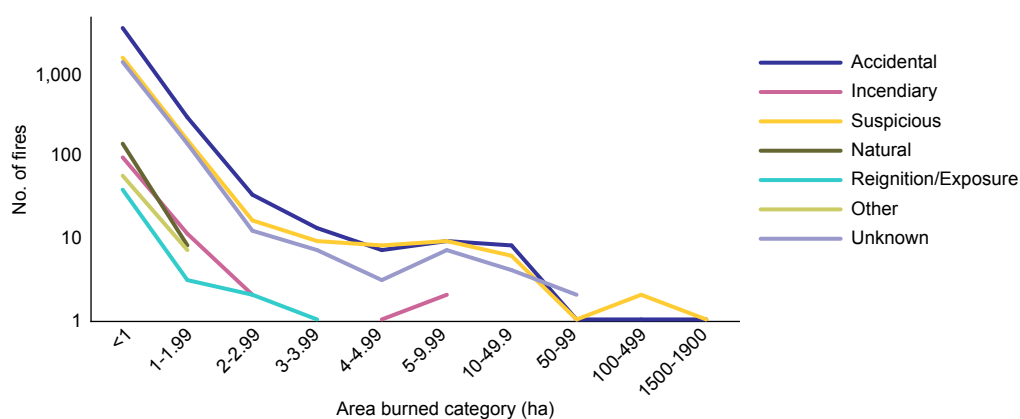
Source: MFB 1997–98 to 2001–02 [computer file]

## Area burned

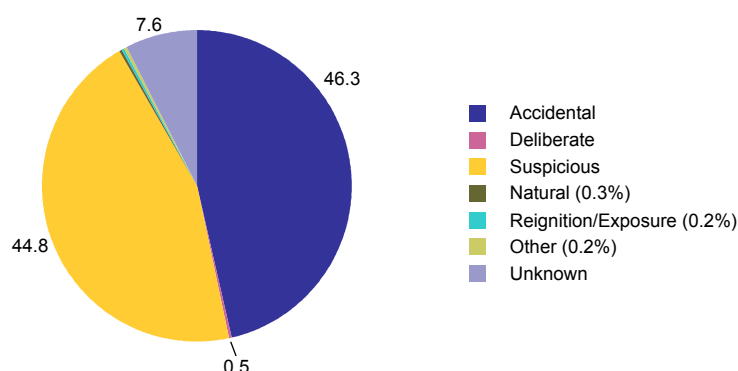
Overall, the number of vegetation fires declined sharply with increasing fire size, irrespective of cause (Figure 35; note that one fire listed as having burned 9,999 ha in inner Melbourne was considered to be in error and was deleted in this analysis). Ninety percent of fires the MFB attended were less than one hectare, and 98 percent were less than two hectares. The two largest fires were a fire of accidental causes that burned 1,945 ha in Northern Outer Melbourne in 2000–01 and a suspicious fire that burned 1,950 ha in Northern Middle Melbourne during the same year.

Approximately 5,800 ha of land was burned in the Melbourne metropolitan area in the five-year interval from 1997–98 to 2001–02. The two large vegetation fires outlined above dominated this total area. Incendiary and suspicious vegetation fires were responsible for 45 percent of the total area burned (Figure 36). A further 46 percent burned in accidental vegetation fires. Natural fires accounted for just 0.2 percent of the total area burned in metropolitan Melbourne. These trends are clearly different from those in regional Victoria, where large natural and accidental fires accounted for a high proportion of the large areas burned. Smoking-related fires burned 333 ha (6%) of the total area in fires the MFB attended.

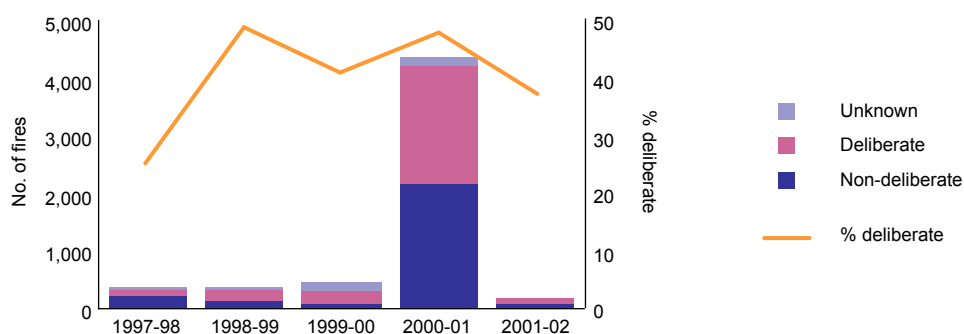
The overwhelming majority of the area burned was burned in 2000–01 (Figure 37). The greatest total area burned was in Melbourne's north, principally due to the two large fires.

**Figure 35: Area burned (ha) categories, by fire cause (number)**

Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 36: Total area burned by cause (percent)**


Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 37: Area burned, by cause (ha) and area burned by deliberate vegetation fires (percent), 1997–98 to 2001–02**


Source: MFB 1997–98 to 2001–02 [computer file]

## Type of incident

Almost two-thirds (62.8%) of all vegetation fires were classified as small vegetation fires, with 56.5 percent categorised as ‘small vegetation fire (less than one ha)’ (Figure 38). A further 1.9 percent and 4.4 percent, respectively, were classified as ‘small vegetation fire; not classified’ and ‘small vegetation fires; insufficient information to classify further’. Grassfires comprised 18.3 percent of all vegetation fires, with scrub/bush/grass mixtures accounting for a further 8.6 percent, and forest or woods (greater than one ha) 0.1 percent.

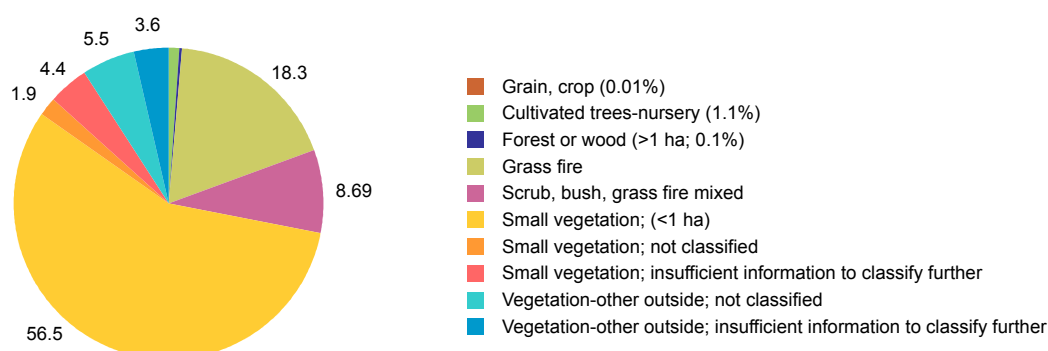
The proportion of each incident type varied slightly across Melbourne SSDs (Figure 39). Small vegetation fires (the three categories combined) formed the lowest percentage (53 to 57%) of vegetation fires in Boroondara City, Eastern Middle Melbourne, Melton–Wyndham, Southern Melbourne, Moreland City and Hume City SSDs. The highest percentage of small vegetation fires (67 to 68%) occurred in Northern Middle Melbourne, Yarra Ranges and Western Melbourne SSDs. Approximately 33 and 27 percent of vegetation fires in Melton–Wyndham and Hume City were grassfires, respectively. In contrast, grassfires comprised just six to seven percent of fires in the Yarra Ranges and Eastern Outer Melbourne. Despite these minor variations between SSDs, there was little evidence to suggest that vegetation fires in one part of the city were fundamentally different in character from those observed elsewhere.

Overall, the percentage of deliberate causes was similar (20 to 26%) across most incident types (Figure 40). The exceptions were cultivated tree/nursery ( $n = 109$ ) and grain/crop fires ( $n=1$ ), which had higher

and lower rates of deliberate fires, respectively. Neither could be regarded as a typical urban vegetation fire. The results showed that there was not a specific type of incident associated with deliberate fires; although a greater number of fires in urban areas were small vegetation fires there was not a higher probability that those fires were deliberately lit. An understanding of the inherent type of vegetation present in each area is needed to assess if it was merely a question of access that governed the proportion of small vegetation fires as compared to grass or forest fires.

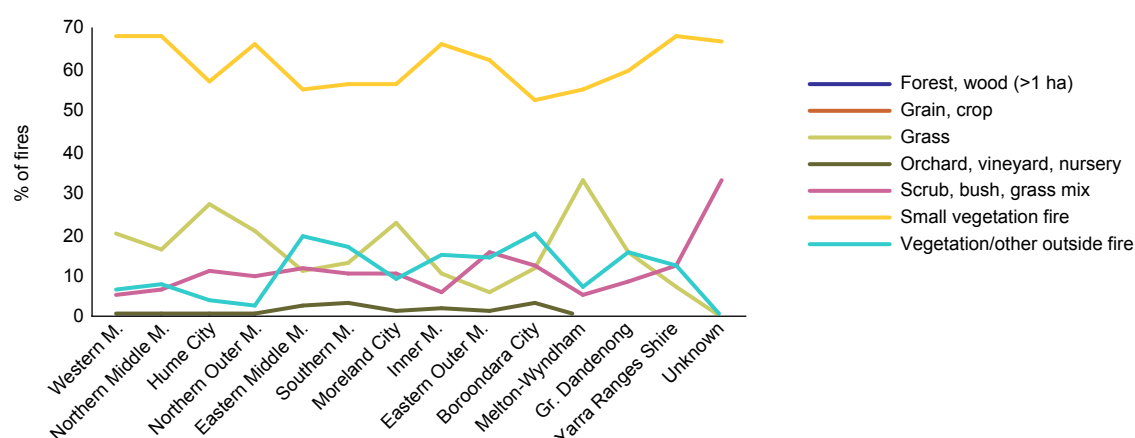
Based on the data provided, it was impossible to estimate the percentage of vegetation fires that were, or had the potential to manifest into, bushfires. However, there was significant positive correlation between the combined number of forest/wood, scrub/bush/grass mixed and grass fires (that is, vegetation fires that could be most reasonably constitute a bushfire) and the total number of vegetation fires ( $r=.96$ ;  $p < .01$ ; Figure 41). Even if most grass fires in the metropolitan area were unlikely to be bushfires, it was evident that the number of forest/wood and scrub/bush/grass fires combined, also increased with an increasing number of vegetation fires, although the relationship is better described by a second order polynomial expression ( $y = -3E-05x^2 + 0.1332x - 3.095$ ;  $r = 0.958$ ) than a linear function ( $r = .88$ ;  $p < .001$ ). The results imply that bushfires were likely to have been most frequent in areas characterised by the highest number of vegetation fires.

**Figure 38: Incident types (percent)**

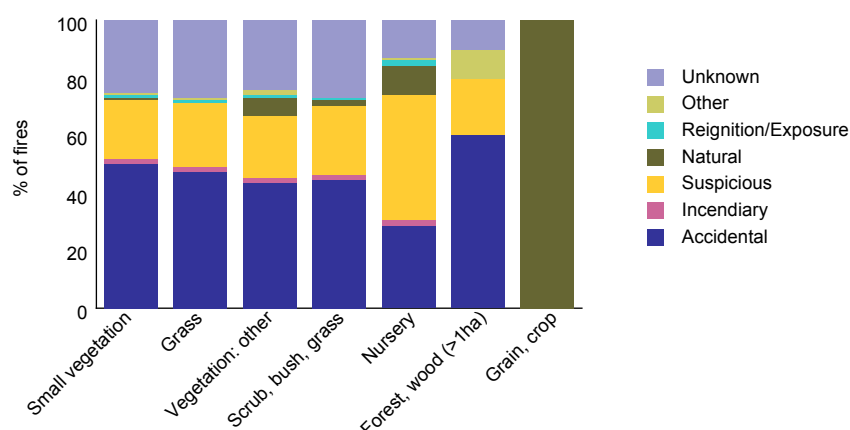


Source: MFB 1997–98 to 2001–02 [computer file]

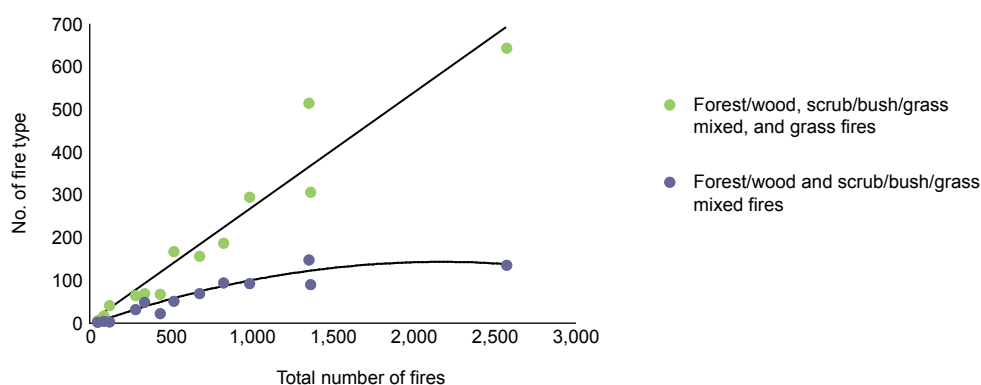
**Figure 39: Incident type by SSD (percent)**



Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 40: Incident type by cause (percent)**


Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 41: Relationship between incident type and number of vegetation fires (number)**


Source: MFB 1997–98 to 2001–02 [computer file]

## Fire danger rating

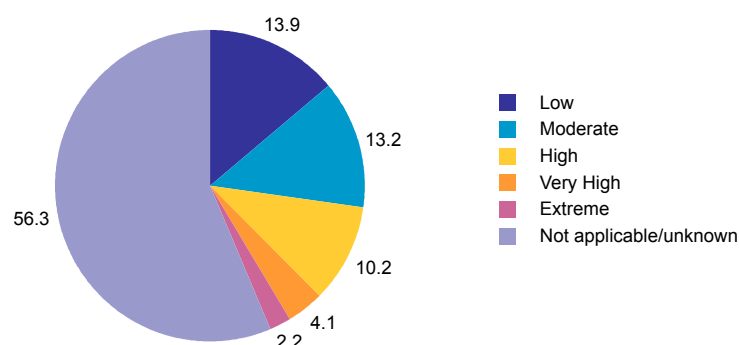
Fire danger rating relates to the likelihood of a wildfire developing, at a particular place, at a particular point in time. The MFB recorded the rating on the day each fire occurred in metropolitan Melbourne in 44 percent of cases (Figure 42). Overall, the percentage of vegetation fires assigned to each category decreased with increased fire danger (Figure 42); that is, fewer fires occurred under conditions of very high and extreme fire danger.

Differences were evident in the distribution of non-deliberate and deliberate vegetation fires between the low to extreme categories (Figure 43). The highest frequency of incendiary and suspicious fires was on moderate fire danger days and decreased with increasing fire danger weather. Overall, the frequencies of all vegetation fires decreased with increasing fire danger, but those that were deliberately lit decreased proportionately with increasing fire danger. They constituted 30 percent of vegetation fires occurring in moderate conditions but less than 20 percent occurring under extreme conditions. The proportion of vegetation fires resulting from an open flame (a high proportion of which were deliberate) decreased as the fire danger increased (Figure 44). Conversely, smoking-related fires made up a higher proportion of fires as the fire danger rating increased.

Although cases where the fire danger rating was documented varied (% known, Figure 45), the proportion of low versus moderate, high, very high and extreme fire danger rating was remarkably uniform across metropolitan Melbourne SSDs. The notable exception was the Melton–Wyndham SSD, where a higher proportion of vegetation fires occurred on high to extreme fire danger days. There was a trend for vegetation fires in the Southern Melbourne, Greater Dandenong City and Yarra Ranges Shire to occur during lower fire danger conditions. The MFB attended fewer fires in the Melton–Wyndham, Greater Dandenong and Yarra Ranges SSD, however, and combined MFB and CFA data are required to assess the accuracy of such trends.

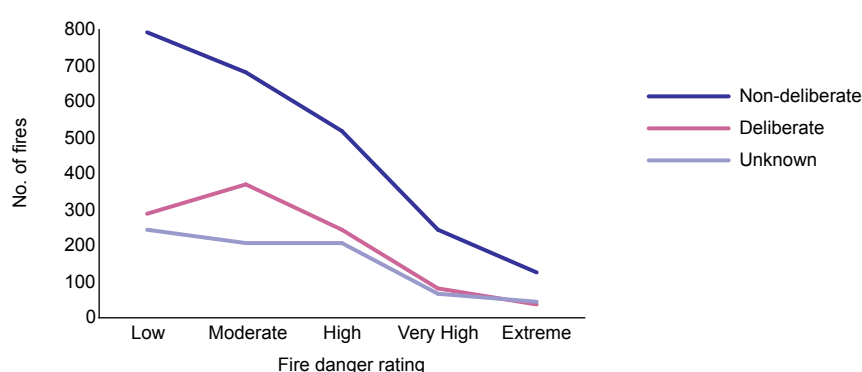
There was a close relationship between the location of deliberate vegetation fires on adverse fire danger days and their location generally. Notably, 84 percent of deliberate vegetation fires on very high fire danger days and 88 percent of deliberate fires on extreme fire danger days occurred in the four SSDs that recorded high numbers of deliberate vegetation fires generally; namely Western Melbourne, Northern Middle Melbourne, Hume City and Northern Outer Melbourne (Figure 46) and between 74 and 82 percent of deliberate vegetation fires during low to high fire danger conditions occurred in these SSDs.

**Figure 42: Fires by fire danger rating (percent)**



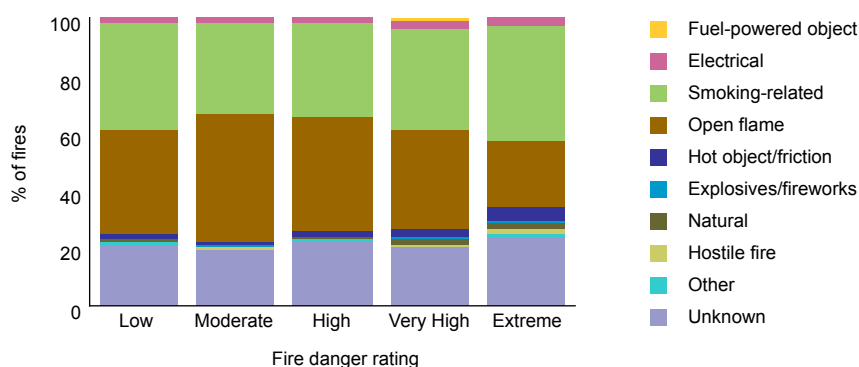
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 43: Fires by fire danger rating (number)**



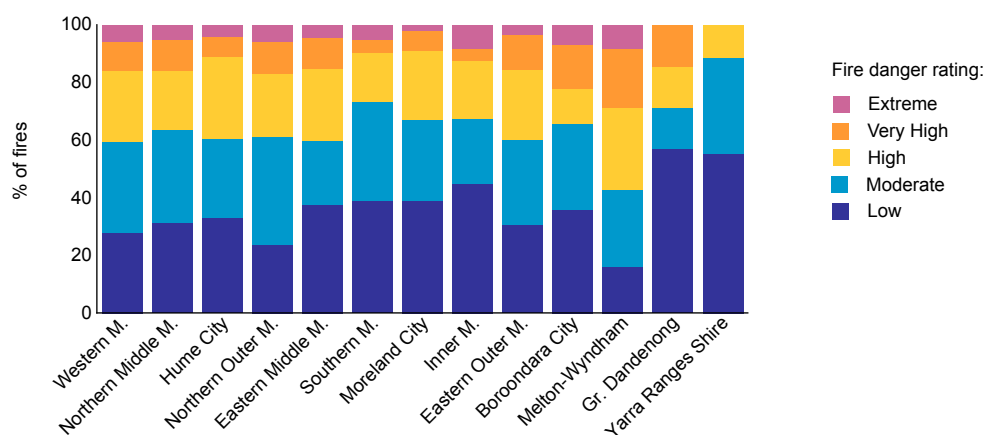
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 44: Fire danger category by form of heat of ignition (percent)**



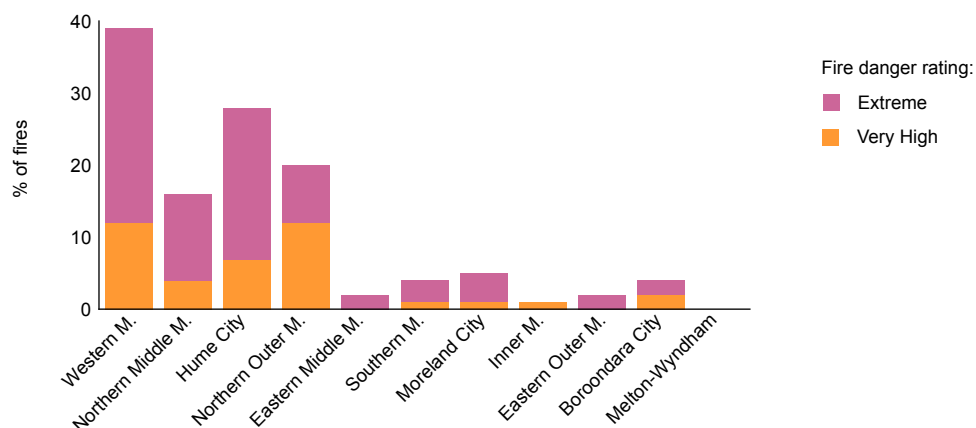
Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 45: Fire danger rating, by metropolitan Melbourne SSD (percent)**



Source: MFB 1997–98 to 2001–02 [computer file]

**Figure 46: Deliberate vegetation fires under very high and extreme fire danger ratings, by SSD<sup>a</sup> (number)**



a: SSDs are arranged in order of decreasing total fire frequency

Source: MFB 1997–98 to 2001–02 [computer file]



## Country Fire Authority

### Background information about the CFA dataset and its analysis

Important information about the Victorian Country Fire Authority dataset and the methodology employed to analyse it is outlined below:

- The data were sourced from the Victorian Country Fire Authority (CFA).
- The database used AIRS classification codes.
- The dataset only included vegetation fires (AIRS wildfires = Type of Incident code 160 to 179).
- The data included vegetation fires from 1999–2000 to 2003–04.
- Cause defined was based on the ignition factor variable.
- Deliberate vegetation fires were all vegetation fires classified as incendiary (AIRS ignition factor code = 110 or 120) or suspicious (AIRS ignition factor code = 210 or 220). It is important to recognise that:  
 the CFA does not use the term ‘deliberate’ in its data recording but uses the terms ‘suspicious’ and ‘incendiary’ in Ignition Factor (E5), or ‘malicious activity’ in Activity in Ignition Area (E3). ‘Deliberate’ is taken to have other interpretations, for example, when used by Police that cannot be assumed by fire investigators when recording Ignition Factor. The term is used in this report to simplify the analysis and is not intended to reflect CFA conclusions about the cause of fires (CFA, pers. com. 2007).
- Natural vegetation fires were defined on the basis of ignition factor codes 800 to 890, which included any natural condition or event: high wind (41.6%), lightning (46.2%), high water (including flood; 0.2%), and any other natural condition (NC/IO; 12.0%).
- Information on form of heat of ignition was not supplied.
- Smoking-related vegetation fires were classified on the basis of:  
 Ignition Factor = Abandoned, discarded material (Code = 310); hence all smoking-related fires were classified accidental in this analysis.
- All vegetation fires attributed to children and discussed in the text were classified accidental in origin; deliberate vegetation fires started by children were classified as incendiary or possibly suspicious and hence could not be identified in this analysis.
- The data included information on ‘type of incident’.
- Definition of regions was based on tourism regions defined by the Australian Bureau of Statistics (2005b). Assignment to tourism region was made from the postcode (not provided) that was derived from the suburb name (provided). There was not an exact concordance between the postcode and tourism regions. The ABS defines tourism regions based on smaller statistical areas. Hence, ABS tourism regions potentially crosscut suburbs and postcodes. In this study, assignment was based on the highest levels of concordance between postcodes and tourism regions; there was not an exact correspondence between tourism regions used in this analysis and ABS tourism regions.
- Statistical local areas (SLA) were defined using the ABS Postal Area to Statistical Local Area Concordance (ABS 2001b) based on the highest levels of concordance. Statistical subdivisions (SSD) were generated from these SLAs using the ABS standard geographical classification (ABS 2001a). Again, there was not an exact correspondence between SLAs and SSDs used here and ABS SLAs and SSDs.
- Area burned data were included.
- Information was available about the status of fire restrictions but not the fire danger index.

For more detail about these methodologies see the methodology chapter.

## Overview

Salient features of the CFA analysis can be summarised as:

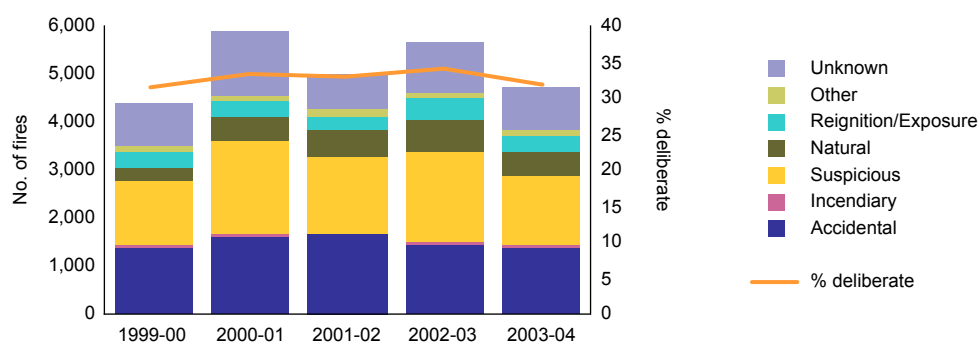
- The CFA attended 25,693 vegetation fires between 1999–2000 and 2003–04, on average, accounting for approximately two-thirds of all vegetation fires attended in Victoria each year. The number of vegetation fires remained relatively stable over the observation period, varying from 4,382 in 1999–2000 to 5,890 in 2000–01, with an average of 5,139 (sd=566; Figure 47). Although high fire frequencies occurred in 2002–03, they were marginally lower than in 2000–01.
- The fires occurred in a range of environments from the outer suburbs of metropolitan Melbourne, in and around major regional centres, to rural and remote locations. The CFA also helps the DSE fight fires on public lands; so many fires may be duplicated across these two agencies.
- The type of vegetation fire incidents attended varied from small vegetation fires in urban environments to large fires: 31.5 percent of incidents were small vegetation fires, 46.1 percent were grass fires, 8.9 percent were scrub/bush/mixed grass fires, 11.5 percent other vegetation and other outside fires (not classified or insufficient information to classify further), and 1.8 percent were forest or wood fires (greater than one ha).
- A total of 1,206,627 ha was burned in fires the CFA attended between 1999–2000 and 2003–04; of this, only 1.4 percent was by deliberate fires.
- Deliberate fires made up 32.9 percent of vegetation fires (40.5 percent of known causes), but were responsible for only 1.4 percent of the total area burned.

## Cause

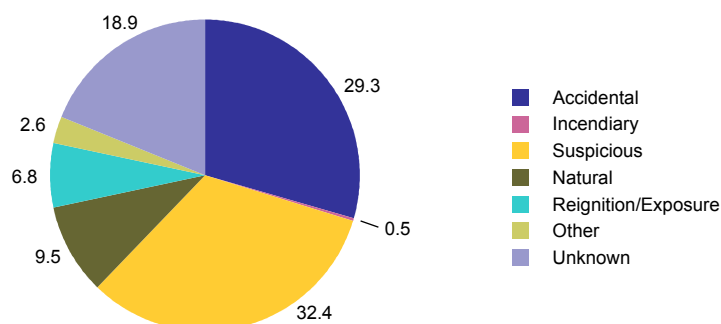
Incendiary causes were responsible for just 0.5 percent of vegetation fires, but a further 32.4 percent were suspicious in origin (Figure 48). Approximately one-third of all vegetation fires the CFA attended were deemed deliberate (incendiary and suspicious combined). A further 29 percent resulted from accidental causes, 10 percent were natural fires and 6.8 percent were from reignition or exposure. The cause of ignition in 19 percent of fires was unknown. Where cause was assigned, deliberate causes accounted for 40.5 percent of cases.

The number of deliberate vegetation fires ranged from 1,378 in 1999–2000 to 2,687 in 2002–03 (Figure 47). However, the proportion of deliberate fires remained stable during the five-year interval, varying between 31.4 percent in 1999–2000 and 34.3 percent in 2002–03 (Figure 47). The highest number of natural vegetation fires occurred in 2002–03 (n=643), followed by 2000–01 (n=515) and 2001–02 (n=508).

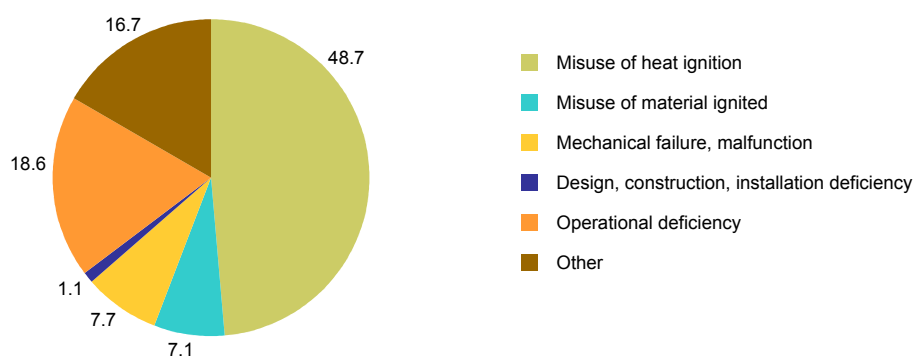
**Figure 47: Vegetation fires by cause (number), and deliberate vegetation fires (percent)**



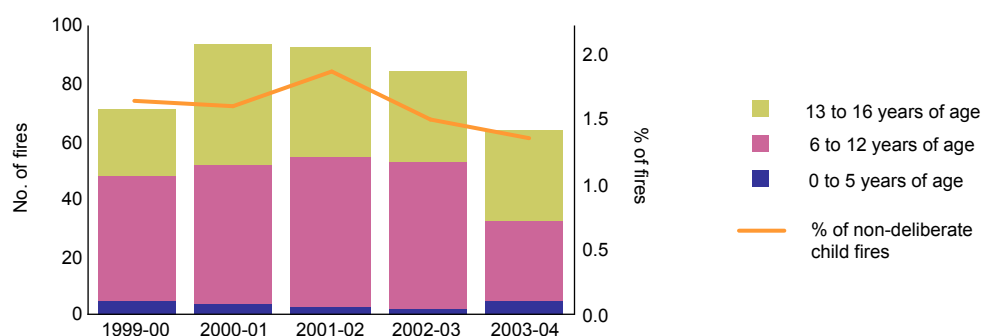
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 48: Cause of vegetation fires (percent)**

Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 49: Accidental fires by ignition factor (percent)**

Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 50: Non-deliberate child fires, by age group, annually**

Source: CFA 1999–2000 to 2003–04 [computer file]

### Specific ignition factors

**Ignition factor:** As the form of heat of ignition was not available, the following analysis can only be conducted on the ignition factor variable; it is therefore limited to non-deliberate fires.

Almost half the accidental vegetation fires resulted from misuse of heat of ignition (Figure 49). Inadequate control of an open fire accounted for 60 percent (n=2,259); abandoned or discarded

materials, 17 percent; children, 11 percent; and cutting and welding, six percent where the ignition factor was listed as misuse of heat of ignition.

Nineteen percent of accidental vegetation fires resulted from an operational deficiency. Of these, leaving a fire unattended accounted for half; spontaneous heating, 12 percent; and improper start-up-shutdown, 11 percent. Vegetation fires classified as 'Other' (in Figure 49) resulted exclusively from vehicles (AIRS code = 960). Vehicles (n=1,259) were the second most significant ignition factor, after inadequate control of open fire, in accidental fires; these were followed by leaving a fire unattended (n=698), and abandoned and discarded materials (n=639; 2.5% of all vegetation fires).

Natural fires may arise from a number of natural conditions or events (see methodology chapter). Only 46 percent of natural fires were indicated to be the result of lightning. Approximately 1,014 fires (42% of natural fires) were attributed to high wind. It is unclear to what extent this genuinely reflected 'natural' ignitions (for example, high winds responsible for power lines clashing) or if wind was an instigating factor in the escape of human-caused, fires such as burn offs (see below). If there was a high proportion of the latter, this analysis may have overestimated the actual proportion of natural fires and underestimated the proportion of accidental ignitions or other causes.

More than 98 percent (n=1717) of fires within the reignition/exposure category resulted from the re-kindling of previous fires; the remainder were the result of attached or separate exposure.

**Fires started by children:** The CFA attributed 406 vegetation fires to children less than 16 years playing (that is, non-deliberate fires) – only 1.6 percent of all fires the CFA attended in the five-year period. The number of deliberate fires started by children was unknown.

The highest number of non-deliberate child vegetation fires occurred in 2000–01 (n=94) and 2001–02 (n=93; Figure 50). In 2001–02, non-deliberate child fires comprised 1.9 percent of all fires, but both the number and proportion of non-deliberate fires decreased in the subsequent two years, with only 64 incidents (1.4% of all vegetation fires) in 2003–04.

Six to 12 year olds started 54 percent of non-deliberate child fires and children aged between 13 and 16 years lit another 41 percent. Only five percent of non-deliberate child fires resulted from fire-play by children five years or younger.

**Activity in the area:** The CFA was one of few agencies that recorded information about the 'activity in the area'. The following analysis provides a valuable perspective on factors that led to fires occurring, but also highlights fundamental difficulties in accurately recording and interpreting causal information.

Sixteen percent of vegetation fires were related to transportation (not off-road). This was the largest 'activity in the area' category (Figure 51). Commercial activities were associated with 14.3 percent of vegetation fires. The overwhelming majority of these were land-based practices such as agriculture. Burning rubbish accounted for 9.4 percent of fires; most of these resulted from the burning of waste heaps, rubbish and garden litter ('rubbish-waste, rubbish' in Figure 51). Recreational activities accounted for 2.2 percent, the majority from activities like camping and picnicking (including home barbecues) rather than hunting, fishing, shooting, hiking and sightseeing. Fuel reduction burning was associated with 5.3 percent of vegetation fires, with an additional 1.9 percent linked to 'land clearing, heaps or windrows etc.'. 'No activity/not applicable' accounted for a further 16 percent, and activity was not recorded in 13 percent of cases.

There is some relationship between the causal classification used elsewhere in this analysis (defined on the ignition factor alone), and the type of activity in the area, but no one-to-one correspondence. This is obvious from the fact that 'malicious activity' accounted for 16.9 percent of all vegetation fires (Figure 51), but incendiary and suspicious causes ignition factor codes were assigned in 32.9 percent of cases (Figure 48). Incendiary and suspicious fires can potentially be associated with many different activities. Apart from

incendiary and deliberate fires, malicious activity was most frequently associated with transportation, no activity/not applicable and activities not classified (Figure 52), accounting for 53, 17 and 32 percent of fires within these categories respectively. Although suspicious and, to a much lesser extent, incendiary fires accounted for just 5.9 percent of commercial land based activity fires, there were 202 such instances and this was the leading source of suspicious fires outside the categories outlined above. Deliberate fires also accounted for 50 percent of commercial water-based, 34 percent of outside-unclassified and 26 percent of commercial logging, forest activities, but the numbers of instances were low.

The converse is also the case; not all vegetation fires identified as malicious activity were classified as incendiary or suspicious within the ignition factor variable (only 89%). This reflects a number of different factors or situations. There were 144 instances (30%) of non-deliberate fires where malicious activity was implicated, in fires attributed to children (Table 2). According to AIRS guidelines, these should be classified as incendiary or suspicious. Approximately 35 percent of fires identified as non-deliberate child vegetation fires were probably malicious (incendiary or suspicious) in character. As noted previously, it is unclear how many other incendiary or suspicious fires were started by children.

There were some scenarios where the link between malicious activity and the ignition factor was not intuitive, for example cutting and welding, lightning or high wind. It was assumed, for the purpose of this analysis, that these did not represent errors, but genuinely reflected the intentions of the fire officer who documented that fire. For example, in the case of lightning, although there may have been reason to suspect malicious activity in the area, there may have been additional factors (known to the recording officer) that indicated lightning as being the most probable cause. In the case of cutting or welding, the officer may have considered specific factors relating to a case, for example, that the person did not take the necessary precautions (including during fire restrictions or total fire bans) when cutting or welding.

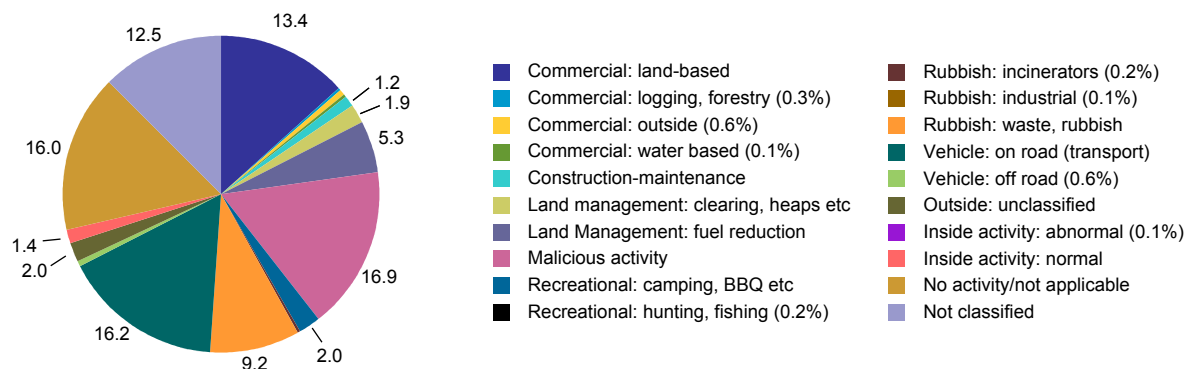
There are other instances where 'malicious activity in the area' is consistent with a deliberate origin. Examples include misuse of heat of ignition, misuse of material ignited, unattended fires, flammable liquid used, etc. In these instances, the fire may genuinely have been deliberate, but this was not indicated in the ignition factor variable. As the classification is based on the ignition factor code, such instances would not have been included in either the suspicious or incendiary categories in this analysis. Overall, malicious activity was associated with 115 accidental (excludes fires caused by children), seven natural, nine reignition/exposure, nine other causes, and 199 unknown cause fires (Table 2).

Such issues are also pertinent to other causal categories. Although many fires started by lightning strikes were coded as no activity/not applicable, there was also a considerable number that fell within other human-related activity categories, such as 'commercial land based' activity (Table 3). Not surprisingly, fires for which the ignition factor was listed as 'high wind' (42% of natural fires), were distributed across many human-related activities, being particularly associated with fuel reduction burns and burning of waste heaps, rubbish and garden litter. It is highly likely that many of the fires within the high wind category should have been classified as accidental as opposed to natural, and that the proportion of natural fires was overestimated. Some confusion arises as there were also fires attributed to lightning strikes that fell within these categories.

This discussion highlights that a classification based on neither the ignition factor nor the activity in the area is likely to enable an accurate assessment of fire causes. This is not a problem specific to the CFA, but is likely to be observed across all fire agencies; the CFA was the only agency for which both the activity in the area and the ignition factor code were available. A classification scheme that uses both components may prove valuable in the future. However, this approach may also encounter some difficulties, as it is problematic to assess how an officer classified fire attributes without being privy to detailed information about the fire. Moreover, such analysis would require more sophisticated and time-consuming analytical procedures. Modifications to the AIRS database to reduce confusion for officers coding the original fire data would assist subsequent analysis. Development of clear guidelines and

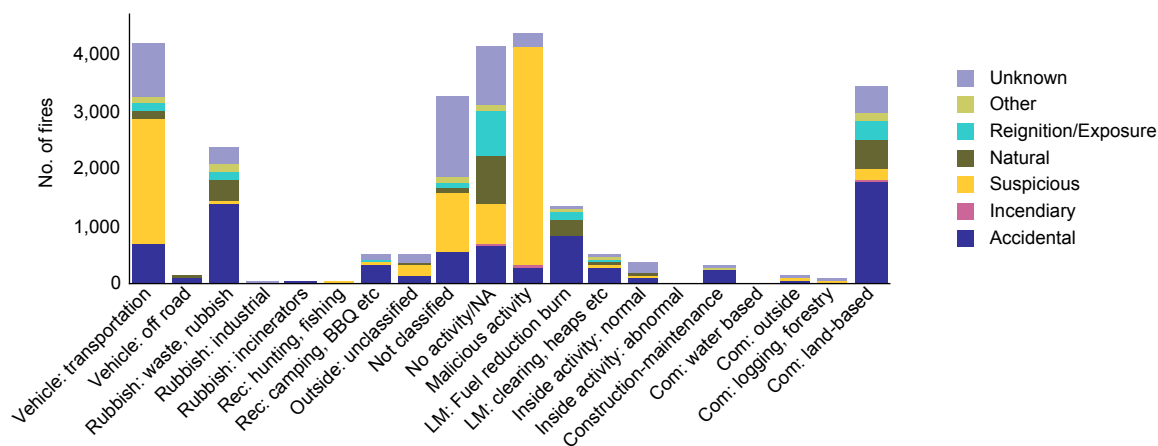
definitions and training modules may improve fire officers' accurate and consistent recording of fire documentation.

**Figure 51: Activity in the area, all vegetation fire causes (percent)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 52: Relationship between activity in the area and fire cause (number)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Table 2: Classification of cause of fire where activity in the area was identified as malicious**

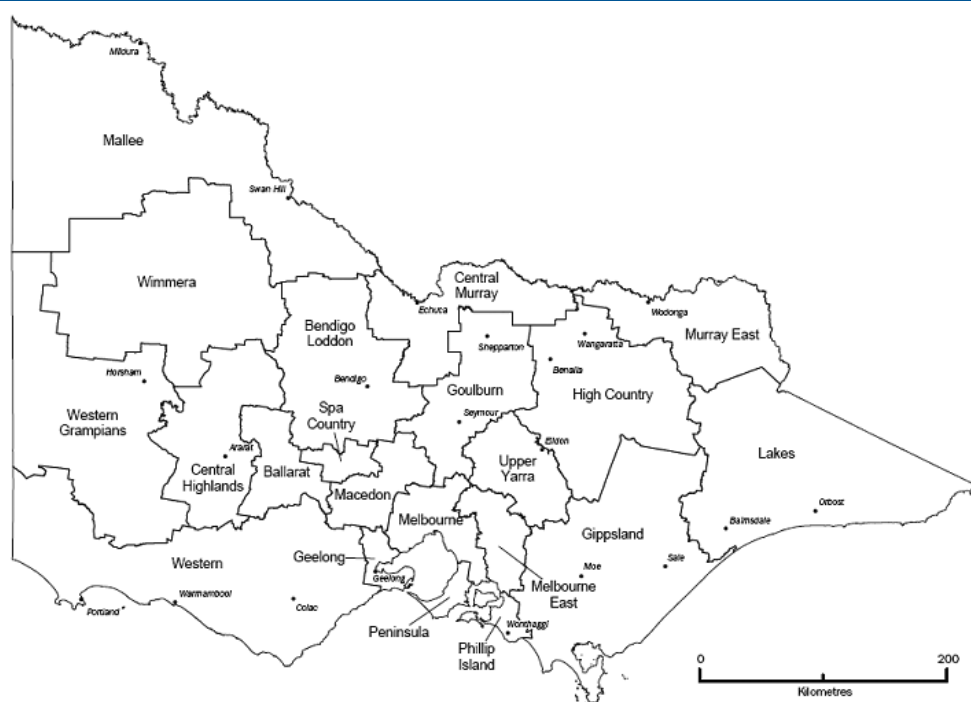
Ignition factor	Accidental	Incendiary	Suspicious	Natural	Reignition/Exp.	Other	Unknown
Children 0–5	4						
Children 6–12	75						
Children 13–16	65						
Mental impairment	2						
Vehicle	28						
Misuse – heat of ignition; insufficient info/not classified	28						
Misuse – material ignited; insufficient info/not classified	17						
Abandoned, discarded material	14						
Flammable liquid used to kindle fire	13						
Inadequate control of open fire	6						
Combustible, too close to heat	2						
Spontaneous heating	2						
Cutting, welding	1						
Fuel spilled, released accidentally	1						
Other electrical failure	1						
Part failure, leak etc	1						
Unattended	1						
Incendiary		48					
Suspicious			3,804				
Lightning				6			
High wind				1			
Re-kindled					9		
Other ignition factor						9	
Ignition factor – Not determined							193
Ignition factor – Not applicable							6
<b>(Total)</b>	<b>(261)</b>	<b>(48)</b>	<b>(3,804)</b>	<b>(7)</b>	<b>(9)</b>	<b>(9)</b>	<b>(199)</b>

Source: CFA 1999–2000 to 2003–04 [computer file]

**Table 3: Relationship between activity in the area and ignition factor for vegetation fires attributed to natural causes**

Activity in area	High water	High wind	Lightning	Natural – not classified	Natural – insufficient information	Total
Commercial – land based		155	302	62	11	530
Commercial – logging, forestry		12	10	2		24
Commercial – outside		1	9	1		11
Commercial – water based			1			1
Construction – maintenance		2		4		6
Land Management – clearing, heaps etc.		53	1	10	2	66
Land Management – fuel reduction burn		221	1	42	10	274
Malicious activity		1	6			7
Recreational – camping, barbecue, etc.		12	5	6		23
Recreational – hunting, fishing		1				1
Rubbish – incinerators		3		2		5
Rubbish – industrial				1	2	3
Rubbish – waste, rubbish	4	328		30	4	366
Vehicle – transportation		59	59	20	6	144
Vehicle use – off road		1	1	1		3
Outside – unclassified		4	12	1		17
Inside activity – abnormal			2			2
Inside activity – normal		4	15	9	3	31
No activity	1	142	638	31	10	822
Not classified		15	62	14	8	99
(Total)	(5)	(1,014)	(1,124)	(236)	(56)	(2,435)

Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 53: Tourism regions of Victoria**Source: Canberra: ABS 2005b  
© Australian Bureau of Statistics



## Location

Information about the location of fires is discussed in relation to the region in which the fire occurred, the density of fires at a postcode level, and the area of origin of the fire.

## Region

The regions used in the analysis of CFA fires were based on the Victorian tourism regions, as defined by the Australian Bureau of Statistics for 2005 (Figure 53; ABS 2005b). The greatest number of CFA vegetation fires occurred in the Melbourne region ( $n=4,699$  in five years), followed by the Gippsland, Bendigo–Loddon, Peninsula, Melbourne East, Goulburn and Western regions (Figure 54). The lowest frequencies occurred in Upper Yarra, Phillip Island, and the Spa Country. Overall, the greatest number of vegetation fires occurred in those regions with high populations, principally within or neighbouring the metropolitan centre of Melbourne or in regions containing major regional urban centres. The predominant causes of vegetation fires varied substantially between regions.

Overall, there was significant positive correlation ( $r=.95$ ;  $p<.001$ ) between the number of deliberate vegetation fires and the number of vegetation fires in each region (Figure 55). That is, there was a strong tendency for the number of deliberate vegetation fires to increase with increases in the total number of vegetation fires.

Nevertheless, the actual percentage of deliberate vegetation fires varied between 0 and 54 percent (Figure 54). The lowest percentage of deliberate vegetation fires occurred in the Wimmera and Western Grampians regions, the highest percentage occurred in the Geelong (54%), Melbourne (49%), Peninsula (48%), Ballarat (42%) and Bendigo–Loddon (37%) regions. The highest proportion of deliberate fires tended to occur in those regions that had moderate to high numbers of fires, but no direct correlation existed between the percentage of deliberate lightings and number of deliberate fires ( $r=.66$ ;  $p<.01$ ), principally because of the localised and differential impact of natural and accidental fires.

The greatest number of natural fires (including lightning strikes, high wind, high water, etc.) occurred in the Gippsland region, followed by the Western, Goulburn, Melbourne East, High Country, Western Grampians and Bendigo–Loddon regions (Figure 54). However, the highest proportion of natural fires (20 to 30%) occurred in the Western Grampians, Murray East, and Lakes regions (Figure 56). Overall, there was a tendency for natural fires to account for a higher proportion of vegetation fires in regions with comparatively lower total vegetation fire frequencies, and a low frequency of deliberate fires. Accidental fires formed the highest proportion of vegetation fires in the Wimmera, Central Murray and High Country regions.

The greatest number of non-deliberate child vegetation fires occurred in the Melbourne, Bendigo–Loddon, Peninsula, Gippsland, and Goulburn regions (Figure 57). Non-deliberate child vegetation fires made up a greater proportion ( $>2\%$ ) of fires in the Bendigo–Loddon, Central Murray and Grampians regions than in the Melbourne, Gippsland, Melbourne East and Western regions ( $<1.5\%$ ). Six to 12 year olds were responsible for a high proportion of non-deliberate child vegetation fires in the Ballarat and Western Grampians regions, whereas in the Geelong region, 13 to 16 year olds were the greatest contributors.

**Table 4: Total number of postcodes with vegetation fires and deliberate fire frequencies within the specific ranges**

Region	Melb.	Gippsland	Bendigo Loddon	Peninsula	East Melb.	Goulburn	Western	Geelong	Central Murray	High Country	Ballarat
No. postcodes recording a fire	81	49	28	29	45	29	66	15	29	25	9
<b>No. postcodes where the total number of fires were in the following ranges:</b>											
>299	3	–	1	–	–	1	–	1	–	–	1
200–299	3	3	3	2	–	–	1	–	1	2	1
100–199	8	1	–	5	5	5	2	2	1	1	1
50–99	14	9	5	6	6	6	4	3	4	2	2
25–49	16	12	9	7	15	7	14	7	8	5	2
0–24	37	24	10	9	19	10	45	2	15	15	2
<b>No. postcodes where the number of deliberate fires were in the following ranges:</b>											
>199	1	–	1	–	–	–	–	1	–	–	–
150–199	3	–	–	2	–	1	–	–	–	–	1
100–149	1	2	2	1	–	–	–	–	–	–	–
50–99	10	1	–	2	1	1	1	3	1	1	3
25–49	11	–	2	4	5	4	3	1	1	2	–
>0 & <25	43	37	18	17	30	18	45	10	24	16	4
No. postcodes recording a deliberate fire	69	40	23	26	36	24	49	15	26	19	8
% Deliberate	49.2	24.9	36.9	48.4	25.3	28.6	22.4	53.6	17.8	19.2	42.4

**Table 4: Total number of postcodes with vegetation fires and deliberate fire frequencies within the specific ranges (continued)**

Region	Mallee	Macedon	Murray East	Western Grampians	Lakes	Wimmera	Central Highlands	Spa Country	Phillip Island	Upper Yarra	Total
<b>All vegetation fires</b>											
No. postcodes recording a fire	33	19	16	20	23	26	9	5	10	11	577
<b>No. postcodes where the total number of fires were in the following ranges:</b>											
>299	–	–	–	–	–	–	–	–	–	–	7
200–299	–	–	–	–	–	–	–	–	–	–	16
100–199	1	3	2	1	1	–	1	1	1	–	42
50–99	5	2	2	3	2	1	2	2	1	3	84
25–49	2	5	3	3	1	6	2	2	2	1	129
0–24	25	9	9	13	19	19	4	–	6	7	299
<b>No. postcodes where the number of deliberate fires were in the following ranges:</b>											
<b>Deliberate vegetation fires</b>											
>199	–	–	–	–	–	–	–	–	–	–	3
150–199	–	–	–	–	–	–	–	–	–	–	7
100–149	–	–	1	–	–	–	–	–	–	–	7
50–99	1	1	–	–	1	–	–	–	1	–	28
25–49	2	1	–	–	–	1	1	3	–	–	41
>0 & <25	22	15	14	12	12	13	5	2	7	9	373
No. postcodes recording a deliberate fire	25	17	15	12	13	14	6	5	8	9	459
% Deliberate	29.9	18.1	26.1	10.2	20.2	12.5	18.0	30.3	32.2	0.0	32.9

Source: CFA 1999–2000 to 2003–04 [computer file]

## Postcode–suburb

Considerable heterogeneity existed in the density of vegetation fires generally, and the density of deliberate vegetation fires, specifically, within suburbs and postcodes in individual regions; the rate observed at a regional level did not necessarily reflect that occurring in a specific suburb.

**All vegetation fires:** Seven postcodes recorded in excess of 300 vegetation fires in five years (Table 4). Of these, three were in the Melbourne region and one each in the Bendigo–Loddon, Geelong, Ballarat and Goulburn regions (Figure 58), concentrated in those regions with the greatest total fire frequencies. These regions incorporate either metropolitan areas or a major regional centre. A further 16 postcodes recorded 200 to 299 fires, and 42 postcodes had 100 to 199 fires in five years.

A small number of postcodes contained a disproportionate number of vegetation fires. Almost one-third of vegetation fires the CFA attended occurred in the 23 postcodes that recorded in excess of 200 vegetation fires in five years. Almost half of all vegetation fires occurred in the 65 postcodes that recorded in excess of 100 vegetation fires in five years.

However, the extent to which vegetation fires were concentrated within specific postcodes varied markedly between regions. For example, in the Ballarat region 75 percent of vegetation fires occurred in the three postcodes that recorded in excess of 100 vegetation fires in five years, whereas in the Central Murray and Western regions, only 26 to 27 percent of vegetation fires occurred in the two or three postcodes that recorded 100 or more vegetation fires in five years. These differences likely reflect the variables of:

- size of the region
- number of postcodes within a region
- population densities and distributions within those regions.

For example, the large regional urban centre of Ballarat dominated the Ballarat region, with high population densities both within the city itself (approximately 90,000 people) and within the neighbouring semi-rural areas. Echuca (population approx. 10,000), the largest urban centre in the Central Murray region, lies within a principally agricultural region. The Western region is one of the largest regions in the state; the largest urban centres are at Warrnambool (pop. 32,000), Hamilton (pop. approx. 9,200), Portland (pop. approx. 12,000) and Colac (pop. approx. 14,000).

Overall, regions more distant from the metropolitan centre, with low population densities and few urban centres, have fewer vegetation fires, and although a single location (urban centre) may record a comparatively high number of vegetation fires (for example, greater than 100 vegetation fires in five years), the overwhelming majority of vegetation fires are sparsely distributed across many different postcodes. For example, in the Wimmera region, 64 percent of vegetation fires occurred in the 26 postcodes that recorded fewer than 25 vegetation fires in five years.

**Deliberate vegetation fires:** Commonly, 80 percent of postcodes within a region that experienced a vegetation fire of any cause also experienced at least one deliberate fire. However, in the Western Grampians, Lakes, Wimmera and Central Highlands regions only 50 to 60 percent of postcodes that experienced a vegetation fire documented a fire of deliberate origin.

The distribution of deliberate vegetation fires, as for vegetation fires generally, was highly variable both within and across regions (Figure 59). For example:

- Three postcodes in Victoria, in the Bendigo Loddon, Geelong and Melbourne regions, recorded in excess of 200 deliberate vegetation fires in five years. Approximately 10 percent of deliberate vegetation fires the CFA attended occurred in these three postcodes.

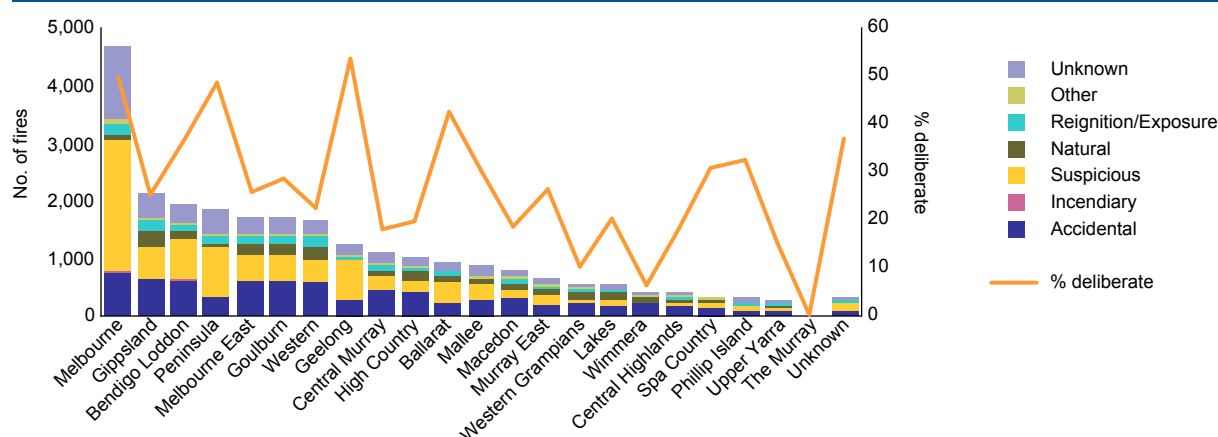
- A further seven postcodes recorded 150 to 199 deliberate vegetation fires. These postcodes, located in the Melbourne (three postcodes), Peninsula (two postcodes), Goulburn (one postcode) and Ballarat (one postcode) regions, accounted for 15 percent of deliberate CFA-attended vegetation fires.
- Another seven postcodes recorded 100 to 149 deliberate vegetation fires, of which two each occurred in the Gippsland and Bendigo–Loddon regions, and one each occurred in the Melbourne, Peninsula and Murray East regions. These seven postcodes accounted for 10 percent of deliberate vegetation fires.
- The 17 postcodes recording 100 or more deliberate fires accounted for one-third of deliberate vegetation fires the CFA attended in Victoria. These 17 postcodes represented less than three percent of all postcodes in Victoria (within the CFA's jurisdiction) to have recorded a vegetation fire of any type.

It is evident therefore, that regions with large population centres and high population densities were characterised by the highest numbers of deliberate vegetation fires (these include Melbourne, Geelong, Ballarat and Bendigo; Figure 59). A high proportion of deliberate vegetation fires within those regions tended to be associated with major urban centres.

Even in areas where low numbers of deliberate vegetation fires occurred, there tended to be a concentration of deliberate fires within specific postcodes, principally postcodes encompassing the major urban centre(s) in the region. For example, two-thirds of deliberate vegetation fires in the Murray East region occurred in the single postcode that encompasses the regional centre of Wodonga. Forty-six percent of vegetation fires in the Lakes region occurred in the postcode that encompasses Bairnsdale and Hillside. Forty-two percent of deliberate vegetation fires in the Central Highlands region occurred in the postcode that encompasses Ararat, even though the total number of deliberate vegetation fires in fire years in that postcode did not exceed 30 deliberate vegetation fires in five years.

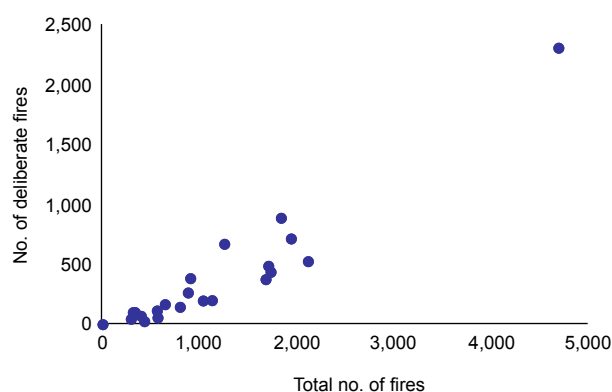
It is evident from Figure 59 that a greater proportion of fires in a region were deliberate, if that region incorporated one or more postcodes with very high numbers of deliberate fires. This reflects the tendency, at a suburb level, for the percentage of deliberate vegetation fires to increase with increasing numbers of deliberate vegetation fires (Figure 60). Greater numbers of deliberate vegetation fires typically occurred in urban areas. This could lead to a disparity in the rates of deliberate fires between urban and rural areas in the same region. For example, 47 percent of vegetation fires in Wangaratta (urban centre) were deliberately lit, compared with a region-wide value of 19 percent. It follows that the average rates of deliberate vegetation fires in areas outside of Wangaratta were actually lower than 19 percent. This example illustrates how differences in population densities generate disparities between regions, as the concentration of urban environments varies markedly across the state.

**Figure 54: Fire cause, by region**



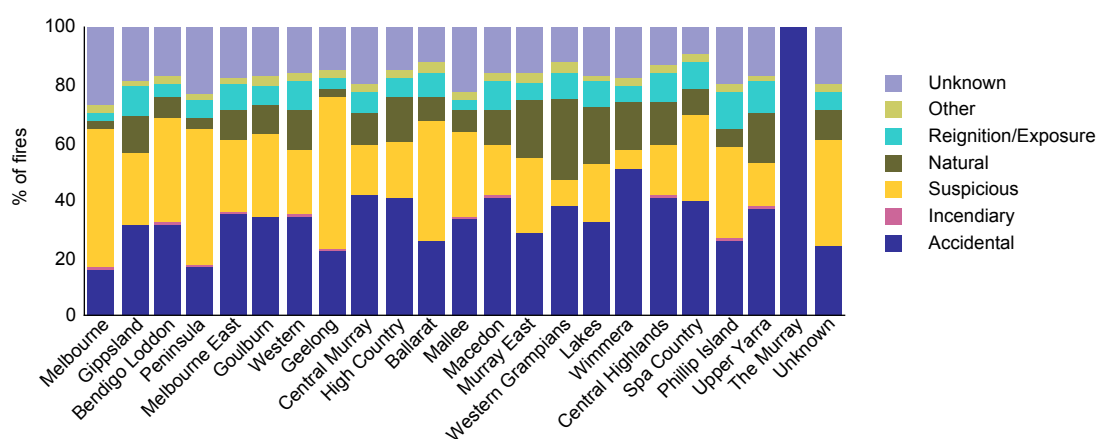
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 55: Relationship between number of vegetation fires and number of deliberate vegetation fires (number)**



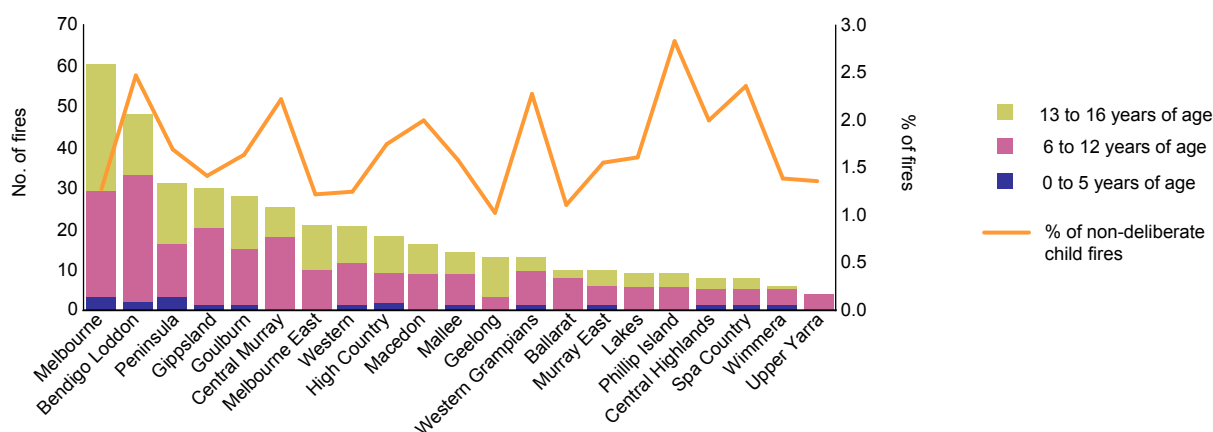
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 56: Fire cause, by region (percent)**



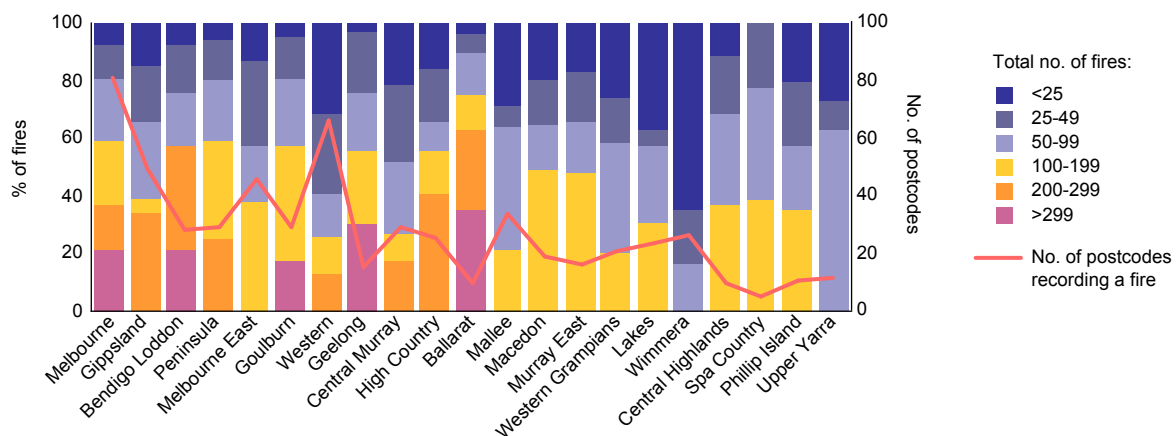
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 57: Non-deliberate child fire, by age and, by region (number)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 58: Percentage of all fires that occur within postcodes within a region that record total vegetation fires within the documented ranges<sup>a</sup>, by region<sup>b</sup>**

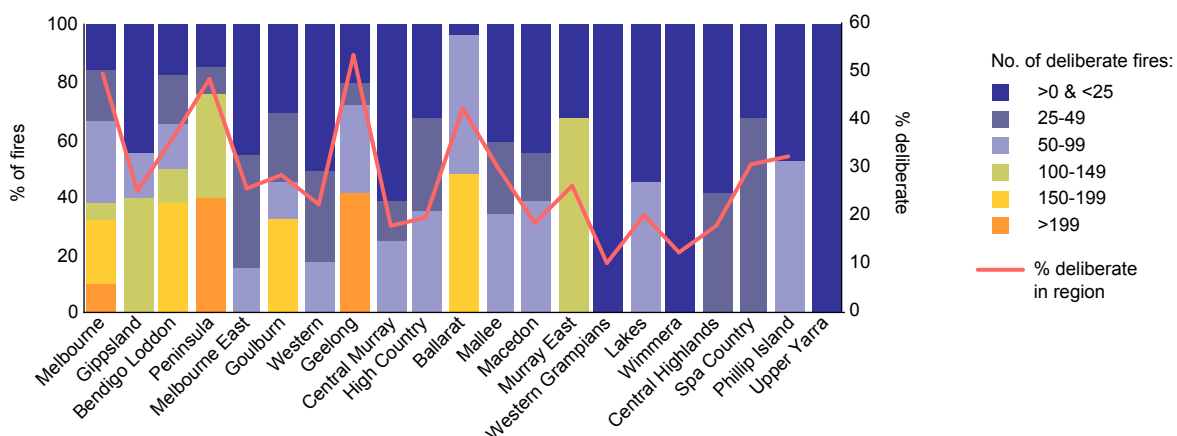


a: frequency ranges are based on total fire frequencies experienced over five-year interval

b: regions arranged in order of descending total fire frequency

Source: CFA 1999–2000 to 2003–04 [computer file]

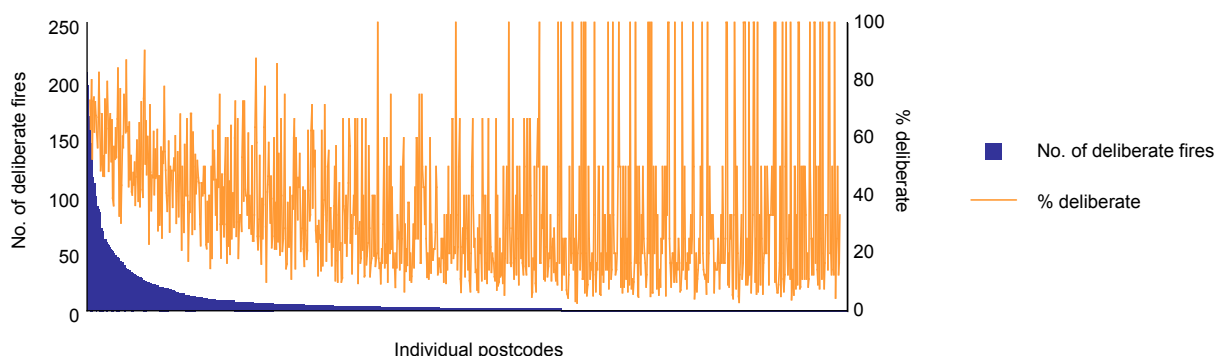
**Figure 59: The percentage of deliberate fires within a region that occurred within postcode that recorded deliberate fires within the documented ranges<sup>a</sup>, by region<sup>b</sup>**



a: frequency ranges are based on deliberate fire frequencies experienced over five-year interval

b: regions arranged in order of descending total fire frequency

Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 60: Number and percentage of deliberate fires in individual suburbs<sup>a</sup>**


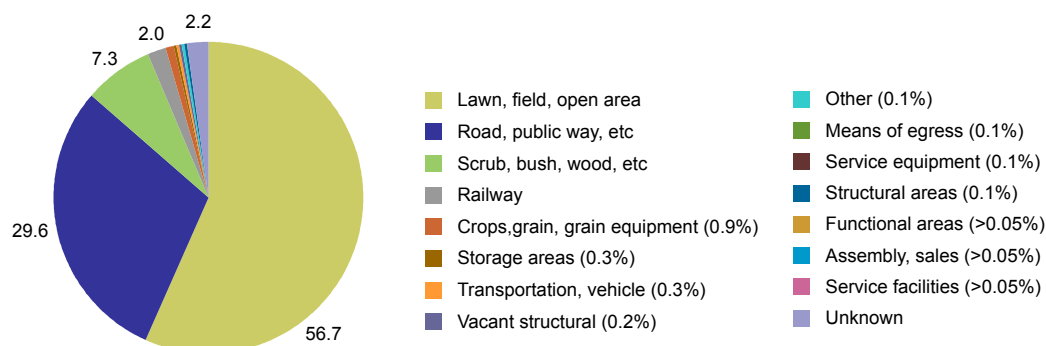
a: suburbs are arranged in order of decreasing numbers of deliberate fires (observed for a five-year period); suburbs identification have been removed intentionally

Source: CFA 1999–2000 to 2003–04 [computer file]

## Area of origin

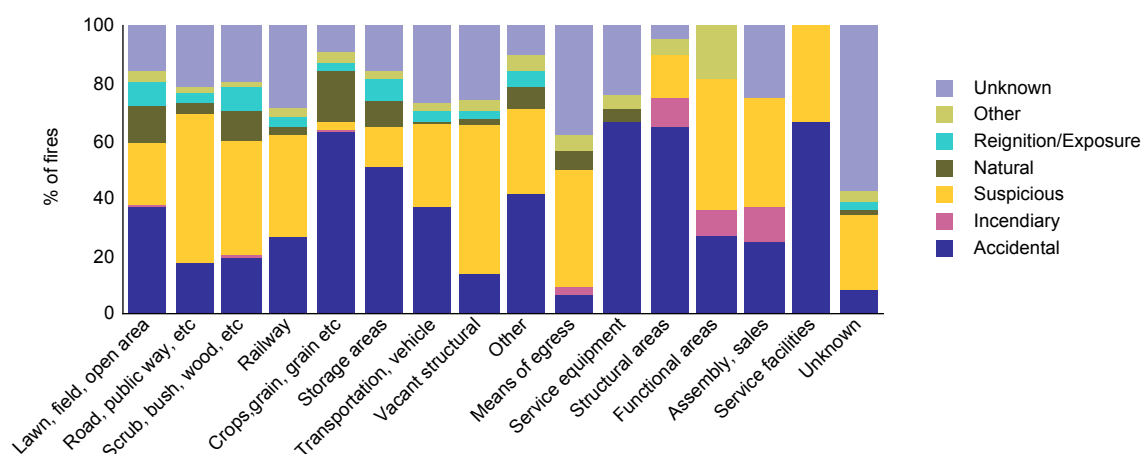
The area of origin analysis was based on AFAC-defined categories, within the variable titled 'Area of origin'. For 57 percent of vegetation fires the area of origin was lawns, fields and other open areas. A further 30 percent of vegetation fires occurred near roads, public ways and parking lots, with 7.3 percent occurring in scrub, bush or woods (Figure 61).

The extent to which deliberate causes contributed to total vegetation fire frequencies varied markedly between different area of origin types. For example, a high proportion (40 to 50%) of vegetation fires occurring in or near 'roads, public ways and parking lots', 'scrub, bush and woodlands', 'vacant structural' properties, and along 'means of egress' were deliberate (Figure 62). In contrast, a high proportion of vegetation fires associated with 'crops, grain and grain equipment', 'service equipment' and structural or storage areas were accidental. Overall, deliberate vegetation fires occurred more frequently near roads, public ways and parking lots ( $n=3,959$ ) than on lawns, fields and other open areas ( $n=3,275$ ) or in scrub, bush or woods ( $n=768$ ).

**Figure 61: Areas of origin for all vegetation fires (percent)**


Source: CFA 1999–2000 to 2003–04 [computer file]



**Figure 62: Cause and area of origin for all vegetation fires (percent)**

Source: CFA 1999–2000 to 2003–04 [computer file]

## Timing

The timing of fires was examined by week of the year, day of the week and time of the day.

### Week of the year

Most CFA-attended vegetation fires occurred between mid November and mid May (Figure 63). Although generally similar to the timing of MFB and DSE fires, some differences were evident between agencies, mostly relating to differences in the principal causes of vegetation fires.

Differences were evident in the timing of vegetation fires from different causes or associated with different types of activities. Deliberate vegetation fires (principally vegetation fires labelled suspicious) mostly occurred between mid November and late April (Figure 63). The greatest number occurred between week 50 and week 4, coincident with the Christmas school holidays; natural fires also peaked in the same period. A smaller, narrower peak was also evident in week 11 (mid March). This pattern is broadly consistent with that for MFB deliberate fires.

Accidental fires broadly defined two distinct peaks (Christmas–New Year and mid April) but overall these peaks occurred somewhat earlier and later than those for deliberate vegetation fires (Figure 63). Although the majority of activities that gave rise to accidental fires peaked around Christmas–New Year and mid March, many accidental fires resulted from fuel reduction burns, and ‘burning waste heaps, rubbish and garden litter’. These activities typically occurred at the beginning and end of the fire season when there are lower risks of escape (Figure 64). This contributed to differences in timing relative to deliberate fires. It also contributed to the evident differences between the CFA and MFB, as comparatively few MFB-attended fires were as a result of fuel reduction burns or the clearing of rubbish.

The greatest number of natural fires occurred early in the New Year. Nevertheless, ‘natural’ fires the CFA attended occurred anywhere from late spring to early autumn. This reflected the fact that many fires within the natural category were actually started by human beings but natural conditions contributed to their escape. Many of the fires in spring and autumn were associated with fuel reduction burns, or the burning of rubbish heaps or other waste.

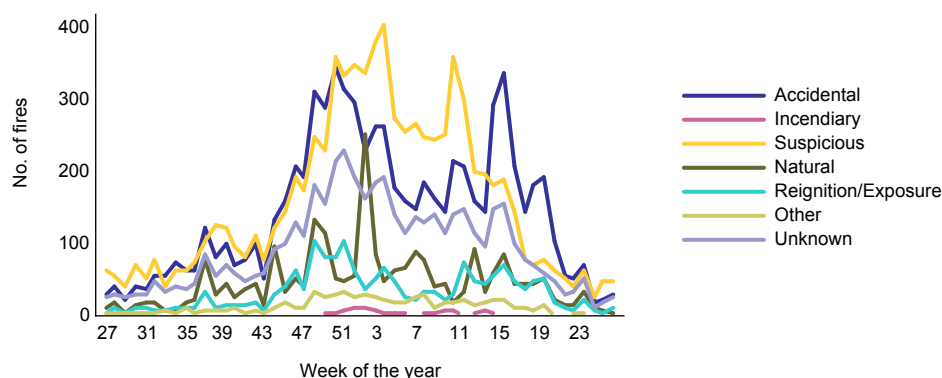
There was an exceptionally strong relationship between the timing of vegetation fires where there was malicious activity in the area, and vegetation fires associated with vehicles (transportation; Figure 65). This may reflect the fact that half of all vehicle (transportation) fires were deliberate.

Climatic conditions vary across the state, giving rise to subtle differences in the predominant fire regime. Such regional climatic variations are likely to be insignificant compared with regional differences in human activities; for example, the propensity for, and timing of, fuel-reduction burns and specific agricultural practices varies regionally according to predominant land use patterns. Both regional variations in climatic conditions and land use patterns are likely to have a subordinate impact relative to the climatic variations that occur from year to year.

In 1999–2000 and 2000–01, there were large spikes in the number of vegetation fires in December–January, followed by reduced fire frequencies throughout the remainder of the bushfire season (Figure 66). In contrast, in 2001–02 and 2003–04, the number of fires was more evenly distributed across the bushfire danger season. 2002–03 was remarkable as high numbers of vegetation fires occurred as early as mid September and remained high until late February. Low numbers of vegetation fires occurred between late February and May. This may reflect the fact that extensive vegetation fires throughout much of the northeast negated the usual need for land management activities (for example, burn offs) at this time.

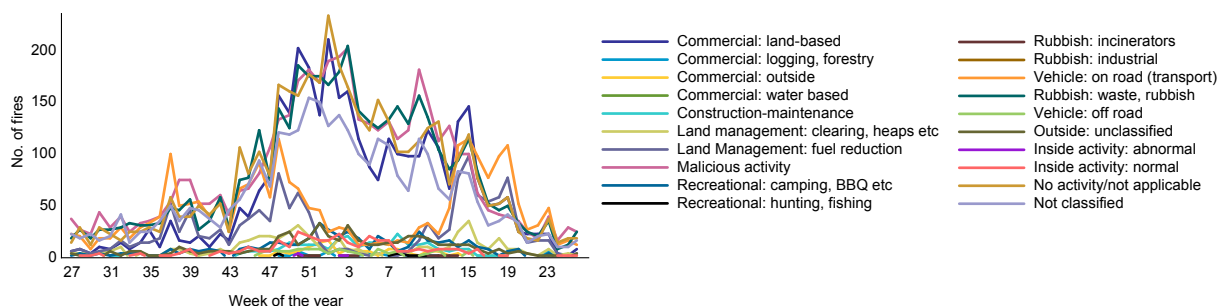
Most non-deliberate child vegetation fires occurred from mid November to late April (Figure 67). The available data indicate that the timing these fires most strongly parallels the distribution described for accidental fires, with peaks in activity lying outside the typical range observed for deliberate fires. However, some caution is needed when drawing significant conclusions from these data, due to the comparatively small number of vegetation fires involved.

**Figure 63: Vegetation fires, by week and cause (number)**

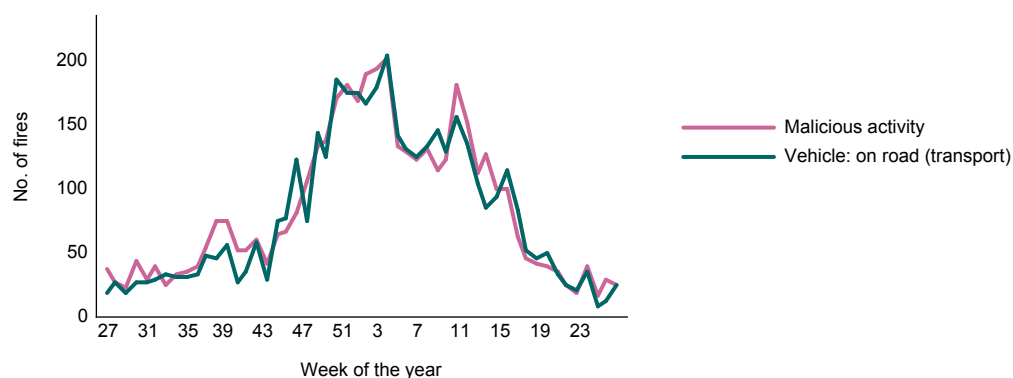


Source: CFA 1999–2000 to 2003–04 [computer file]

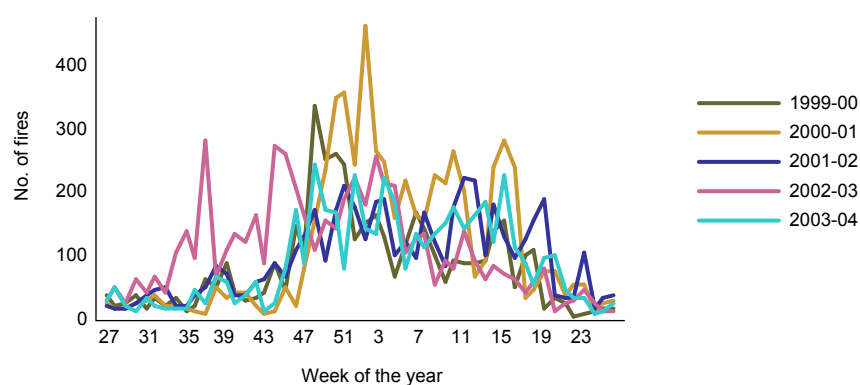
**Figure 64: Vegetation fires, by week and 'activity in the area' (percent)**



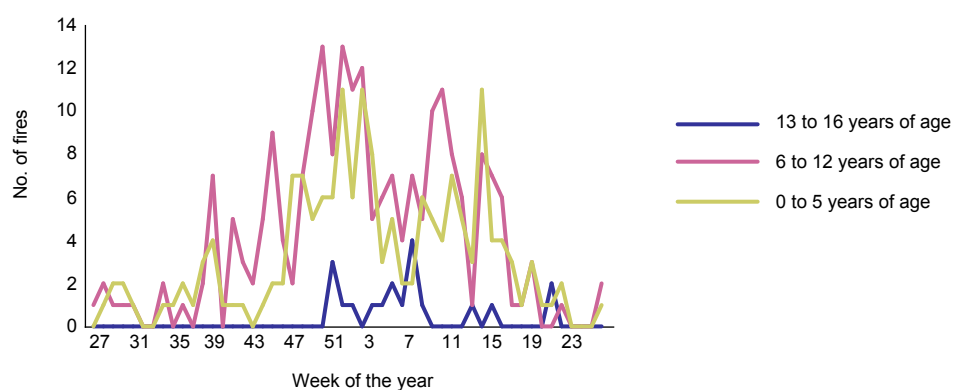
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 65: Malicious and transportation vegetation fires, by week (number)**


Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 66: Vegetation fires, by week and year (number)**


Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 67: Non-deliberate vegetation fires lit by children, by year (number)**


Source: CFA 1999–2000 to 2003–04 [computer file]

## Day of the week

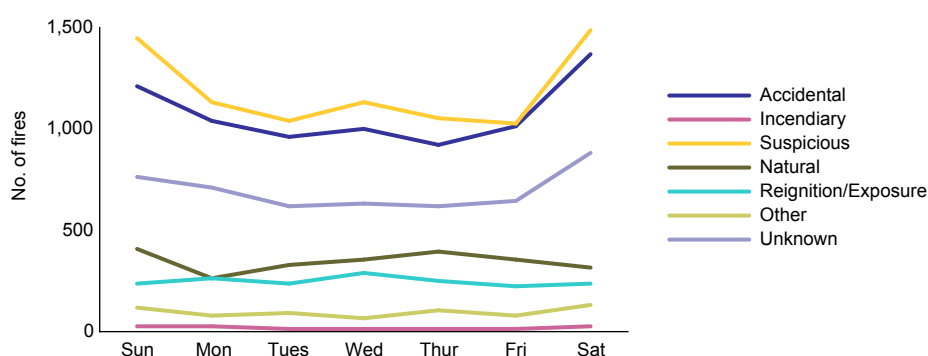
Approximately 1.2 times more vegetation fires occurred on Sunday, and 1.3 times more on Saturday, than on the average weekday. Nevertheless, the tendency for higher numbers of weekend fires was highly cause specific (Figure 68). Not surprisingly, no weekend bias was evident for natural fires or fires resulting from reignition-exposure. Approximately 1.2 and 1.4 times more accidental vegetation fires occurred on Sunday and Saturday, respectively, than on the average weekday. Between 1.9 and 2.1 times more incendiary fires occurred on weekend days than on the average weekday. This bias was less evident for suspicious vegetation fires, where 1.3 to 1.4 times more vegetation fires occurred on Saturday and Sunday.

Understandably, the type of vegetation fires on weekends related to the type of activity in the area (Figure 69). For example, approximately 2.3 to 2.5 times more vegetation fires associated with recreational activities, such as camping, picnicking and barbecues, occurred on a Saturday or Sunday than on the average weekday. Similarly, 1.4 to 1.6 times more vegetation fires associated with incinerators and the burning of rubbish, waste and garden litter occurred on a weekend day than on the average weekday. Not surprisingly, given normal working hours, no increase in the number of industrial rubbish vegetation fires occurred on weekends.

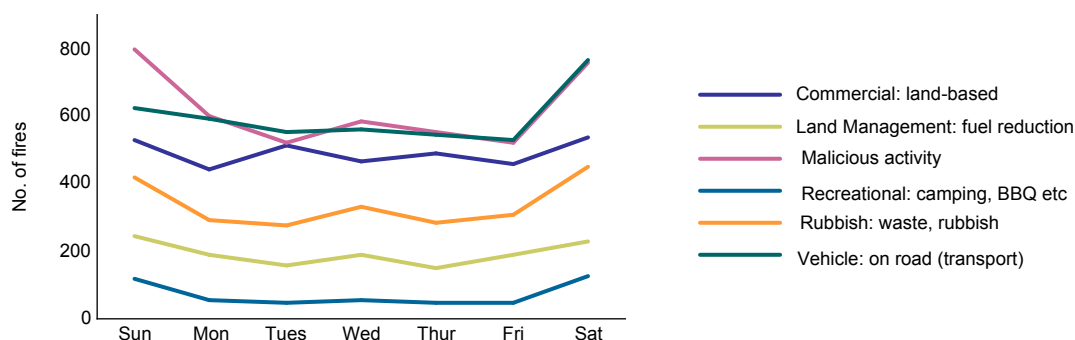
Although vegetation fires associated with commercial land-based activities were only 12 to 13 percent more likely to occur on a weekend, 30 to 40 percent more vegetation fires pertaining to land management activities, such as fuel reduction burning, the clearing of land, heaps and windrows, occurred on weekends, highlighting that a different subset of the population may be engaged in these activities.

Despite the fact that many non-deliberate vegetation fires occurred during the school holidays, children lit 1.75 and two times more vegetation fires on Sunday and Saturday, respectively, than on the average weekday. This was evident for both 6 to 12 and 13 to 16 year olds (Figure 70). A greater number of 13 to 16 year olds caused vegetation fires on Sunday than on Saturday. The number of fires lit by 6 to 12 year olds decreased as the week progressed but increased markedly on Saturday.

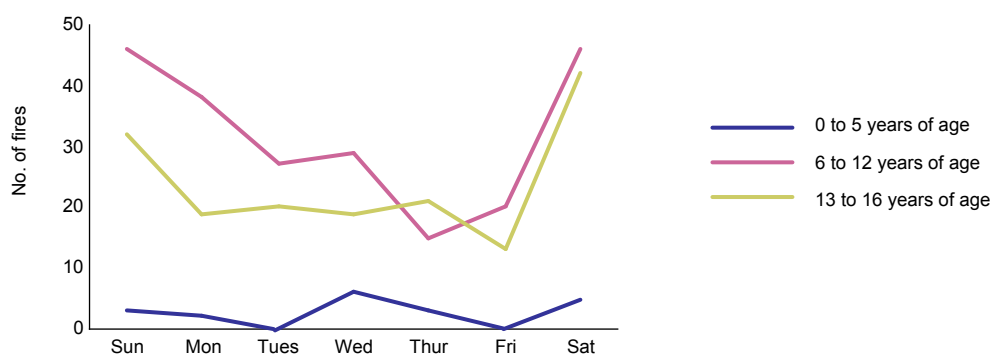
**Figure 68: Vegetation fires, by day of the week and cause (number)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 69: Vegetation fires, by day of the week and activity (percent)**

Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 70: Non-deliberate child fires, by day of the week and age group (number)**

Source: CFA 1999–2000 to 2003–04 [computer file]

### Time of day

The time each incident occurred was available for more than 99.9 percent of CFA-attended vegetation fires from 1999–2000 to 2003–04. As observed elsewhere, the distribution of detection times varied markedly between deliberate and non-deliberate vegetation fires.

Accidental fires principally occurred during daylight hours, peaking at 2 to 3 pm (Figure 71). Natural fires, from lightning and other causes, occurred within a similar timeframe, although peak numbers were from 2 to 4 pm; similar trends occurred for 'other' and reignition/exposure categories.

In contrast, deliberate fires occurred throughout the day, with fires during both the daytime (working hours) and the night-time (conventional leisure hours). Like non-deliberate fires, the greatest number of deliberate fires occurred during the daytime. However, the greatest number of deliberate vegetation fires occurred between 4 and 6 pm, later than the 2 to 3 pm peak time for accidental fires.

Substantial differences also existed in the number and proportion of night-time fires. Forty-five percent of all deliberate fires occurred between 6 pm and 6 am, compared with 23 percent of accidental fires. The differences between non-deliberate and deliberate causes were most evident for the interval between 12 and 6 am. Notably, 14.3 percent of all deliberate fires occurred within this timeframe, compared with just 3.4 percent of accidental fires.

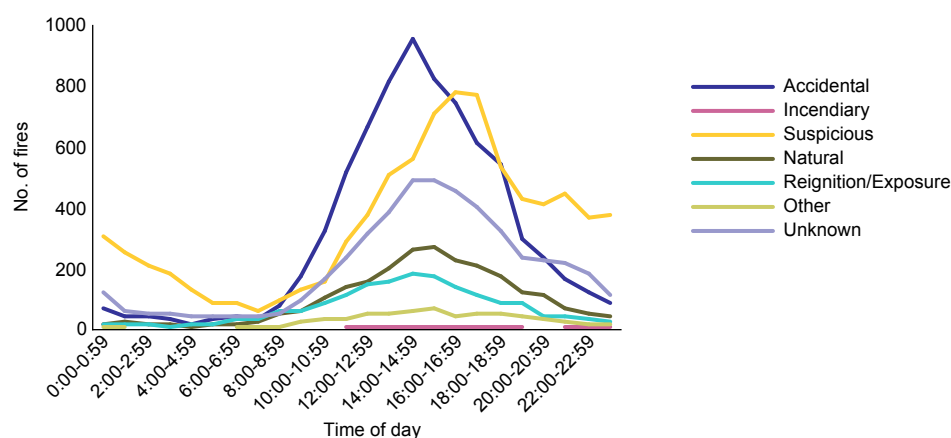
Overall, the proportion of deliberate vegetation fires that occurred between 6 pm and 6 am was similar to that observed by the MFB for deliberate vegetation fires. Nevertheless, there is a clear distinction between the distribution of MFB and CFA deliberate vegetation fires. In contrast to the MFB, the number of fires occurring between 7 and 12 pm was distinctly lower than the daytime maximum. This probably highlights a fundamentally different balance between the principal contributors to deliberate fires for these jurisdictions.

It is easier to comprehend the difference between accidental and deliberate vegetation fires when the day of the week on which the fire occurred is taken into account. Unlike accidental fires, where the only noticeable difference is an increased number of daytime fires on the weekend (Figure 72), there were clear differences between the distribution of deliberate vegetation fires on weekends and on weekdays (Figure 73). The distribution of deliberate vegetation fires on weekends was similar to that observed for accidental fires with peak numbers of deliberate vegetation fires occurring at 3 to 4 pm, emphasising that was the weekday distributions that were skewed toward later times (Figure 73). The increase in the number of deliberate fires between 4 and 6 pm on weekdays, but not weekends, indicates that children or adults on the way to or from school or work may have lit many of the deliberate daytime fires. Most non-deliberate child vegetation fires occurred from 5 to 6 pm (Figure 74).

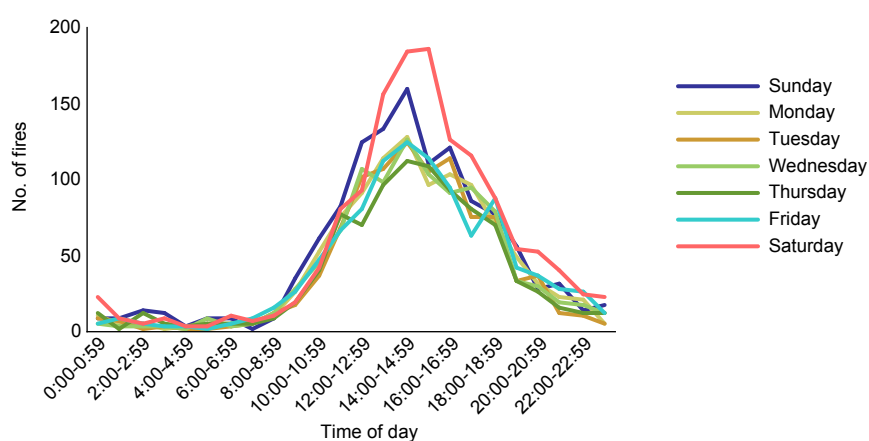
The number of deliberate fires between 6 pm and 6 am was higher on Friday night–Saturday morning and Saturday night–Sunday morning. However, owing the higher frequency of daytime fires, the actual proportion of deliberate fires that occurred within this timeframe was comparable across all days of the week. The most notable difference for deliberate vegetation fires on weekends and weekdays occurred for fires between midnight and 6 am. On Saturday and Sunday, 19 to 20 percent of all deliberate fires occurred within this timeframe, whereas on weekdays, it was typically 10 to 12 percent. The exception was Wednesday night, where 14 percent of deliberate fires occurred from 12 to 6 am. The timing of deliberate night-time fires was consistent with deliberate fires on the way to or from social activities. However, greater numbers of fires on weekends stemmed from higher numbers of both day and night-time fires.

The trends outlined above are the agglomeration of trends that occurred across the state, and are not necessarily representative of the trends at a local scale. At a regional level, the percentage of fires that occurred between 6 pm and 6 am varied from a low of 45 percent for Macedon to a high of 60 percent for the Wimmera region (Figure 75). Typically, 10 to 20 percent of all fires within a region occurred between midnight and 6 am, but levels were locally higher in the Wimmera (30%) and Geelong (23%) and lower in the Macedon (6%) and Spa Country (8%) regions (Figure 75).

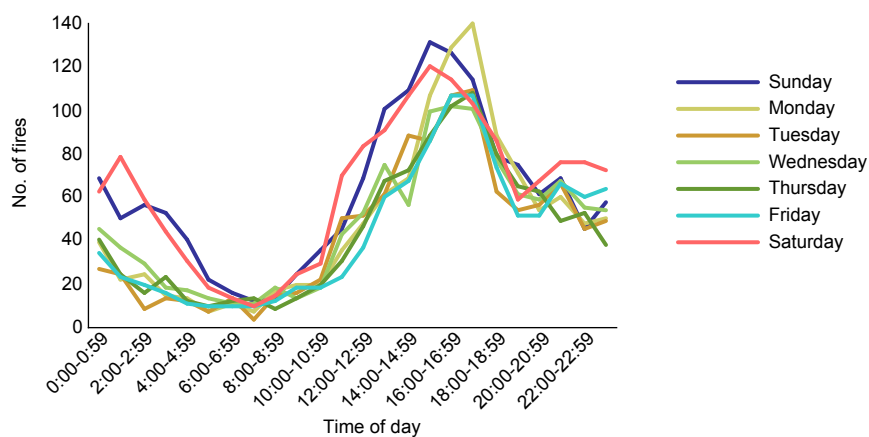
To examine the tendency for deliberate fires to occur on some nights of the week it is necessary to examine contiguous timeframes from 6 pm to midnight on one day and from midnight to 6 am on the following morning. Deliberate fires on Friday night–Saturday morning and Saturday night–Sunday morning accounted for between 18 and 49 percent of all deliberate fires that occurred between 6 pm and 6 am (values less than 29 percent indicate less night-time fires on weekends and values greater than 29 indicate more night-time fires on weekends than might be expected from an even distribution throughout the week). The greatest percentage of night-time fires occurred on Friday night–Saturday morning and Saturday night–Sunday morning in the Lakes (49%), Mallee (46%) and Melbourne East (45%) regions, whereas the lowest proportions occurred in the Macedon (18%), Central Highlands (24%) and Western Grampians (27%) regions (Figure 75). Obviously, regional trends are also an agglomeration of trends that occurred at a local scale, and to reduce deliberate fires, local trends should be identified and appropriate strategies implemented.

**Figure 71: The time of day fires occurred, by cause (number)**


Source: CFA 1999–2000 to 2003–04 [computer file]

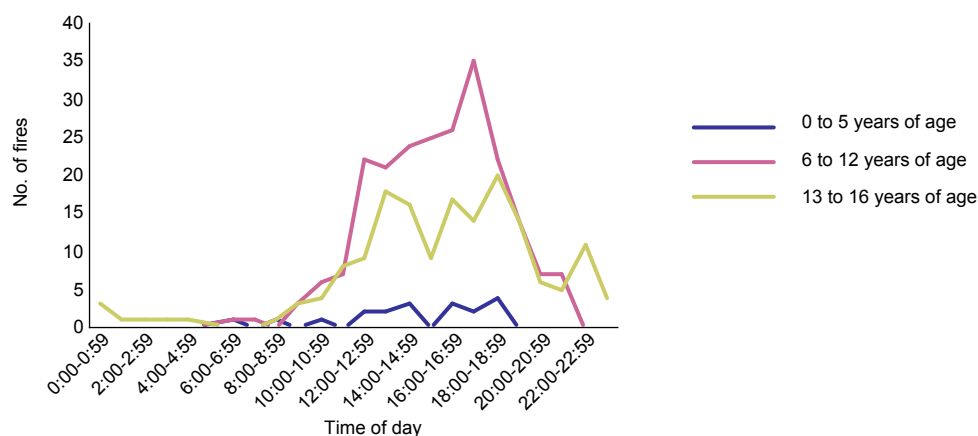
**Figure 72: Accidental fires by, time of day, by day of the week (number)**


Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 73: Deliberate fires by, time of day, by day of the week (number)**


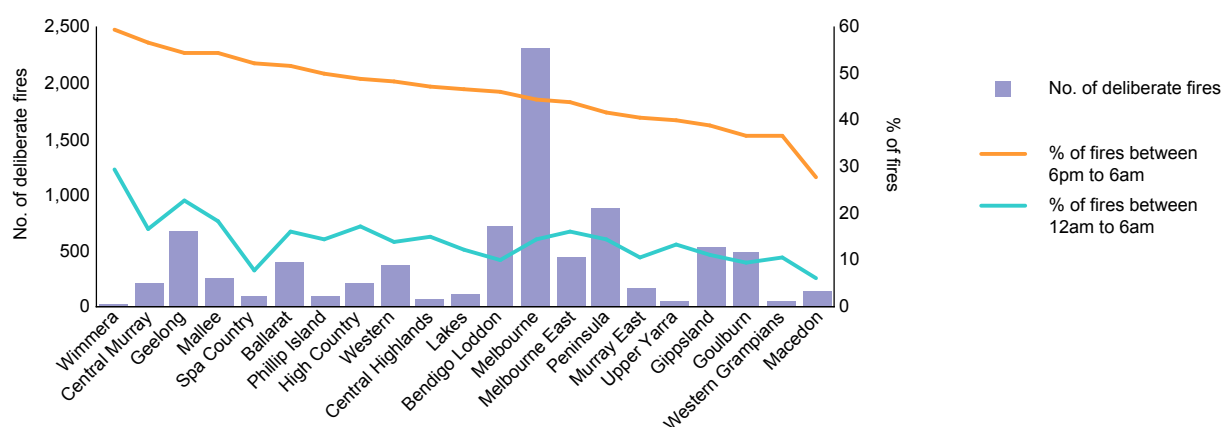
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 74: Non-deliberate child fires by, time of day, by day of the week (number)**



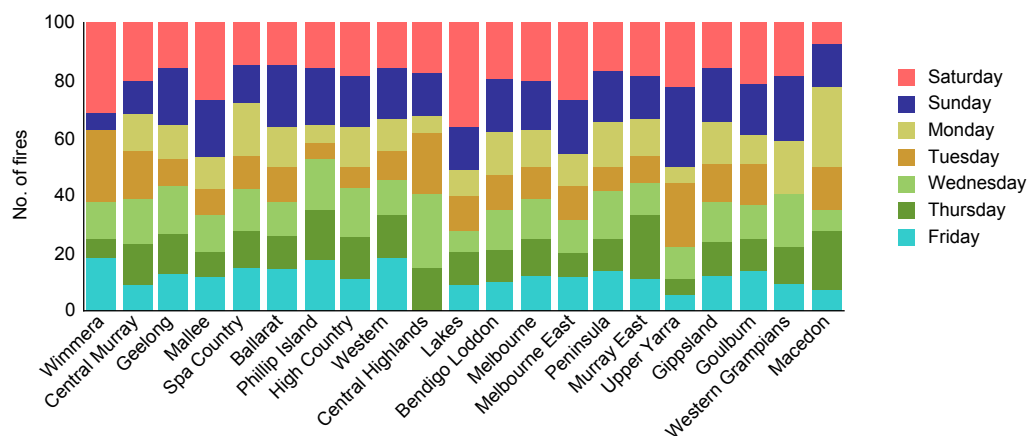
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 75: Deliberate fires at night, by region (number)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 76: Deliberate fires between 6 pm and 6 am for contiguous night–mornings, in each region (percent)**



Source: CFA 1999–2000 to 2003–04 [computer file]



## Area burned

The number of vegetation fires of a given size decreased with increasing total area burned, with the characteristic hump in the pattern for the 10 to 49.9 and 100 to 499 ha categories. This pattern occurred irrespective of cause (Figure 77).

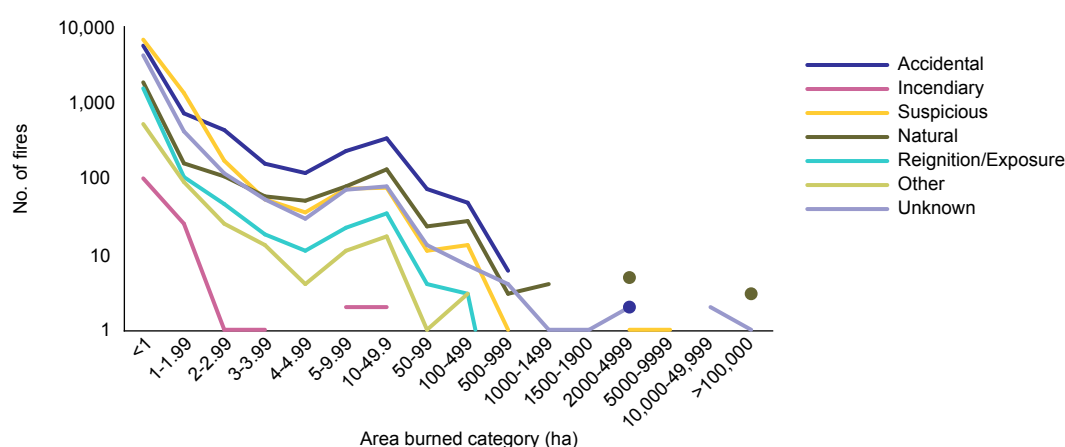
Overall, deliberate causes accounted for a decreasing proportion of fires as the size of the vegetation fire increased (Figure 78). Of the 25 fires that burned 1,000 ha or more, only two were suspicious. The largest burned 6,100 ha in the Goulburn region in 2001–02; the other burned 3,000 ha in the Central Highlands in 1999–2000. Only one suspicious fire fell within the 500 to 999 ha range, and 13 fires in the 100 to 499 ha range were suspicious. The largest fires labelled incendiary burned 12 ha.

The majority of large vegetation fires were either natural or of unknown origin. Of the 12 natural fires that burned 1,000 ha or more eight were the result of lightning. Lightning was responsible for the three largest fires the CFA attended; these burned 175,455 ha, 307,542 ha and 326,180 ha in the Lakes, High Country and Murray East regions respectively, all during 2002–03. The largest natural fire not related to lightning was attributed to high wind. This fire burned 4,537 ha in the Lakes region in 2003–04. One fire of unknown cause burned 271,479 ha in the Lakes region in 2002–03, with another two fires of 10,000 ha burning in the Central Highlands and High Country regions in 2000–01 and 2002–03 respectively.

Approximately 1.2 million hectares was burned in CFA-attended vegetation fires from 1999–2000 to 2003–04. Clearly, the total area burned was dominated by large fire events. Hence, approximately 70 percent of the total area was burned in fires of natural causes (principally lightning), of which a further one-quarter was burned by fires of unknown causes (Figure 79). Deliberate fires (principally suspicious rather than incendiary) accounted for only 1.4 percent of the total area burned.

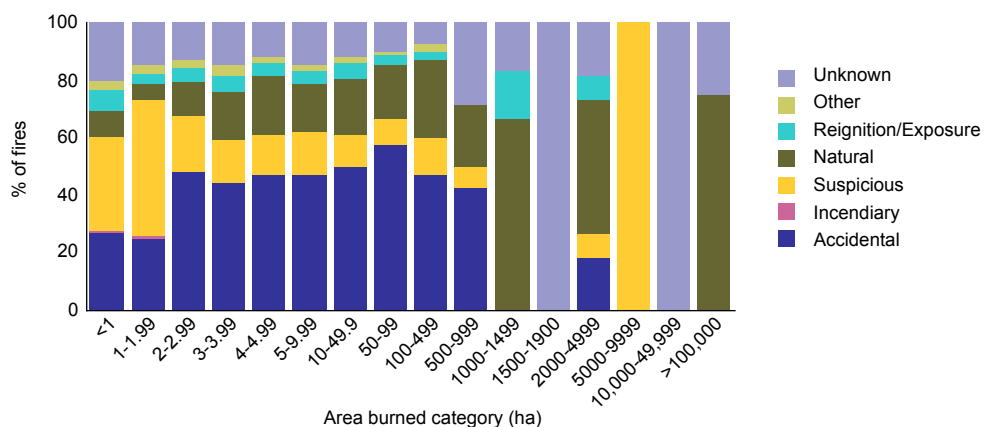
The overwhelming majority of the total area burned was burned in 2002–03 (Figure 80), in the northeast of the state. The largest area burned by deliberate fires occurred in 2001–02 (total deliberate = 7,495 ha) and in 1999–2000 (total deliberate = 3,893 ha), with the total area burned by deliberate fires in those years being dominated by the two large suspicious fires outlined above. In those two years, deliberate fires were responsible for almost 30 percent of the total area burned. Deliberate fires burned 2,312 ha in 2002–03 and less than 1,500 ha in 2000–01 and 2003–04. In the latter two years, deliberate fires comprised less than six percent of the total area burned.

**Figure 77: Area burned category (ha), by cause (number)**



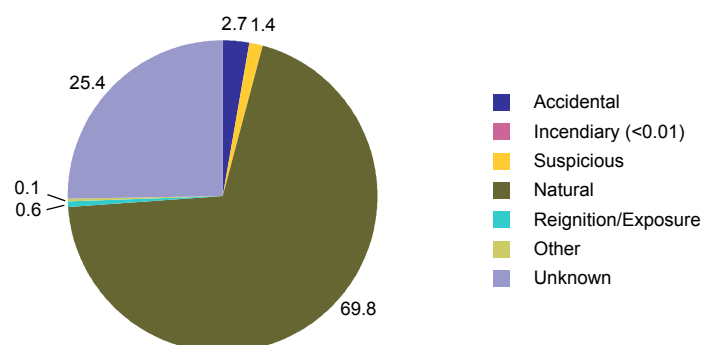
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 78: Area burned category (ha), by cause (percent)**



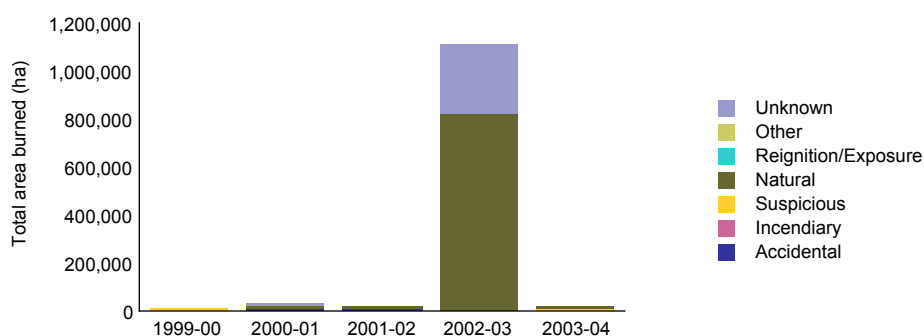
Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 79: Total area burned in vegetation fires, by cause (percent)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 80: Total area burned by vegetation fires each year, by each cause (number)**



Source: CFA 1999–2000 to 2003–04 [computer file]

## Type of incident

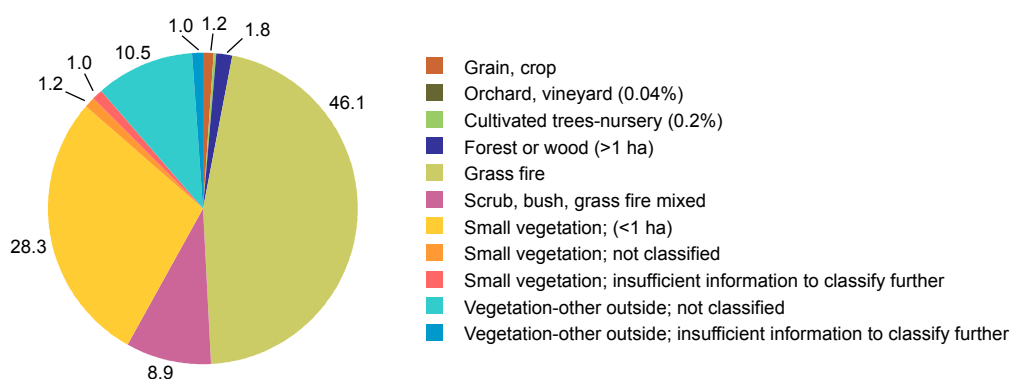
Forty-six percent of vegetation fires the CFA attended were classified as grassfires, with a further 31 percent being small vegetation fires (Figure 81). A further nine percent were mixed scrub, bush and grass fires and 12 percent other vegetation and outside fires. Only 1.8 percent of fires were forest or wood fires.

Deliberate causes were responsible for 26 to 38 percent of all incident types with the exception of grain and crop fires and fires that occurred in orchards/vineyards/nurseries (Figure 82). While comparatively few (2%) grain and crop fires were deliberate, half of all fires in orchards/vineyards/nurseries (including cultivated tree fires) resulted from deliberate causes. Grassfires were more likely to have been classified as deliberate (38%) than fires in forest and woods (26%).

Collectively, the proportion of grass and small vegetation fires combined was remarkably constant (typically 70 to 80%) across Victorian regions, although the ratio between small vegetation fires and grassfires varied markedly in detail (Figure 83). There was an antipathetic relationship between the two, with areas characterised by a high proportion of grassfires having a lower proportion of small vegetation fires and vice versa. Areas with a high proportion of grassfires included the Melbourne, Geelong and Ballarat regions. Areas with a higher proportion of small vegetation fires included Phillip Island, Macedon, and the Central Murray regions; and a higher than normal proportion of mixed scrub, bush and grass fires occurred in the Spa Country. Not surprisingly, given land use patterns, a higher proportion of fires that occurred in the Wimmera region were grain or crop fires.

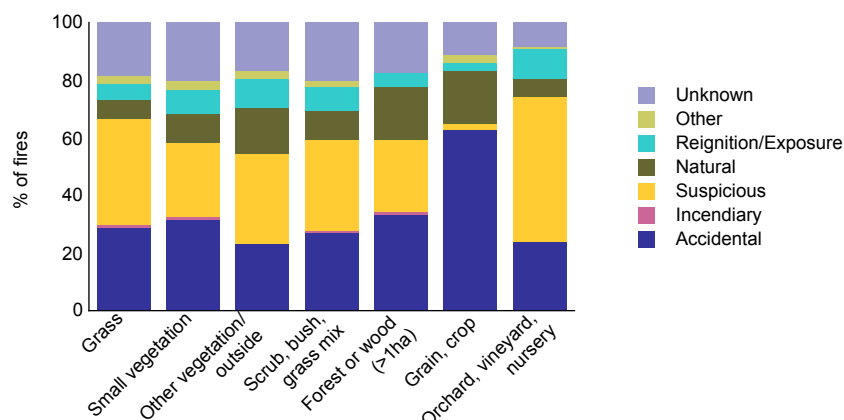
It is impossible to assess, from the available data, how many fires were bushfires or had the potential to develop into a bushfire. However, it is evident that there was a significant positive correlation between the number of grass, forest/wood, and mixed scrub/bush/grass fires combined ( $r=.98$ ;  $p<.001$ ) and the total number of vegetation fires within a given region (Figure 84). A significant positive relationship ( $r=.94$ ;  $p<.001$ ) also existed between the number of forest/wood and mixed scrub/bush/grass fires (combined) and the total number of vegetation fires within a given region (Figure 84). Hence, even though it was difficult to specify what proportion of fires potentially constituted a bushfire, there was likely a strong relationship between the distribution of bushfires specifically and the distribution of vegetation fires generally.

**Figure 81: Type of vegetation fire incident (percent)**



Source: CFA 1999–2000 to 2003–04 [computer file]

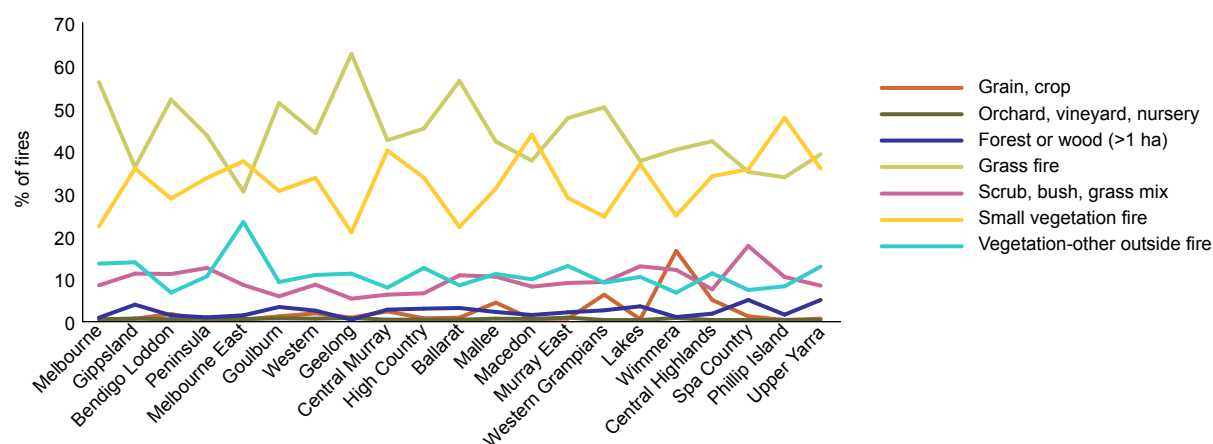
**Figure 82: Cause of each incident type<sup>a</sup> (percent)**



a: incident type arranged in order of decreasing frequency

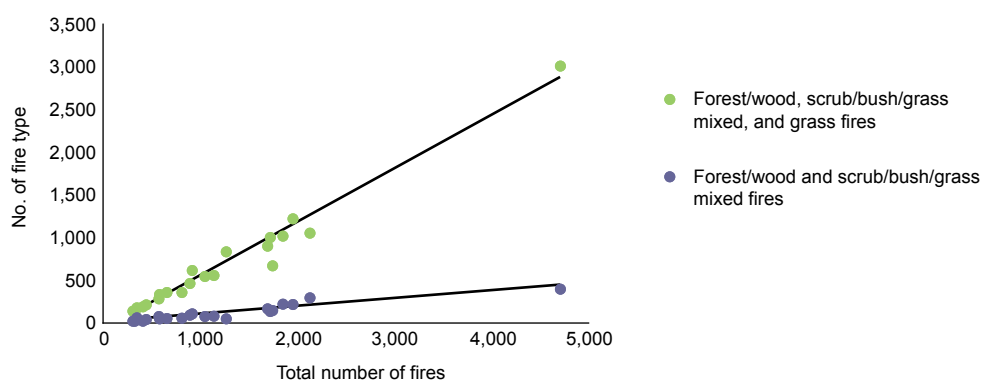
Source: CFA 19599–2000 to 2003–04 [computer file]

**Figure 83: Type of incidents in each region (percent)**



Source: CFA 1999–2000 to 2003–04 [computer file]

**Figure 84: Relationship between specific incident types and the total number of vegetation fires in each region (number)**



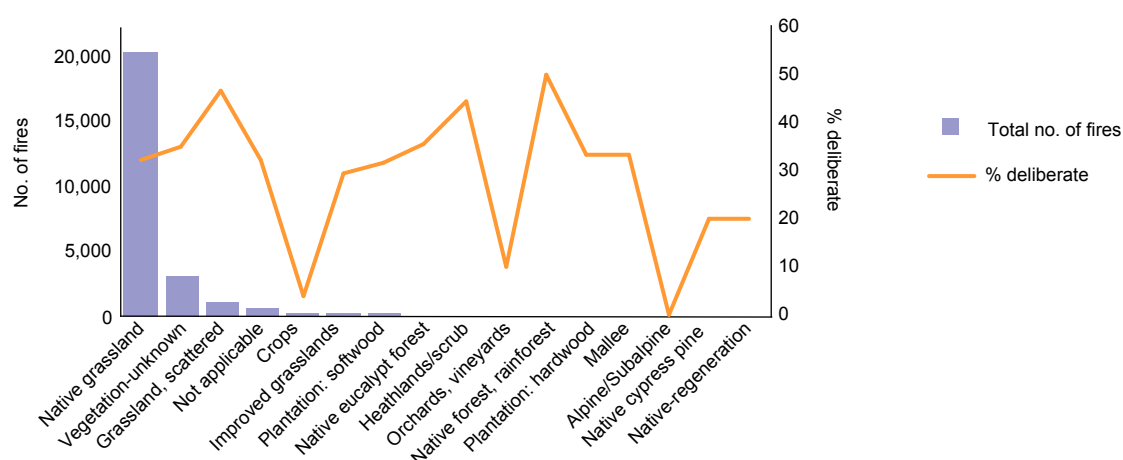
Source: CFA 1999–2000 to 2003–04 [computer file]

## Vegetation burned

Information about the primary vegetation type affected was available in 96 percent of cases. In keeping with the incident type documented above, 78 percent of fires, where the type of vegetation was assigned, occurred in native grassland (Figure 85). A further 3.7 percent occurred in grasslands in which there were scattered trees. Only one-third of the fires in native grasslands were native hummock grasslands. The remainder were in grasslands that could be grazed.

A comparatively high proportion of fires in grasslands, heath lands and scrub, and in native rainforests were deliberate in origin. Low proportions of crop fires, fires in orchards and vineyards and alpine or sub-alpine vegetation were deliberate.

**Figure 85: Number of fires, percentage of deliberate fires, within each vegetation type**

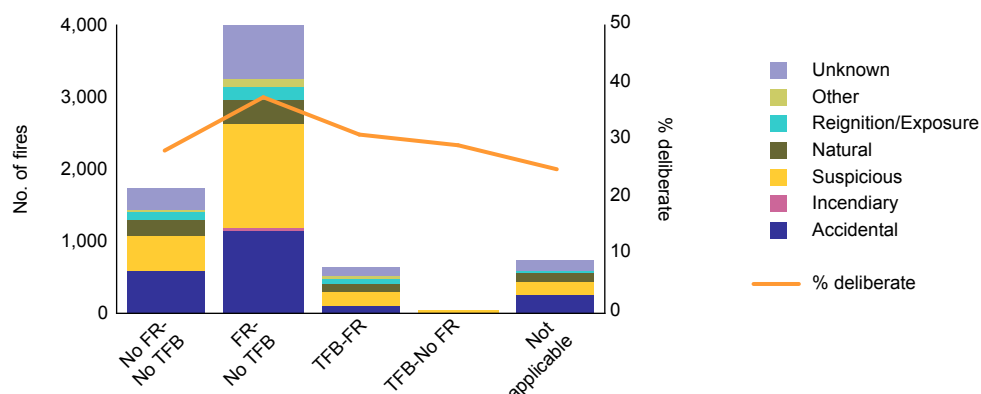


Source: CFA 1999–2000 to 2003–04 [computer file]

## Fire restrictions/total fire bans

The status of fire restrictions and total fire bans, including instances where not applicable values were assigned (2.9%), were available for 27.8 percent of vegetation fires. Of these, 24 percent occurred under conditions when there was neither fire restrictions or a total fire ban in force and 56 percent occurred when there were fire restrictions but no total fire ban (Figure 86). A further nine percent occurred when both restrictions and a ban was in force, with just 0.7 percent of fires occurring when there was a total fire ban and no fire restrictions.

The highest proportion of deliberate fires (37%) occurred under conditions when there were fire restrictions but no total fire ban in place. This value decreased to 30 percent or less when a total fire ban was in place.

**Figure 86: Cause of vegetation fires under different fire restrictions<sup>a</sup>**

a: FR = fire restrictions; TFB = total fire ban

Source: CFA 1999–2000 to 2003–04 [computer file]

## Combined agency analysis

This section combines data from both the MFB and CFA to yield an overview of vegetation fires in Victoria. However, in order to do this it is first necessary to compare and contrast data from these two agencies in order to highlight issues pertaining to cross-agency comparisons. In order to eliminate differences introduced by yearly variations the analysis is restricted to data from 1999–2000 to 2001–02; that is, years for which data was available for both agencies. The analysis is broken into two components:

- Combined MFB and CFA data for the Melbourne and Melbourne East regions
- MFB and CFA population analysis for Victoria

### Combined MFB and CFA data for the Melbourne and Melbourne East regions

Both the MFB and the CFA provided coverage in the highly populated Melbourne and Melbourne East regions, although the coverage by each varies markedly between different statistical subdivisions (SSDs). The MFB was the sole provider of services for vegetation fires attended in Inner Melbourne, Moreland City and Boroondara City SSDs and attended the highest proportion of fires in more centrally located SSDs of Western Melbourne, Northern Middle and Northern Outer Melbourne, Eastern Middle Melbourne, Southern Melbourne and Hume City. Fires in more distal locations increasingly fell under the CFA's jurisdiction. The CFA was sole or principal provider of services in the South Eastern Melbourne, Yarra Ranges Shire, Greater Dandenong City, and Melton–Wyndham, and Eastern Outer Melbourne SSD, but also attended 29 percent of fires in the Hume City SSD and 35 percent of fires in the Northern Outer SSD for the 1999–2000 to 2001–02 period. Overall, there were 109 postcodes for which the MFB was the sole attendee in the Melbourne and Melbourne East regions, but 53 instances where both the CFA and MFB attended fires in the same postcode. The net result is that neither the MFB nor the CFA provided a complete overview of total fire frequencies in the Melbourne–Melbourne East regions.

Based on the combined data for 1999–2000 to 2001–02, 40 percent of all fires in Victoria (excludes DSE data) occurred in the Melbourne region, with a further five percent occurring in the Melbourne East region. The greatest number of vegetation fires occurred in the Western Melbourne SSD, followed by Hume City, Northern Outer Melbourne, Northern Middle Melbourne and Melton–Wyndham SSDs (Figure 87). A

comparatively low incidence of vegetation fires occurred in eastern and southern Melbourne (as indicated by the MFB data alone) but the total number of vegetation fires in these areas was higher than in the inner SSDs of Moreland City, Boroondara City and Inner Melbourne areas.

Fundamental difficulties occurred when trying to integrate the MFB and CFA data due to considerable differences in the proportion of deliberate vegetation fires each agency identified within the same area; for example, differences of 10 percent to greater than 40 percent occurred in individual SSDs (Figure 87). Some legitimate reasons exist as to why this might occur. In many instances, the number of vegetation fires one agency attended was markedly smaller than that attended by the other, and therefore may be unrepresentative of fires causes overall. Local differences in the rates of deliberately lit fires may also occur because the CFA and MFB cover distinctly different areas and potentially different types of environments within the same SSD.

These disparities were more evident at the postcode level. Rarely, did both the CFA and MFB attend a large number of fires in the same postcode. Rates of deliberate fires based on a small number of incidents are likely to be less accurate. Hence, greater differences are evident in the proportion of deliberate vegetation fires at a postcode level (Figure 88).

However, it is clear that the CFA consistently documented higher percentages of deliberate fires than did the MFB at a SSD level. Large discrepancies occurred in the Eastern Outer Melbourne region; even though the numbers of vegetation fires were more evenly distributed between the two agencies in this area there was a 44 percent difference in the estimated rate of deliberate fires. The implication from CFA data is that although the overall number of vegetation fires in the Eastern Outer Melbourne and Greater Dandenong SSD was comparatively low (compared with Western Melbourne or Hume SSDs) these areas recorded among the highest rates of deliberate fires (greater than 50%) in the Melbourne–Melbourne East regions. Clearly, that the MFB data does not reflected this alone, would in part be due to low fire frequencies. However, both agencies support low rates of deliberate fires in the Yarra Ranges Shire.

One of the principal differences between the CFA and MFB trends in Figure 87 and Figure 88 lies in the number and proportion of vegetation fires attributed to smoking-related causes (Figure 89). Notably, smoking-related causes accounted for 31 percent of fires the MFB attended from 1999–2000 to 2001–02, but only 2.1 percent of CFA-attended fires were classified as smoking-related, based on the variables available for this analysis. Hence, the number of smoking-related fires classified from the ignition factor will inherently be lower than that indicated in the ‘form of heat of ignition’ variable.

Part of the difference between the CFA and MFB data may pertain to the different methodologies used to derive the number of smoking-related fires for these two agencies. Notably, the number of smoking-related fires for the MFB was derived from the heat of ignition variable (AIRS codes 300 to 390), whereas the number of CFA smoking-related fires were derived from the ignition factor (abandoned and discarded materials) variable. Fires classified as smoking-related within the heat of ignition variable may have been assigned a number of different codes in the ignition factor variable, including incendiary and suspicious.

However, differences in methodology are unlikely to be the complete explanation for differences in the number of CFA and MFB smoking-related fires. Notably, just over 80 percent of all MFB smoking-related fires (based on the form of heat of ignition) were classified within the abandoned and discarded materials category. That is, the difference in methodology is only likely to account for 20 percent of the difference in the number of smoking-related fires, unless the CFA adopted a radically different approach to coding smoking-related fires, which is unlikely. Only five percent of MFB smoking-related fires were classified as deliberate; 92 percent were non-deliberate.

The other potential difference between the CFA and MFB data lay in the proportion of non-deliberate child fires. Non-deliberate child fires comprised 15.5 percent of all fires the MFB attended, but just 1.6 percent of vegetation fires the CFA attended. The classification adopted for child fires could potentially heavily

influence this analysis. According to the AIRS manual, if the intention was malicious (regardless of age) the ignition factor should be recorded as incendiary or suspicious, or else child fires are classified independently within the ignition factor variable under the appropriate age classification. In this analysis, these fires are classified as accidental. The assignment of intent is complex in relation to children, being dependent not only on the age and maturity levels of the child, but also on the personal biases of individuals recording the fire cause. It may even be influenced by organisational policies (this is not specifically implicated for the MFB and CFA; see below).

The MFB and CFA recognise the potential difficulties posed by jurisdictional boundaries and seek to address those differences. For example, the CFA works closely with both DSE and MFB, and with other agencies such as Victoria Police, at all levels. There are provisions for joint investigation, improved interagency cooperation, better information sharing and interchangeability of data.

**General comment about jurisdictional boundaries (all fire agencies):** Urban expansion leads to demographic changes that influence not only the propensity for but also the predominant causes of vegetation fires within a region. Areas that may have once been rural or regional becomes incorporated in the greater metropolitan region. The net result is that without an adjustment to jurisdictional boundaries, two different agencies may be responsible for neighbouring suburbs within what may currently represent a continuous urban mass. This does not take into account the jurisdictional boundaries that already exist between land management (for state forests and national parks) and other fire agencies. Although there may be genuine differences between the rates of smoking-related and deliberate fires in neighbouring CFA and MFB regions (it is impossible to determine from this analysis), the above discussion shows that it is possible for marked differences in causal attributions to occur across jurisdictional boundaries.

Inherent uncertainties existed in determining the cause of a vegetation fire. In the majority of cases, no formal investigation of vegetation fires was undertaken, with assessment of the cause of a fire being dependent on the attending fire officer's best estimate. In light of the difficulty in assigning fire causes, the varying skills of attending officers, the available investigative resources, and the inherent flexibility of the AIRS database, it is highly possible that any two officers attending the same fire would attribute a different causal factor or code that information in a different way. It is also likely that differences existed at an organisational level, such as procedural differences (policy and implementation, both formal and informal), the extent and types of training provided to fire officers, the resources available to the organisation for fire investigation etc., which would generate across-agency differences in causal attributions.

A hypothetical example of what this might look like for child fires is as follows. The AFAC guide to classification of child fires is:

If the intent was malicious, regardless of the age, the ignition factor should be recorded as incendiary or suspicious according to the circumstances. As an example, children playing with matches who accidentally start a fire in a house would be recorded here. If however, they had taken matches and set fire to grass with the intention of initiating an uncontrolled fire, the ignition factor would be recorded as incendiary.

Rarely would a child be caught in the act of lighting a fire and the exact intention of the child be elucidated. One agency might take the line: 'well we don't really know what the intention was, so the incendiary and suspicious categories are reserved for cases where there is very good evidence that the intention was malicious'. The advantage of taking this approach is that a large amount of information about the incidence and age of child fires is retained, information that would be lost within the database itself if those fires were simply classified as incendiary or suspicious. The agency could then use this information to direct when, where and how often to undertake fire awareness campaigns with children. On the hand, an agency might take the view that if a child takes matches to open grassland and proceeds to set it on fire, the intention was clearly to generate an uncontrolled fire, in which case it would direct its officers to classify those fires as incendiary or suspicious unless there were strong evidence that such fires were the result of play. Both approaches would fall within the AFAC guidelines but yield highly different results with regard to the incidence of suspicious and incendiary fires. The greater the incidence of child fires, the greater the discrepancy that may result between agencies.



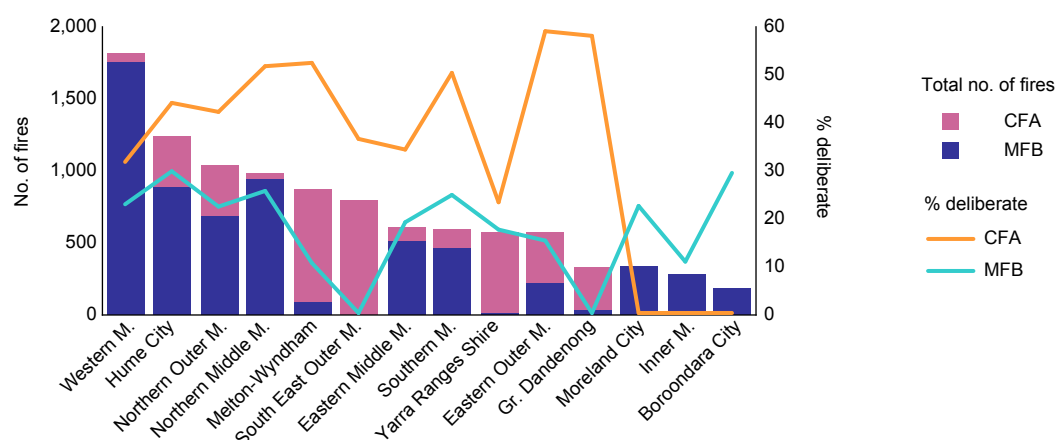
Jurisdictional boundaries pose limitations for fire agencies that do not exist for the general population, for the societal issues that may contribute to higher incidences of deliberate fires, or to the individuals who light fires. There are a number of levels at which jurisdictional boundaries may pose difficulties for fire agencies including, in the detection of fires, in the investigation of fires, and in the implementation of appropriate arson prevention strategies. The issue of detection is most central to themes of this report.

Jurisdictional boundaries potentially result in an incomplete knowledge of the incidence of vegetation fires (all causes) within a particular area. Temporal and spatial distributions of fires at a local level provide valuable insight about the cause of fires and the social patterns surrounding deliberately lit vegetation fires. When fires occur across jurisdictional boundaries, it is inherently more difficult to identify those patterns. Effectively, one agency may be unaware of how many fires another agency attended in the same area, or their distribution. Individually the number of fires may not seem large, but when the data are combined, the actual extent of the problem may be revealed.

Jurisdictional boundaries also potentially result in an incomplete knowledge of the principal cause of vegetation fires within a particular area. Although both agencies may be aware of a high incidence there may be vastly different perceptions about the relative importance of different causes. It is not difficult to envisage, from the CFA and MFB analysis outlined above, that one agency may have considered deliberate fires to have been particularly problematic in a given area, while the agency in a neighbouring area may have regarded the rates of deliberate fires to be comparatively low. Similarly, differing perceptions may arise about smoking-related fires and child fires, among other causes. There may be a flow-on effect to policies fire agencies adopt with regard to fire management in those areas, and to the level with which it is deemed necessary to implement arson reduction strategies (note: this is a hypothetical example and is not intended for either the CFA or the MFB).

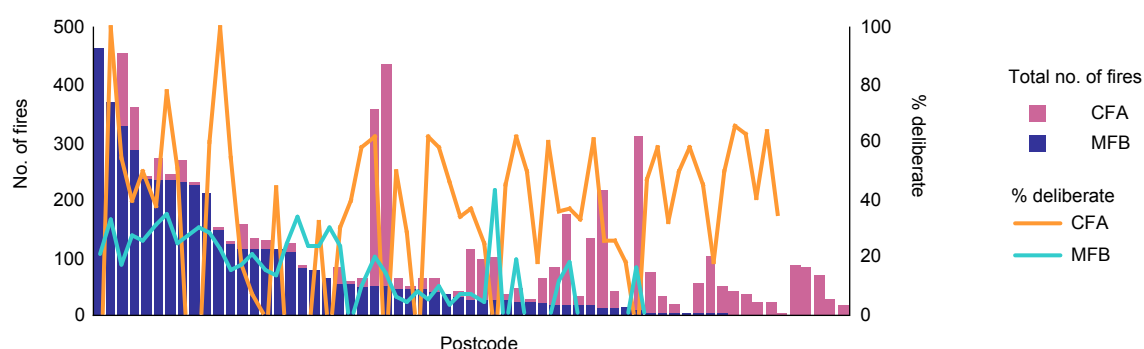
Given that police are also critical to the investigation and prosecution of offenders, local, regional, and state and territory boundaries in police services may also provide an added level of complexity over and above the jurisdictional boundaries that exist within the fires services. This is not to say that such problems would not exist in a single agency. In a single agency differences that manifest between officers or at a local (station) or regional level would be imbedded within datasets, that is they would exist but would be inherently more difficult to identify. Addressing the issue of arson prevention at all levels – detection, investigation and arson reduction – requires extensive liaison and information sharing within and between fire agencies, and police agencies, both at management and operational levels.

**Figure 87: Number of vegetation fires and percentage deliberate fires, by fire agency, in each SSD; 1999–2000 and 2001–02**



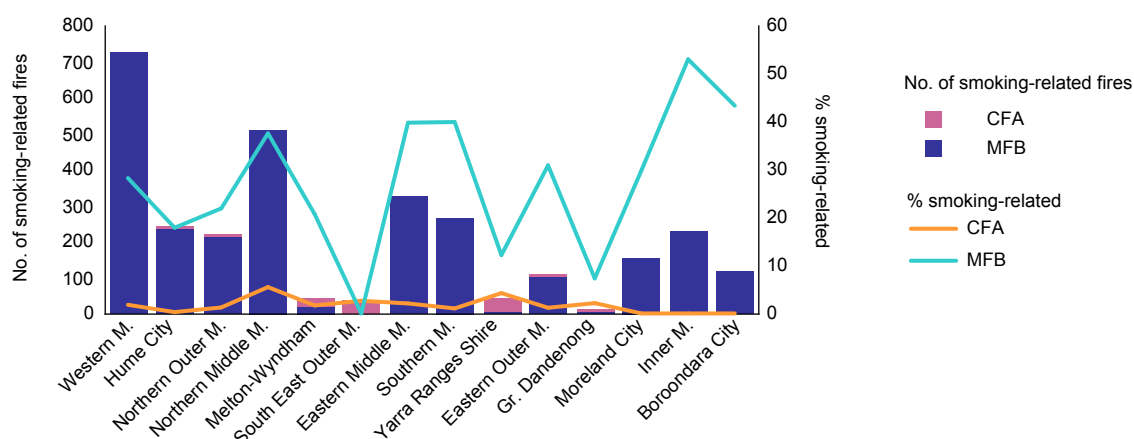
Source: CFA 1999–2000 to 2001–02 [computer file] and MFB 1999–2000 to 2001–02 [computer file]

**Figure 88: Number of vegetation fires and percentage deliberate fires, by fire agency, in each postcode; 1999–2000 and 2001–02**



Source: CFA 1999–2000 to 2001–02 [computer file] and MFB 1999–2000 to 2001–02 [computer file]

**Figure 89: Number and percentage of smoking-related fires, by fire agency and by SSD, 1999–2000 and 2001–02**



Source: CFA 1999–2000 to 2001–02 [computer file] and MFB 1999–2000 to 2001–02 [computer file]

## MFB and CFA – Population analysis for Victoria

**All vegetation fires:** A distinct association exists between high fire frequencies and high population densities. That such a relationship exists is supported by the general increase in total number of vegetation fires with increasing population within each postcode, although the actual rates were highly variable within a population of a given size, with distinct differences occurring between regional and metropolitan areas (Figure 90). Commonly, postcodes in metropolitan Melbourne recorded a lower number of vegetation fires per person than regional postcodes with an equivalent population, at all but the greatest fire frequencies.

The recorded rates of vegetation fires within individual Victorian postcodes varied between one and 1,000 fires per 10,000 people per year. Nevertheless, it is evident that when population is taken into account, the total number of fires per 10,000 people per year decreased with increasing postcode population (Figure 91). The slope of this line and the actual values recorded at lower population densities is likely to have been affected by the short observation period. A single vegetation fire determines the lower limit in a single year (base rate). As the population increases, the base rate determined by a single fire event will necessarily decrease. Overall, the trend observed in regional Victorian postcodes with less than 5,000

people parallels the base rate slope. A short observation period has a greater impact on postcodes with a small population.

Twenty-eight Victorian postcodes recorded no vegetation fires in a three-year period. Postcodes in the Melbourne region typically recorded between one and 60 vegetation fires per 10,000 people per year. In outer metropolitan and regional areas, typical values decrease from 10 to 100 vegetation fires per 10,000 people per year for postcodes with a population of 1,000, to seven to 60 vegetation fires per 10,000 people per year for postcode with more than 10,000 people, overlapping with the higher end of the range observed for Melbourne postcodes.

### Deliberate vegetation fires

The rates of deliberate fires per 10,000 people per year were also highly variable for Victorian postcodes. Typical rates ranging between 0.3 and 55 deliberate vegetation fires per 10,000 people per year.

Again, the minimum rate was determined by one deliberate fire in one postcode in a three-year period, and again the short observation period may lead to higher rates of deliberate vegetation fires per 10,000 people per year for very small communities. The maximum recorded rates of deliberate fires per person per year (20 to 30 deliberate fires per 10,000 people per year) remained comparatively uniform across a broad population range for postcodes with more than 1,000 people.

As observed for vegetation fires, the base rate as governed by one deliberate fire in three years decreased with increasing population. However, there was a critical population beyond which the minimum rates began to increase again. For regional Victoria this point occurred at approximately 5,000 people, whereas in the Melbourne region the value was over 10,000, attesting to the generally low rates of deliberate vegetation fires recorded for most Melbourne postcodes on a per-person basis. It is worth reiterating, that differences between the causal attributions for the CFA and MFB data discussed above may be important in generating the differences observed between the rates of deliberate vegetation fires on a per-person basis between the Melbourne and other outer metropolitan and regional areas.

Postcodes that recorded both high populations and high rates of deliberate vegetation fires per person per year have a large impact on the total vegetation fire frequencies in the state. Such postcodes were particularly evident in the Melbourne, Geelong, Bendigo–Loddon, Peninsula regions, and to a lesser extent the Ballarat region. Based on the combined CFA and MFB data, the eight postcodes that recorded in excess of 100 deliberate fires in three years accounted for eight percent of all deliberate vegetation fires (Table 5). The 20 postcodes that recorded 50 to 99 deliberate vegetation fires, and the 56 postcodes where 20 to 49 deliberate vegetation fires occurred (in three years), accounted for 16 and 23 percent of all deliberate fires in the state, respectively. One-quarter of all postcodes recording a fire, did not record a deliberate fire, and over half of the postcodes (N=268) recording a deliberate fire experienced less than five deliberate fires in three years. Collectively, postcodes recording less than five deliberate fires in three years were responsible for one-quarter of all deliberate fires in Victoria (excluding DSE fires). On average, the percentage of fires that were deliberate in a particular postcode decreased as the total number of deliberate fires in that postcode decreased. That is, on average a higher proportion of fires were deliberate in postcodes that recorded the highest number of deliberate fires (Table 5).

Although many Melbourne postcodes recorded low rates of deliberate fires per person per year, they commonly had a higher percentage of deliberate fires when compared with other areas with comparable rates of deliberate fires per person (Figure 92). This is despite the differences between the MFB and CFA data. Other fire causes played a more important role in regional Victoria.

**Comment:** Using population corrected data enables some perspective when comparing fire frequencies across vastly different regions, but some understanding of the statistical limitations is needed. It can be

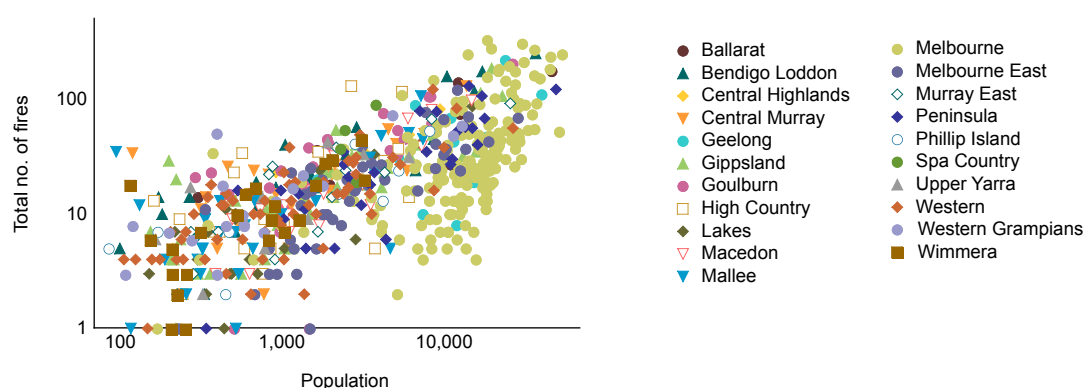
particularly useful to identify those areas where deliberate fires may have been more problematic than otherwise suggested by the data. For example, the Spa Country region recorded only 304 vegetation fires in the five-year period, with 30 percent of fires being deliberate. However, it is evident from Figure 92 that three postcodes, with approximately 5,000 people, had comparatively high rates of deliberate fires per person. Typically, 40 percent of fires in those postcodes resulted from deliberate causes.

**Table 5: Total number of postcodes with vegetation fires and deliberate fire frequencies within the specific ranges; CFA and MFB data combined; 1999–2000 to 2001–02**

Postcodes with deliberate fires	Number of postcodes	No. of deliberate fires	Total no. of fires (all causes)	% of fires in these postcodes that were deliberate	Proportion of all deliberate fires in Victoria
>99	8	1,033	1,773	58.3	8.2
50–99	20	1,386	3,355	41.3	15.6
20–49	56	1,791	4,957	36.1	23.0
10–19	80	1,092	3,647	30.1	16.9
5–9	81	541	2,389	22.6	11.1
<5	268	561	5,431	13	25.2
Total	512	6,404	21,552	29.7	100.0

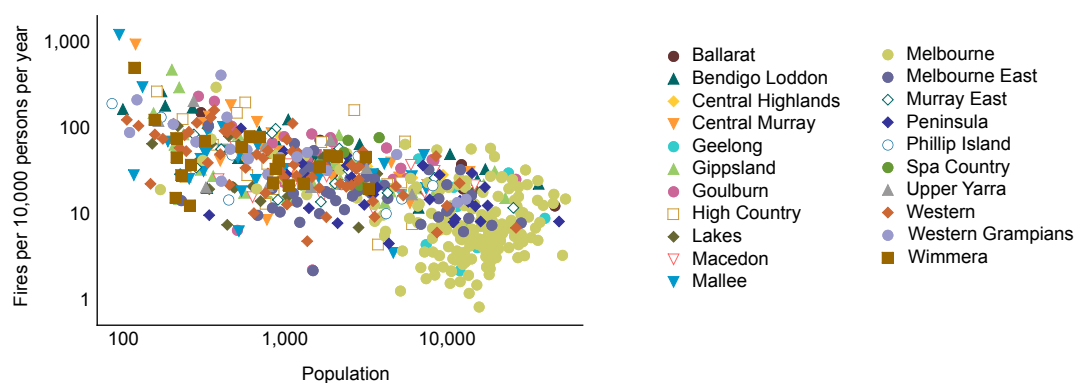
Source: CFA 1999–2000 to 2001–02 [computer file] and MFB 1999–2000 to 2001–02 [computer file]

**Figure 90: Vegetation fires and population, by postcode and by region (number)**

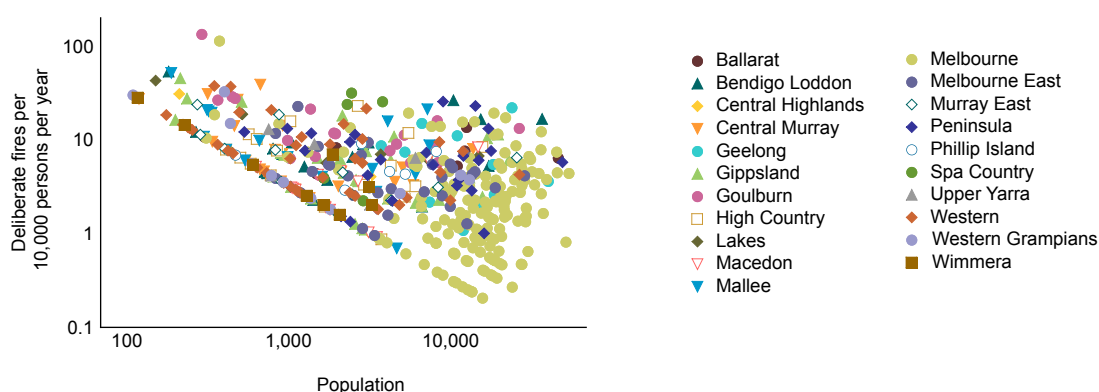


Source: CFA 1999–2000 to 2001–02 [computer file]; MFB 1999–2000 to 2001–02 [computer file]; ABS 2004. Population by post office area, 2001 [computer file]

**Figure 91: Fires per 10,000 people, for individual postcodes within each region (number)**



Source: CFA 1999–2000 to 2001–02 [computer file] and MFB 1999–2000 to 2001–02 [computer file]

**Figure 92: Deliberate fires per 10,000 people, for individual postcodes within each region (number)**

Source: CFA 1999–2000 to 2001–02 [computer file]; MFB 1999–2000 to 2001–02 [computer file]; ABS 2004. Population by post office area, 2001 [computer file]

## Department of Sustainability and the Environment

### Background information about the DSE dataset and its analysis

Important information about the Department of Sustainability and the Environment (DSE) dataset and the methodology employed to analyse it is outlined below:

- The data were sourced from the Victorian Department of Sustainability and the Environment (DSE).
- The database does not use AIRS classification codes.
- The dataset principally included vegetation fires; the database included 85 domestic rubbish fires and 31 industrial rubbish fires, although it is unclear if these fires were contained rubbish fires or subsequently spread to nearby vegetation. Similarly, not all fires that occurred in motor vehicles spread to surrounding vegetation.
- The DSE analysis is based on all fires within the DSE database, and although the term vegetation fires is used in this report to describe all DSE fires, a small number of fires may not genuinely have been vegetation fires.
- The analysis includes data from 1993–94 to 2003–04; the analysis is consistent with (that is, uses the same causal classification) and locally draws on data presented in Davies (1997) analysis of 1976–77 to 1995–96 DSE fire data in order to provide an overview of long-term variations in bushfire activity.
- The cause is defined based on the 'cause' variable.
- Deliberate vegetation fires pertain to all vegetation fires classified as 'deliberate lighting (malicious)' and 'burning vehicle, machine'. In order to be consistent with the analyses presented for other agencies, the term incendiary is used in all instances of the seven-fold causal classification scheme (that is, accidental, incendiary, suspicious, natural, reignition/prescribed burn/exposure, other and unknown), but the term deliberate is used in the non-deliberate versus deliberate classification scheme. The term deliberate is retained for instances where the causal category used Davies' Fire Management Branch (FMB) classification. However, it is only use of the terms that changes as deliberate (FMB) = incendiary = deliberate in all instances.
- All natural fires were the result of lightning.
- Smoking-related vegetation fires were classified on the basis of:  
Cause = 'Pipe, cigarette, match'. All smoking-related fires were considered accidental.

- The DSE defines an independent variable for the agent responsible for the fire. Hence, vegetation fires started by children in this analysis included all instances where a child was considered or identified as being responsible for the fire, and may be categorised as either accidental (non-deliberate) or incendiary (deliberate).
- The 'region' classification scheme used for the DSE analysis is based on DSE regions, and hence, are not consistent with the regions defined for the CFA or MFB data.
- Data does include area burned.

For more detail about these methodologies see the methodology chapter.

**Note:** Although causal information pertaining to the analysis may have stated with certainty, for example, '32 percent of DSE vegetation fires were deliberate', there was, in fact, considerable uncertainty about the actual number and proportion of fires that arose from a specific cause. Moreover, changes in other variables, such as the level of fire investigation training, can generate apparent trends that do not reflect actual changes in the cause of vegetation fires.

## Overview

Salient points about DSE fires are summarised as:

- The DSE attended 8,355 fires from 1991–92 to 2003–04. The average number of fires attended was 641 fires per year (sd=212), but actual fire numbers ranged between 247 in 1992–93 and 1,070 in 1997–98 (Figure 93). On average, the DSE attends nine percent of vegetation fires in Victoria each year (this does not take into account that the CFA may, depending on the size, location, and potential danger etc. also attend).
- The DSE attended fires both on the public lands that lay within its jurisdiction as well as fires on neighbouring lands where fires potentially posed a hazard for public lands. There may also have been instances where the DSE was called to assist the CFA and MFB. Hence, not all DSE-attended fires occurred in national parks or forestry reserves and, as indicated above, individual fires may appear in several agencies fire databases.
- Approximately four million hectares was burned in the interval from 1976–77 to 2003–04; the vast majority was burned in 1982–83 and 2002–03. Deliberate fires were responsible for 0.5 percent of the total area burned.
- Deliberate causes were responsible for 31.8 percent of vegetation fires, which represented 35 percent of 'known' causes.

## Cause

Almost one-third (32%) of DSE fires were classified incendiary (Figure 94). This was the single largest assigned cause of fires, comprising 35 percent of 'known' causes. Almost 28 percent of all fires during this interval were accidental in origin, with a further one-quarter of fires resulting from natural causes. Fires were assigned an unknown cause (includes missing data) in 9.4 percent of cases.

## Specific ignition factors

FMB cause reflects the methodology Davies (1997) used in his analysis of DSE data for the period 1976–77 to 1995–96. This section is based on annual data from 1991–92 to 2003–04 (includes data from Davies 1997) and five-year averaged from 1976–77 to 2003–04. The last period from 2001–02 to 2005–06 was incomplete. Figures that draw on the percentage cause represent actual values calculated on the

restricted data range, but frequencies were estimated for the five-year interval based on available frequencies over the restricted timeframe.

Notable finding can be summarised as:

- Both the annual data from 1991–92 to 2003–04 (Figure 95) and the five-year averages from 1976–77 to 2004–05 (incomplete; Figure 96) record an increase in the average number of deliberate fires over time, although the actual number tended to be somewhat variable from year to year.
- The number of natural fires started by lightning strikes was highly variable, with distinctly higher numbers of natural fires occurring in 1997–98, and to a lesser extent 2002–03. Heterogeneity also existed within the five-year averages. There was great potential for a single year, like 1997–98, to strongly affect the five-year average within which it lies.
- The number of fires recorded as escapes of campfires and barbecues increased slightly over the observation interval. This was evident both for five-year average data from 1976–77 to 2004–05 and the annual data from 1991–92 to 2003–04.
- Long-term, the numbers of fires resulting from escaped burn offs decreased. This was evident in the long-term, five-year average data but was not obvious in the annual data from 1991–92 onwards.
- There was a marked decrease in the number of smoking-related fires. This was evident from the early 1990s, being reflected in both the annual data and the five-year averages.

Although the number of deliberate fires has continued to increase since the mid 1970s, the proportion of deliberate fires has remained stable at 30 to 32 percent since the early 1990s (Figure 97). This compares with values of 18 to 21 percent for the period from the mid 1970s to the early 1990s.

There appears to be an antipathetic relationship between the proportion of deliberate and natural vegetation fires (Figure 97). In years with a higher frequency of lightning strikes, such causes typically account for a higher proportion of fires and hence deliberate cause comprises a lower proportion of all fires. This was particularly evident for 1997–98 and to a lesser extent 1998–99.

Based on five-year averages, the percentage of escaped burn offs (not departmental burns) and smoking-related fires decreased, and the proportion of escapes of recreational fires (campfire, barbecue) increased, over the extended observation period (Figure 98). These trends were less evident in the annual data (Figure 97).

Despite the dramatic increase in the proportion of deliberate fires in the early 1990s some caution is required before extrapolating these results longer-term, for example, by inferring that the rates of arson have dramatically increased in recent years. Potentially many factors affect data long-term; one of the most fundamental pertains to causal assignments.

In the early 1990s, the DSE implemented a training program covering fire investigation for a large number of their regional staff. It would be expected that as staff became more skilled at identifying the likely cause of a fire, in particular separating accidental and deliberate fires, there would be a marked shift in subsequent causal attributions. This is one possible explanation for the sudden shift in deliberate, but also other causes, in the early 1990s.

**Smoking-related fires (including matches):** Smoking-related fires are one category that may have been affected by the 1990s fire investigation training. The numbers of smoking-related fires (including matches) dropped from 55 to 60 fires per year in the mid eighties, to 10 to 15 fires per year since the mid 1990s (Figure 99). Although higher frequency were principally recorded in 1991–92, 1994–95 and 1996–97, the proportion of smoking-related fires has continued to decline, owing to increased numbers of fires of other causes. Smoking-related causes were considered responsible for starting 157 out of 7,482 (2.1%) of fires between 1993–94 and 2003–04.



**Deliberate fires – burning vehicles:** Approximately 18 percent of all deliberate lightings that occurred between 1993–94 and 2003–04 involved burning vehicles, with this cause comprising almost five percent of all fires attended by the DSE in Victoria. On average 30.5 vehicles were burned on public land in Victoria every year, ranging from seven in 1993–94 to 54 in 1997–98 (Figure 100). Burning vehicle fires comprised between six and 26 percent of deliberate fires in any given year, and have commonly accounted for five percent of all DSE-attended fires since 2000 (Figure 100). In many instances the vehicle fires did not spread to surrounding vegetation, but merely resulted in incineration of the vehicle. This does not, however, negate the potential danger that such fires posed to the environment.

**Agent responsible for fire:** Human beings were implicated in 43.8 percent of DSE-attended fires. This represents 64 percent of all cases when the agent responsible for the fire was ‘identified’. People involved in recreational activities contributed to 9.8 percent of fires, residents 8.1 percent, farmers and graziers 7.2 percent, and children 6.5 percent (Figure 101).

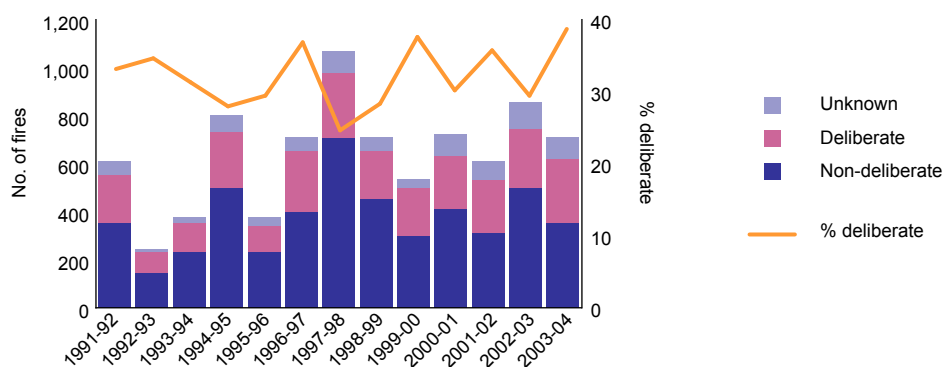
The causal attributions varied markedly between agent types. Not surprisingly, burn off escapes were the most important factor in fires attributed to government employees, farmers/graziers and residents, and escapes of campfires and barbecues were the principal causal category associated with recreationists (Figure 102).

The agent responsible for deliberate fires was unknown in 56 percent of cases from 1993–94 to 2003–04. Of those where the agent was known, the largest number were lit by children (n=340), ‘other’ agents (n=233), recreationists (n=151), residents (n=120), followed by farmers/graziers (n=108) and travellers (n=82).

Seventy percent of fires lit by children were classified as deliberately lit, with a further 13 percent of child fires being smoking-related (Figure 102). The causal attributions for travellers most closely approximated those observed for children; 57 percent of traveller fires were deliberately lit, with a further 11 percent being smoking-related. Approximately 40 percent of fires lit by ‘other’ agents and 20 percent of fires lit by recreationists, residents and farmers/graziers were classified as deliberate.

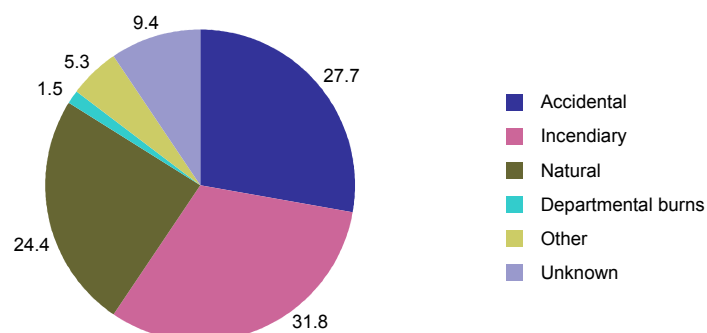
Recreationists were further classified into four categories, based on the activities that brought them into the regions where the fires started; namely, bushwalkers, campers, day visitors and fishermen. Most fires attributed to recreationists were started by campers (54%), followed by day visitors (27%), fishermen (17%) and bushwalkers (3.3%). Fires originating from the escape from campfires and barbecues were highest among campers and, to a lesser extent, fishermen (Figure 103). Day visitors lit the greatest number of deliberate fires (n=68), followed by campers (n=47) and fishermen (n=27). Although deliberate causes comprised a high proportion of fires started by bushwalkers (almost 40%), this group was only responsible for nine deliberate fires in 11 years.

**Figure 93: Number and cause of vegetation fires each year**

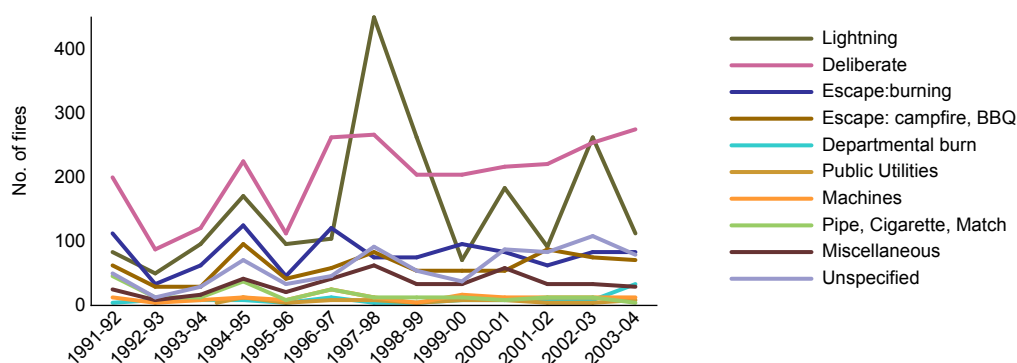


Source: DSE 1993–94 to 2003–04 [computer file]; Davies 1997

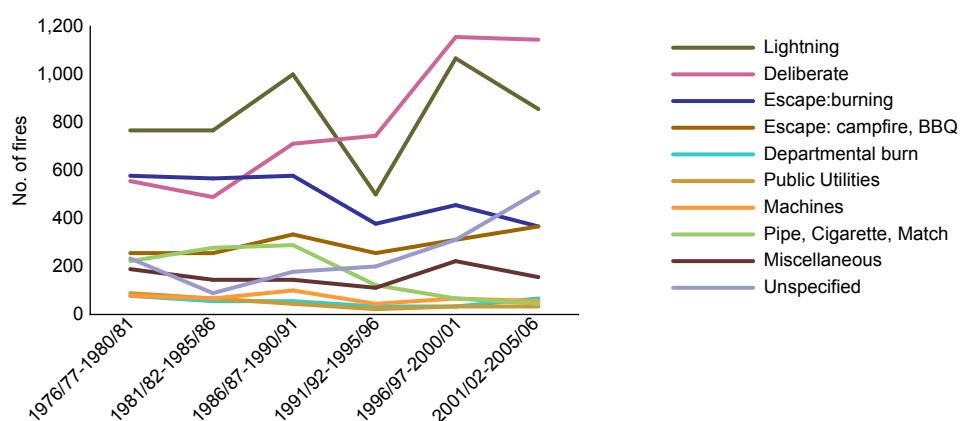


**Figure 94: Fire cause, 1991–92 to 2003–04 (percent)**

Source: DSE 1993–94 to 2003–04 [computer file], Davies 1997

**Figure 95: FMB cause each year (number)**

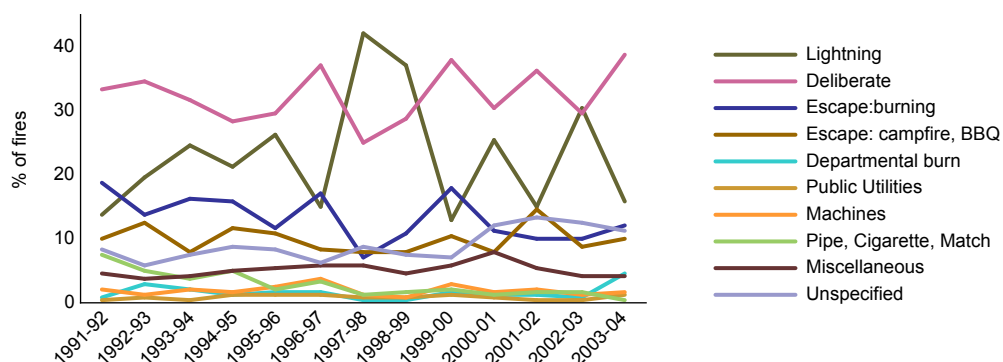
Source: DSE 1993–94 to 2003–04 [computer file], Davies 1997

**Figure 96: Five-year average of FMB cause (number)<sup>a</sup>**

a: the number of fires in the 2001–02 to 2005–06 interval were estimated based on the frequencies and relative proportions of fires between 2001–02 until 31 January 2005

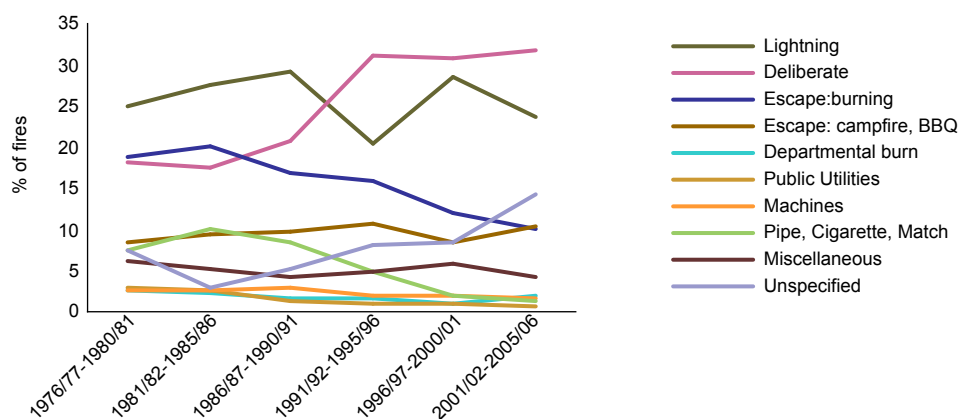
Source: DSE 1993–94 to 2003–04 [computer file], Davies 1997

**Figure 97: FMB cause each year (percent)**



Source: DSE 1993-94 to 2003-04 [computer file], Davies 1997

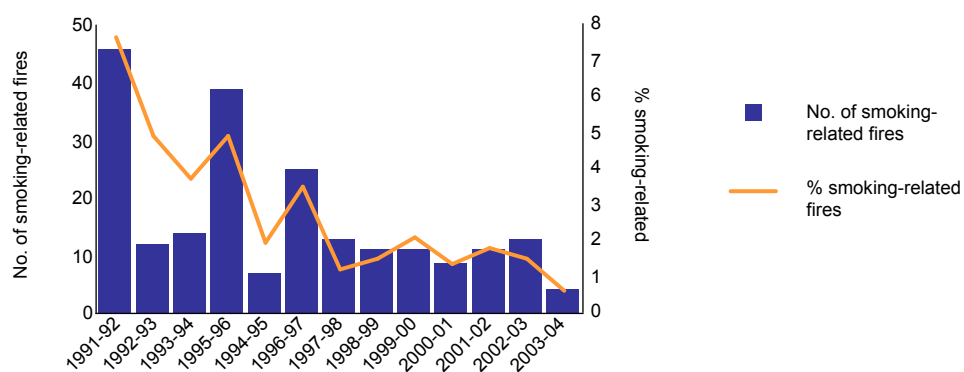
**Figure 98: Five-year<sup>a</sup> average of FMB cause (percent)**



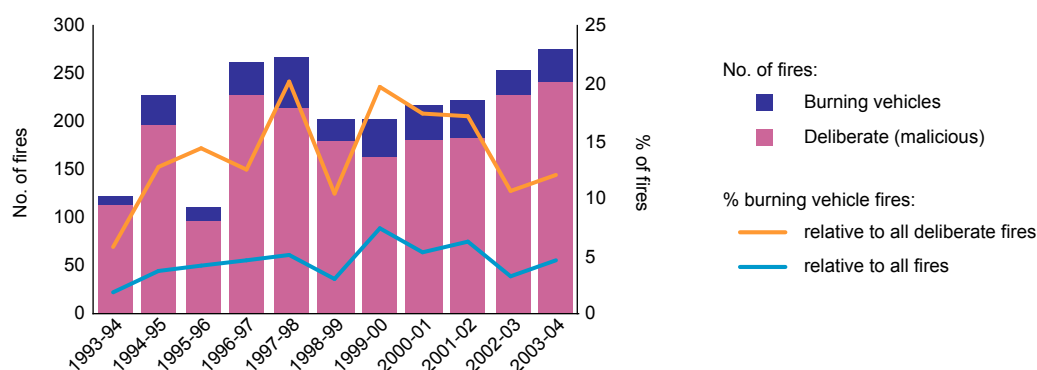
a: values for 2001-02 to 2005-06 are based on actual data for 2001-02 to 31 January 2005

Source: DSE 1993-94 to 2003-04 [computer file], Davies 1997

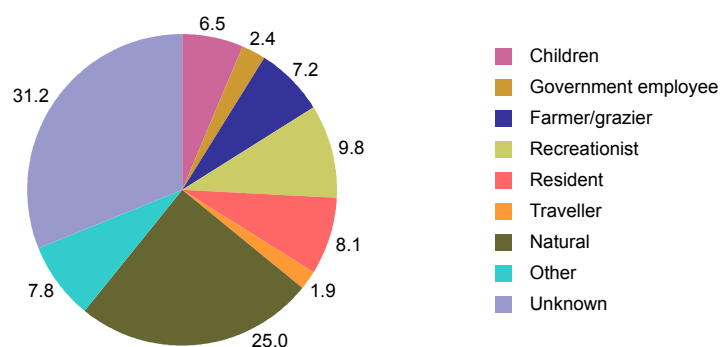
**Figure 99: Number and percentage of smoking-related fires, by year**



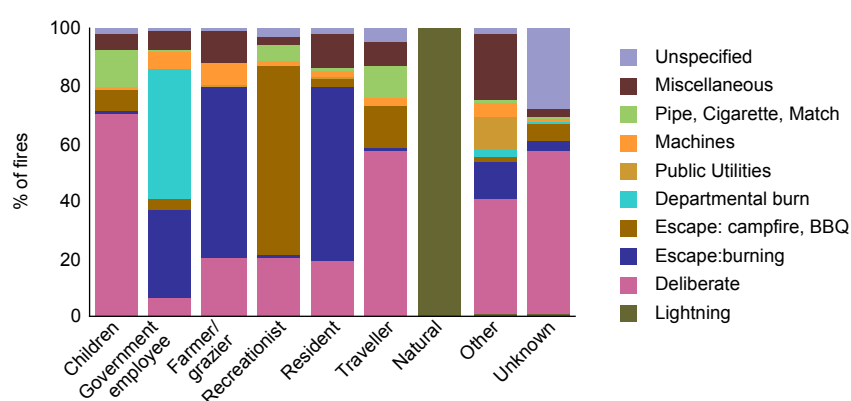
Source: DSE 1993-94 to 2003-04 [computer file], Davies 1997

**Figure 100: Deliberate (malicious) fires and burning vehicle fires, by year**

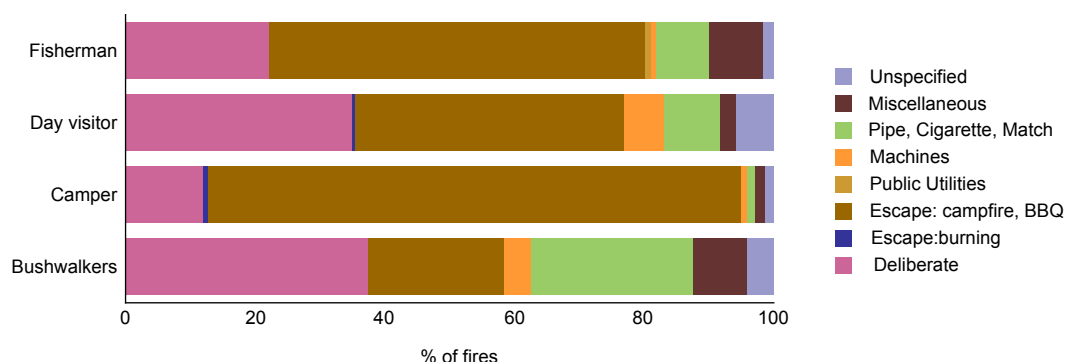
Source: DSE 1993-94 to 2003-04 [computer file]

**Figure 101: Agents responsible for fire (percent)**

Source: DSE 1993-94 to 2003-04 [computer file]

**Figure 102: Agent responsible for fire, by FMB cause (percent)**

Source: DSE 1993-94 to 2003-04 [computer file]

**Figure 103: Fires started by recreationists, by FMB cause (percent)**

Source: DSE 1993–94 to 2003–04 [computer file]

## Location

The location of DSE-attended fires was examined by region, including the regional distribution of fires of specific causes, and the agent responsible for fires, as well as the tenure of land on which the DSE attended fires.

## Region and districts

The DSE defined five regions in Victoria, including the North East, North West, Gippsland, South West and Port Phillip (Figure 104). Vegetation fires were comparatively evenly distributed across all Victorian regions except the Port Phillip region, where the comparatively small number of fires reflected the small geographical extent of DSE tenure in that region. There were regional differences in the dominant cause and dominant agents responsible for vegetation fires in each region reflecting, among other variables, differing population distributions and land use practices. These are discussed below.

## Cause

Regional differences in the cause of DSE fires for the period 1993–94 to 2003–04 are summarised as:

**Deliberate fires:** The greatest number of deliberate fires occurred in the North West (796 fires) and South West (705 fires) regions (Figure 105). Other regions recorded from 177 to 360 during the same interval. Deliberate fires comprised a high proportion of fires in both the North West and South West (42 to 44%), but also in the Port Phillip region (37%; Figure 106). The latter was intermediate between, but broadly consistent with, the values the CFA documented for the Melbourne (49% deliberate) and Melbourne East (25% deliberate) regions.

**Natural fires:** the greatest number and proportion of fires started by lightning occurred in the Gippsland (n=754; 43%), North East (n=449; 28%), and South West regions (n=428; 22%).

**Escapes of burn offs:** This a minor factor responsible for fires in all areas, typically accounting 13 to 15 percent of vegetation fires in each region. The exception was the North West where just eight percent of fires arose from this cause.

- **Recreational fires:** The greatest number of recreational fires occurred in the North East (248 fires), North West (217 fires) and to a lesser extent the South West (129 fires) regions (Figure 105). In these regions, recreational fires contributed to 16 percent, 12 percent and 6.8 percent of fires respectively (Figure 106).
- **Burning vehicles:** The greatest number of fires involving burning vehicles occurred in the South West, followed by the North East, and North West regions. Burning vehicles accounted for 17 to 18 percent of deliberate fires in the Port Phillip and South West regions, but only eight to nine percent of deliberate fires in the Gippsland and North West regions. In the North East region, such causes accounted for 28 percent of all deliberate fires. Roughly 10 vehicles have been burned on or near DSE lands in the North East every year since 1996–97.

**Smoking-related fires:** Between 16 (Port Phillip) and 44 (South West) smoking-related fires occurred in any one region over the observation period. Smoking-related fires comprised between 1.5 percent (Gippsland) and 3.9 percent (Port Phillip) of vegetation fires. That a higher proportion of smoking-related fires were reported for the Port Phillip region is not surprising given the high incidence of fires documented for the Melbourne region generally (see MFB analysis), and the comparatively lower contributions from natural causes. The Port Phillip region has the greatest population density of any DSE region, and reserves in close proximity to metropolitan Melbourne have high visitation rates.

**Agent responsible for vegetation fires:** Some caution is needed when drawing conclusions from regional variations in the causal agents responsible for fires owing to the greater body of unknown causal agents. Based on the available attributions, the following trends were ascertained:

- **Children:** The greatest numbers of fires were attributed to children in the North West (n=226) region followed by the South West (n=129) and North East (n=72) regions (Figure 107).

In the North West, children were identified as being responsible for 12.4 percent of all fires in the region (Figure 108), and were the largest single identified causal agent, comprising 22 percent of cases where the causal agent was 'known'. Approximately 96 percent of all child fires in the North West region occurred within the Bendigo district, and principally within and around the city of Bendigo. The high number of fires started by children (indeed deliberate fires generally) around Bendigo reflects the extensive interface between the urban environment and the state forest, and other parks and reserves throughout the city and environs. Approximately 82 percent of child fires in the North West were deliberately lit, with a further 10 percent being smoking-related.

Despite the high number, fires attributed to children comprised just 6.8 percent of all fires in the South West region. The greatest number of child fires in the region occurred in the districts of Bacchus Marsh (33% of child fires in the South West region), Ballarat (43%) and Horsham (16%). Although the majority (59%) was considered malicious, 18 percent resulted from escaped campfires and barbecues, and a further 15 percent were smoking-related.

In the North East region, children were responsible for 4.5 percent of all fires. Approximately 54 percent of these are deliberately lit, with children accounting for at least 12 percent of all deliberate lightings in the North East region; this represents 22 percent of deliberate fires where the agent was 'known'. Twenty-two percent of child fires in the North East were smoking-related with a further 11 percent representing escapes from campfires and barbecues.

Although the frequency was comparatively lower, children accounted for 9.6 percent of fires in the Port Phillip region, a finding that is consistent with observations from the MFB and CFA data. In contrast, only 1.4 percent of fires in the Gippsland region were attributed to children, with 10 of the 18 child fires in that region being considered deliberate.

- **Other agents:** Further summarised points about other causal agents are:

In keeping with the causal data, recreationists were responsible for the greatest number of fires in the North East and North West regions (Figure 107); they were responsible for 21 percent of cases where the agent was known (Figure 108).

Residents in all regions started similar proportions of fires. With the exception of the Port Phillip region, the proportion of all vegetation fires started by farmers/graziers was also comparable across regions.

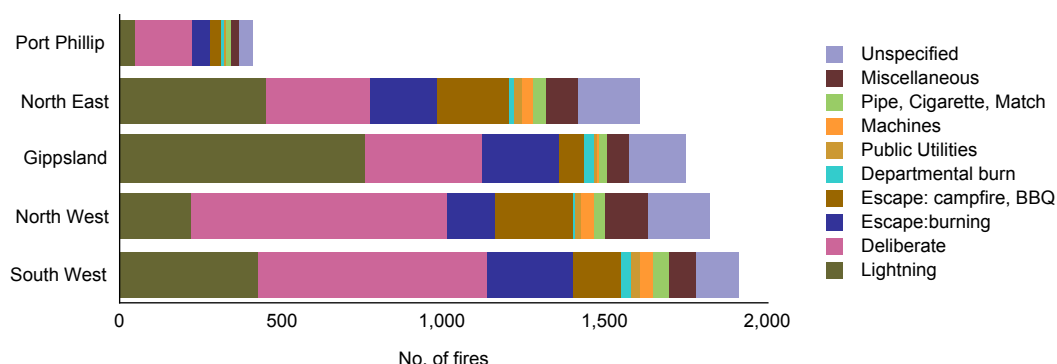
A refined examination of only the agents specifically responsible for deliberate fires in each region shows that children were responsible for a higher proportion of deliberate fires in those areas that recorded a high number of child fires generally (Figure 109). Recreationists were responsible for a high proportion of deliberate fires in the North East but not in the North West, despite both regions recording high numbers of fires started by recreationists. Similarly, residents contributed to a high proportion of deliberate fires in the Gippsland region. Farmers and graziers were responsible for the highest proportion of deliberate fires in the North East and Gippsland regions. There is, however, some uncertainty in these results as there were very high levels of unknown/unidentified causal agents for deliberate fires.

**Figure 104: Map of DSE regions**

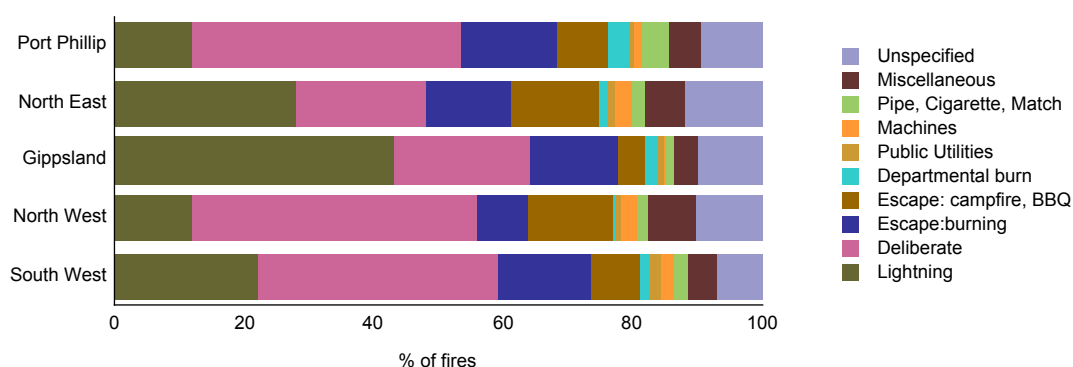


Source: DSE 2007a

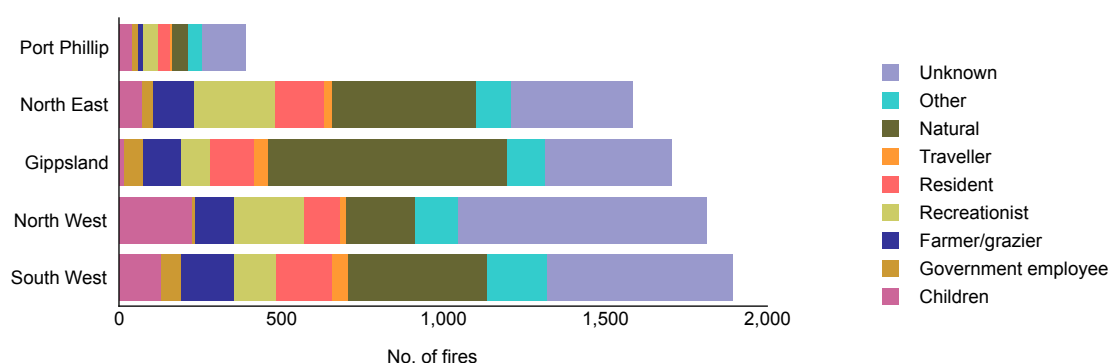
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**Figure 105: Fire cause, by DSE region (number)**


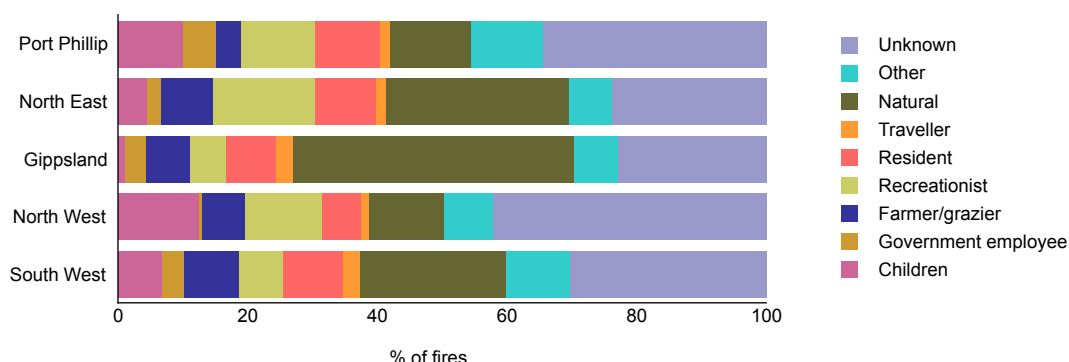
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 106: Fire cause, by DSE region (percent)**


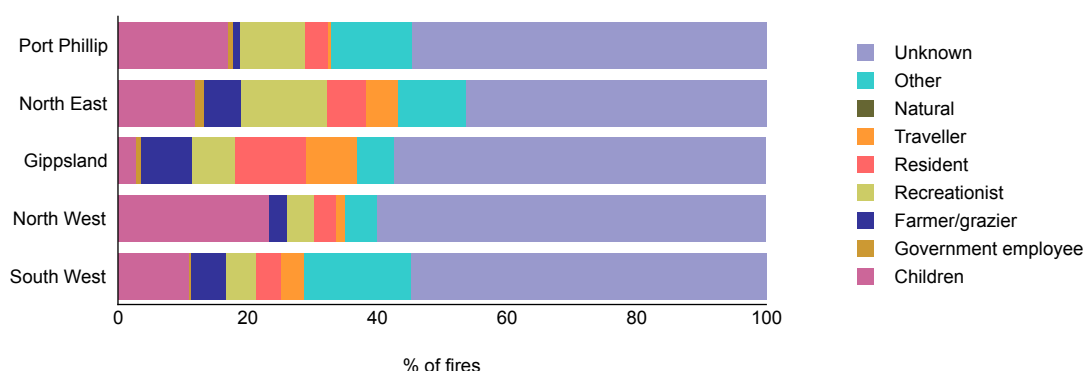
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 107: Agent responsible for fire, by region (number)**


Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 108: Agent responsible for fire, by region (percent)**


Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 109: Agent responsible for deliberate fires, by region (percent)**


Source: DSE 1993–94 to 2003–04 [computer file]

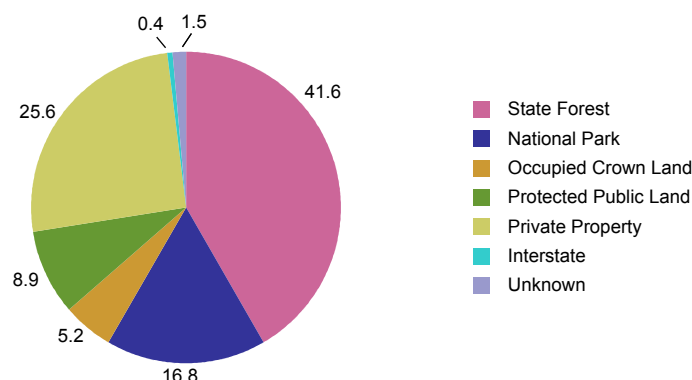
## Tenure

It is emphasised the land tenure may have changed markedly over the last 20 years. The following analysis is based on statistics provided for fires since 1993–94.

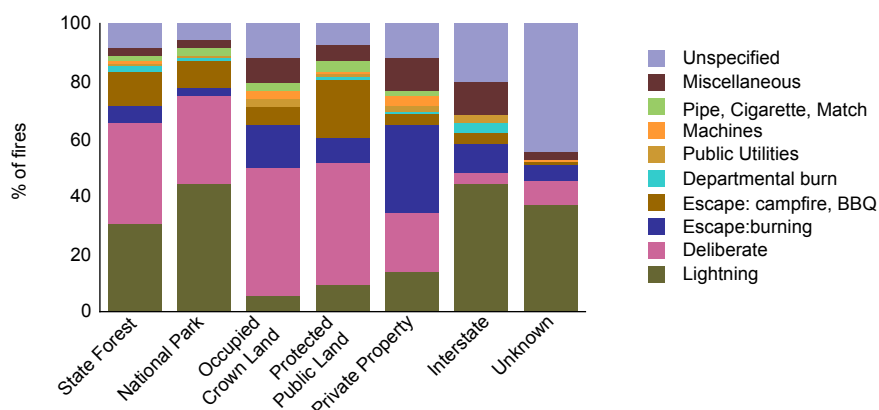
Forty-two percent of DSE-attended fires occurred in state forests with 26 percent on private property and 17 percent in national parks (Figure 110). In state forests deliberate lightings outweighed natural fires 6:5 and collectively these two causes accounted for two-thirds of fires in this tenure (Figure 111). In contrast, natural fires were 1.5 times more frequent than deliberate lightings in national parks. Collectively, natural and deliberate causes accounted for three-quarters of all fires on that tenure. Approximately 43 to 44 percent of fires on unoccupied Crown land and protected public lands also resulted from deliberate causes.

A high proportion of fires on private property resulted from the escape of burn offs (31%). However, 20 percent of the fires on private property were classified deliberate.



**Figure 110: Land tenure on which fires occurred (percent)**

Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 111: Land tenure on which fires occurred, by region**

Source: DSE 1993–94 to 2003–04 [computer file]

## Timing

The timing of fires was examined by week of the year and by day of the week.

### Week of the Year

Most vegetation fires occurred between mid September and late April, with the greatest number of fires occurring in the weeks around Christmas–New Year. Nevertheless, the principal time that fires occurred varied between causes (Figure 112 and Figure 113). Natural fires typically occurred within a narrow interval that spanned end November to end February (Figure 112). Although, deliberate fires were more evenly distributed throughout the year, peak numbers coincided with the peak numbers in natural fire frequencies. Recreational fires (campfires and barbecues) were most common around Christmas–New Year and March–April, coinciding with Christmas and Easter holidays respectively (Figure 113).

Fires collectively described as burning off comprised fires lit for vegetation removal, burning for regeneration in areas where timber has been harvested, and fuel reduction burning for wildfire mitigation. The timing of burn offs may vary between these different activities, as there are fundamentally different

objectives. Commonly, escaped burn offs in November and December related to fires that started on freehold land, but subsequently spread to public land. There was a large increase in the number of burn offs in November–December, immediately before seasonal fire restrictions (Figure 113). Similarly a large number of burn offs occurred in late March–April, when fire restrictions were removed.

The timing of the bushfire season and, hence, the dominant timing of DSE vegetation fires varied subtly between years (Figure 114):

- In 1997–98, 214 fires occurred during week 48 (early December), before the late December–early January maxima. Of these, 179 resulted from lightning strikes. The majority (n=132) occurred in the Gippsland region. Only one deliberately lit fire occurred in the Gippsland region during that week.
- In 2001, 166 fires occurred during week 1 of 2001. Of these 134 were natural. These fires primarily occurred in the Gippsland and South West regions although elevated numbers of fires occurred in the North East region. Only three deliberate fires were lit during this week.
- In 2002–03, several small spikes in fire activity in mid September and early November preceded the early January fires that subsequently burned 1,000,000 ha in the state's northeast. The spike in mid September resulted from a mixture of causes, although burning off stubble and grass, and deliberate fires featured most frequently. In contrast, 48 of the 68 fires in week 44 (early November) resulted from lightning. Seven deliberate fires were lit during this week.

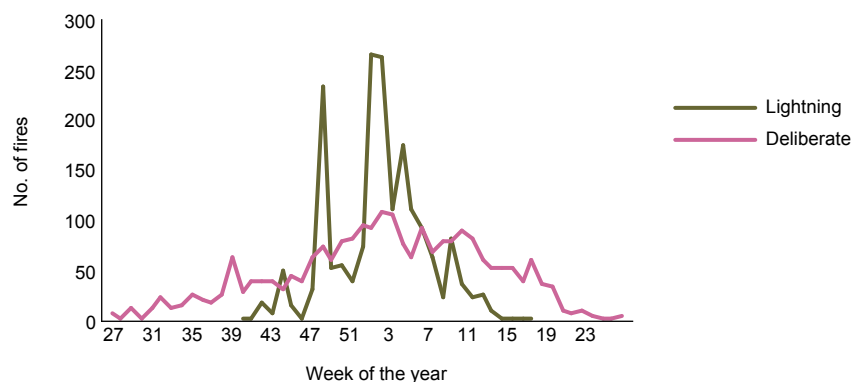
There were strong parallels between the distribution of deliberate and child fires throughout the year. The greatest number of child fires occurred during late December–early January, with the number of child fires decreasing as the school holidays progressed (Figure 115). The number of child fires decreased in February, but subsequently increased in March. Presumably, this reflected increased numbers of fires during the Easter school holidays (the timing of which varies from year to year).

No substantial differences were evident between the timing of fires in different regions of Victoria.

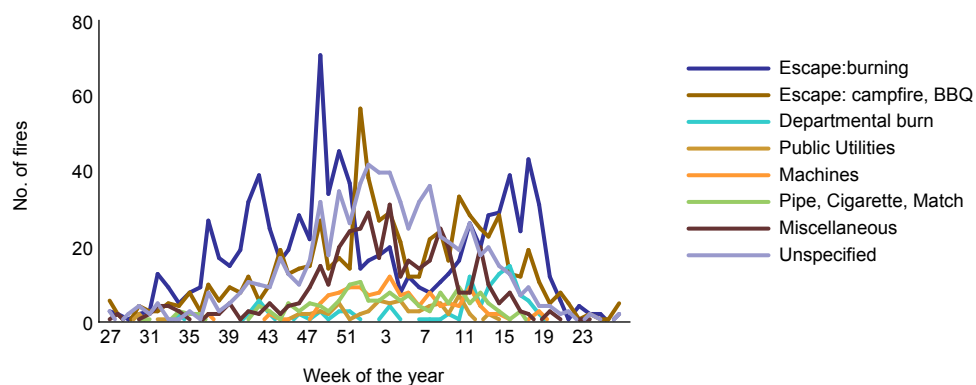
### Day of the week

No substantial or predictable differences were evident in the numbers of non-deliberate, deliberate and unknown fires that occurred on different days of the week (Figure 116). Nevertheless, trends were evident for specific groups. For example, recreationists lit 70 percent more fires on Saturday and Sunday than on the average weekday (Figure 117). Children lit about 30 percent more fires on Saturday than on the average weekday, with subtly higher fire numbers also occurring on Sundays and Mondays (Figure 117). The lack of distinctly higher numbers of child fires on weekends may be consistent with the observation that many child fires occurred during school holidays, but was not reflected in either the metropolitan or regional fire data.

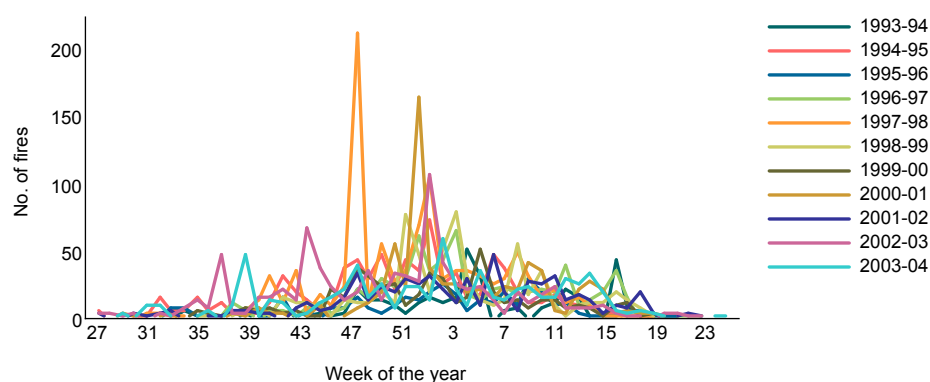
Overall, greater numbers of campfire/barbecue escapes occurred on Saturday, Sunday and Monday than on other days of the week (Figure 118). The number of deliberate fires was also greater on Sunday and Monday, but not on Saturday.

**Figure 112: Natural and deliberate fires, by week of the year (number)**


Source: DSE 1993–94 to 2003–04 [computer file]

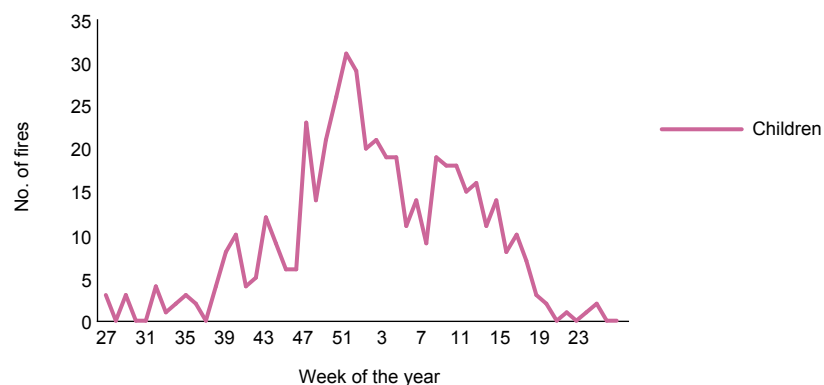
**Figure 113: week of the year fires occurred, by cause (number)**


Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 114: The week of the year fires of all causes occurred, by year (number)**


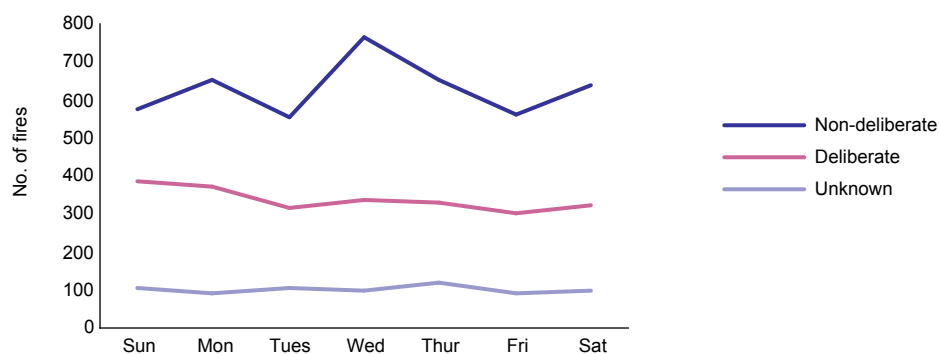
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 115: Fires started by children, by week of the year (number)**



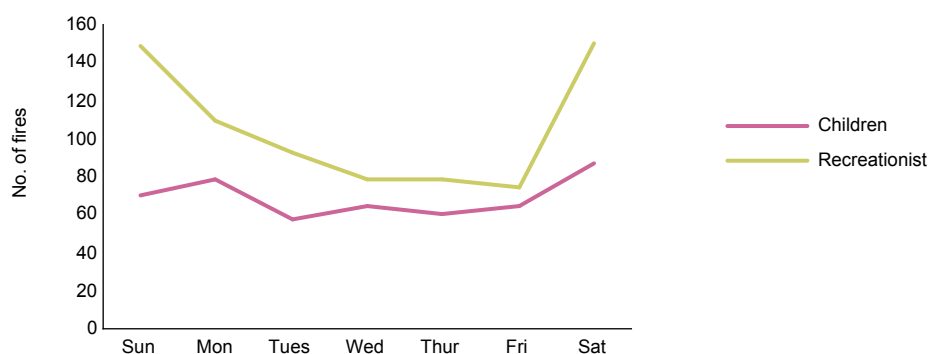
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 116: Day fires occurred, by cause (number)**

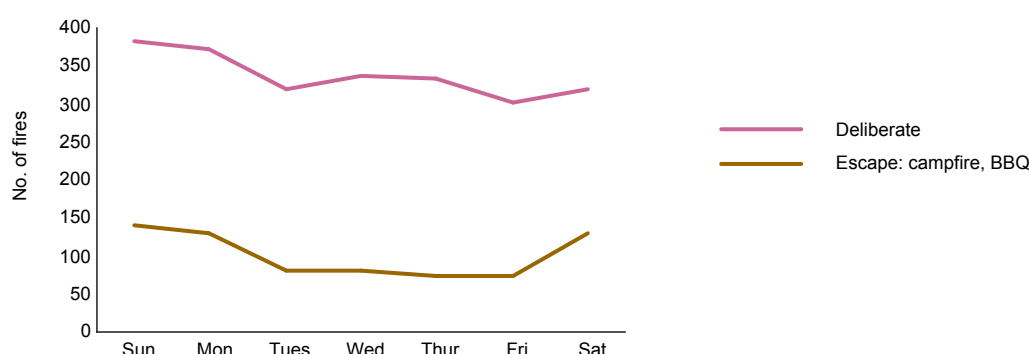


Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 117: Day fires occurred, for children and recreationists (number)**



Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 118: Deliberate fires and escapes of campfires/barbecues, by day of the week (number)**

Source: DSE 1993–94 to 2003–04 [computer file]

## Area burned

The majority of fires the DSE attended were small; 59 percent were less than 1 ha and 86 percent were less than 10 ha. Overall, the number of fires decreased with increasing fire size, although as observed elsewhere there was a characteristic hump for the 10–49 and 100–500 ha categories (Figure 119). The distribution for area burned was similar across all years for fire size of fires less than 500 ha, but large events were restricted to specific years. These were generally years characterised by many large fires, not just one-off large fires, and were typically associated with drought.

The distribution of large fire events determines the total area burned in any one year. For example, fires of 10,000 ha were responsible for 86 percent of all land burned in DSE-attended fires during 1993–94 and 2003–04. Fires between 1,000 and 9,999 ha contributed to a further 8.7 percent. Fires less than 100 ha accounted for just 1.6 percent of the total area burned. Many factors may affect fire size. For example, given the same drought conditions and fire weather, fires that started in remote locations would result in larger fires, as it is more difficult to establish control lines as compared with fires that occurred in areas of higher population density where there are adequate road systems and more available suppression forces.

Although the number of fires decreased with increasing fire size for all causes (Figure 119), there were some differences in the distribution of fires based on cause (Figure 120):

- A high proportion of large fires were natural in origin. Lightning was the only cause of fires larger than 100,000 ha (n=2).
- Escapes of departmental burns tended to be moderately large in size. Almost half burned in excess of 10 ha, and 10 fires (9%) burned greater than 500 ha. The largest burned 28,800 ha in the North West of the state in 2001–02.
- Deliberate fires, overall, accounted for a decreasing proportion of fires with increasing area burned (Figure 120). Nevertheless, exceptions were noted. Sixteen deliberately lit fires burned 500 ha or more, and seven burned 1,000 ha or more. Four of those seven fires occurred in the South West region, but the two largest, which burned 6,100 and 5,149 ha, occurred in the North East region. Of those deliberate fires greater than 1,000 ha only one occurred during 2002–03, that is, during a particularly adverse year. Only two fires greater than 500 ha were deliberately lit during 2002–03.

- The proportion of fires resulting from escape of campfires or barbecues and smoking-related fires were primarily small, and such fires generally accounted for a decreasing proportion of fires in larger area categories. Nevertheless, some exceptions are noted. There were two cases where escapes from a campfire or barbecue resulted in more than 10,000 ha being burned. In 1994–95 one fire burned 10,050 ha in the South West region. The largest burned 32,000 ha in the Gippsland region during 1997–98. The largest smoking-related fire burned 2,310 ha in the North West region during 2000–01.

Approximately 1.7 million hectares were burned in total, in DSE-attended fires on and off public lands from 1993–94 to 2003–04. Fire statistics for the total area burned were necessarily dominated by large fire events during this period.

From 1993–94 to 2003–04, fires started by lightning strikes accounted for 92 percent of the total area burned in DSE-attended fires in Victoria (Figure 121). These figures are dominated by the 2002–03 statistics when a fire started by lightning burned 1,092,421 ha in the North East region. Another two fires started by lightning during the same year burned 181,400 ha and 31,530 ha in the North West and Gippsland regions respectively. These fires accounted for three-quarters of the total area burned in DSE fires between 1993–94 and 2003–04.

In the same period deliberate fires accounted for only 0.5 percent, escapes from campfires or barbecues 2.7 percent, and smoking-related fires just 0.2 percent of the total area burned. Escapes from campfires or barbecues actually contributed to the largest area burned by any human-related activity (2.7%; Figure 121) followed by departmental burns (2.4%), and escapes from burn offs (1.0%). For all causes, the proportion of the total area burned was dominated by largest fire events relating to each cause.

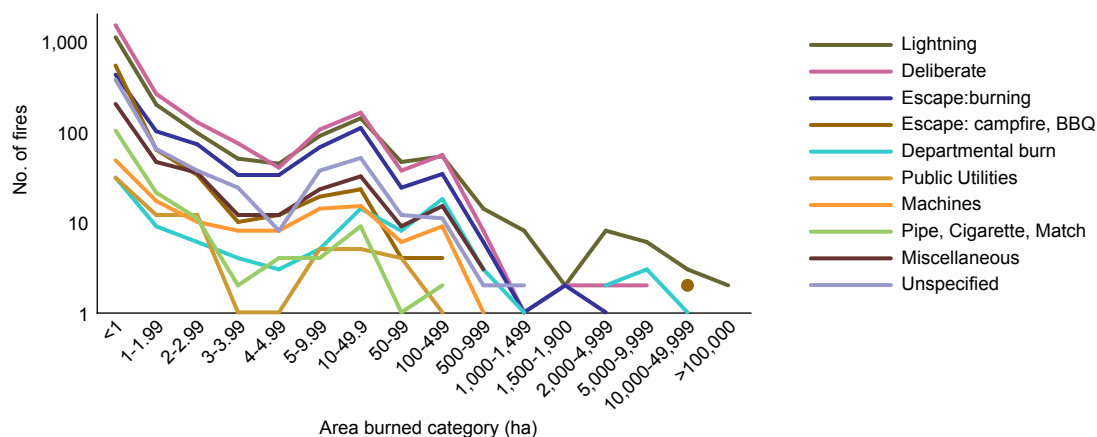
The amount of land burned in any one year was highly variable, ranging from 1,345,654 ha in 2002–03 to 14,170 ha in 1993–94. The total area burned and the principal causal attribution varied markedly between years, being determined the largest fire events in each particular year. No single cause was consistently responsible for the area burned; for example, natural fires were responsible for 82 to 98 percent of the total area burned in 1995–96, 1998–99 and 2002–03, but less than 36 percent in all other years, being between six and 20 percent in six of the 11 years (Figure 122). Escapes of campfires and barbecues accounted for a high proportion of the total area burned in 1994–95 and 1997–98. Departmental burns accounted for 39 to 65 percent of the total area burned in 1993–94, 1999–2000, 2001–02 and 2003–04 (most were contained on public lands), whereas burn offs accounted for the highest proportion of area burned (36 to 49%) in 2000–01 and 2003–04. Deliberate fires were commonly responsible for three to 16 percent of land burned in any one year, but in 1995–96 and 1999–2000 accounted for 40 and 28 percent of the area burned, respectively.

Using Davies' 1997 data, it is possible to evaluate longer-term variations in the total area burned. Approximately four million hectares was burned by DSE-attended fires from 1976–77 to 2003–04; the vast majority of this burned in 1982–83 and 2002–03, and to a lesser extent 1980–81, 1984–85 and 1990–91 (Figure 123). It is possible, from the five-year averages, to examine variations in the cause of the total area burned over time (Figure 124). Fires resulting from public utilities, burn offs, departmental burns and other miscellaneous causes burned greater areas in the first half of the observation period than in the latter half. Overall, comparatively small areas were burned in any one year from the mid 1980s until 2002–03 when large areas were burned by natural fires. Excluding the two largest natural fires in 2002–03, the total area burned in that year was comparable to other years in the 1993–94 to 2003–04 interval. It is emphasised that a single fire event under adverse conditions can have a dramatic impact on area burned in any one period, and that caution is needed when extrapolating the presented data; that is, when inferring long-term trends based on these results.

Although the number of deliberate fires increased from the mid 1970s to the mid 2000s, the total area burned by these fires has been substantially lower than in the mid 1970s to mid 1980s. With the exception of the 2001–02 to 2005–06 period, which was profoundly affected by the 2002–03 fires,

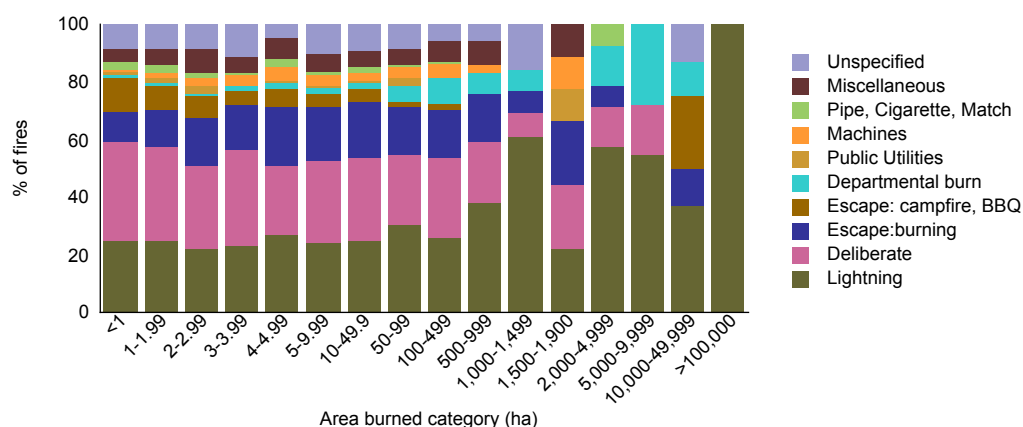
deliberate fires were responsible for 10 to 15 percent of the total area burned within a five-year interval, irrespective of the total area burned (Figure 122).

**Figure 119: Area burned category (ha), by FMB cause (number)**



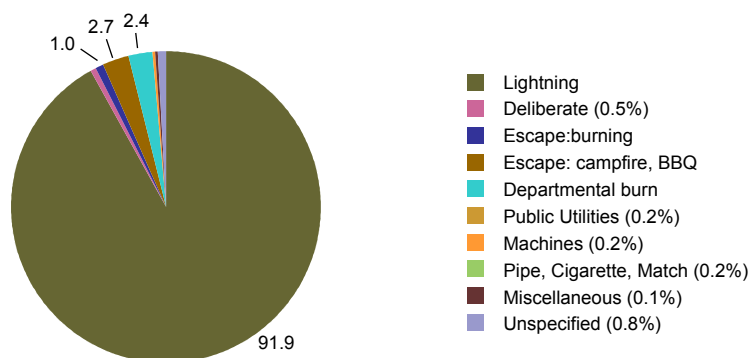
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 120: Area burned category (ha), by FMB cause (percent)**



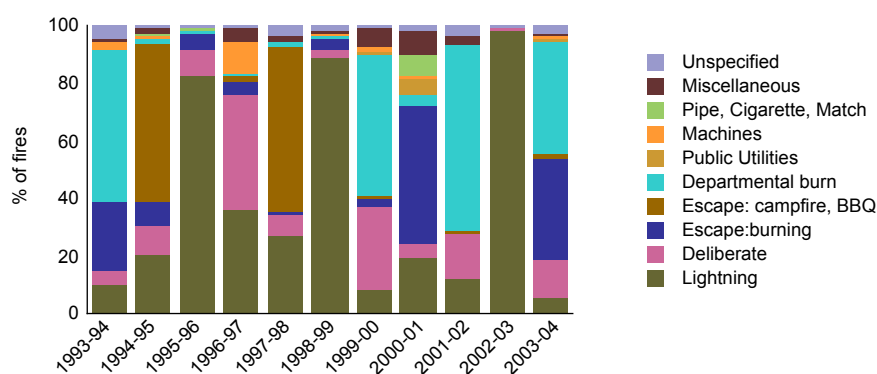
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 121: Total area burned, by each FMB cause (percent)**



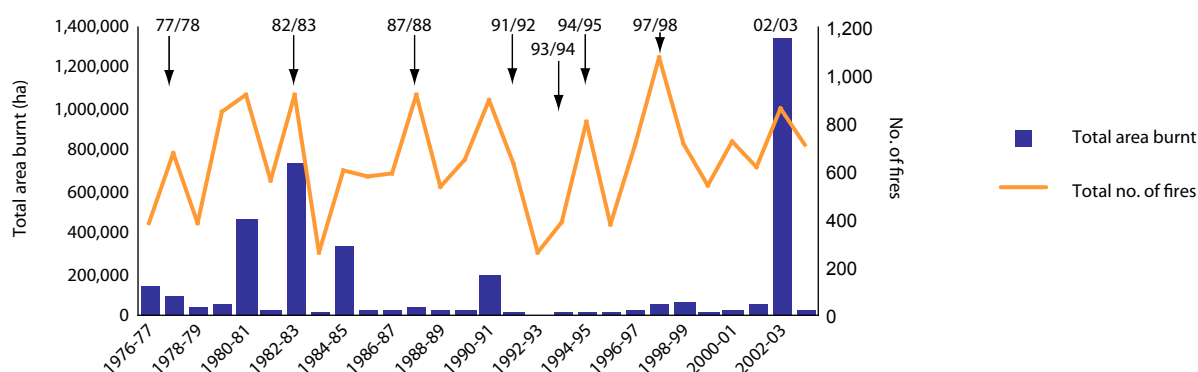
Source: DSE 1993–94 to 2003–04 [computer file]

**Figure 122: Total area burned, by FMB cause, each year (percent)**



Source: DSE 1993-94 to 2003-04 [computer file]

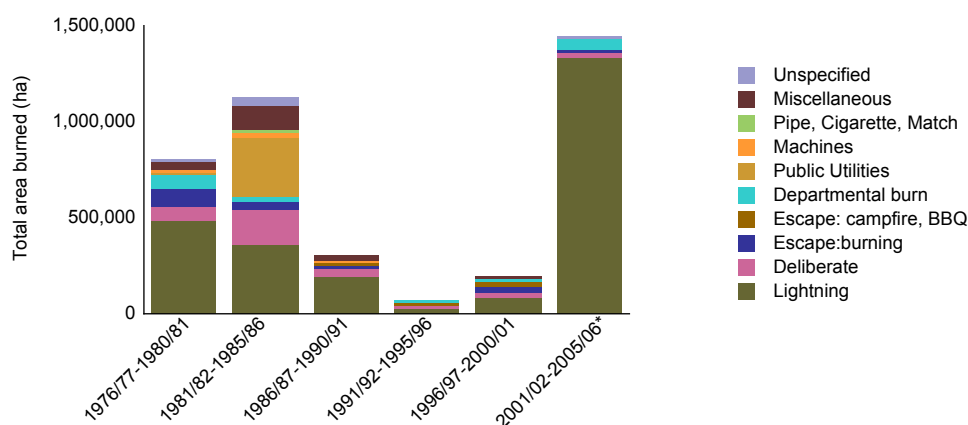
**Figure 123: Number of fires and total area burned by vegetation fires each year from 1977-78 to 2003-04<sup>a</sup>**



a: annotated numbers refers to years in which the average Southern Oscillation Index was less than -10, classified as an El Niño event by the Australian Bureau of Meteorology

Source: DSE 1993-94 to 2003-04 [computer file]; Davies 1997

**Figure 124: Total area burned in five-year intervals for each FMB cause (number)**



Source: DSE 1993-94 to 2003-04 [computer file]; Davies 1997



## Cause and climate

Widespread drought in southeastern Australia commonly occurs during an El Niño cycle. During an El Niño event warmer air masses in the Pacific result in a slackening of easterly trade winds that would normally bring moist air over eastern Australia. The outboard movement of air masses from the Australia–Indonesia region towards central tropical regions, results in many parts of eastern and southern Australia experiencing conditions ranging from lower than normal rainfall to severe drought.

The Southern Oscillation Index (SOI), which measures relative differences in air pressure across the Pacific, provides a simple measure of these large-scale changes in climatic conditions that affect so many aspects of Australian life such as, the strong relationship between variations in SOI and wheat yield (Rimmington & Nicholls 1993). The link between SOI and rainfall across the country is strongest during winter and spring (June–November) in southern and eastern Australia. This may be problematic from a bushfire perspective as, during an El Niño cycle, hot dry summer conditions follow a dry winter and spring that leads to earlier curing of grasses, potentially profound drought, and generation of exceptionally adverse bushfire weather. The Australian Bureau of Meteorology typically classifies an El Niño event as one where the average SOI was less than  $-10$ .

This relationship between vegetation fires and an El Niño cycle are examined below. Of additional concern is whether the number of deliberate fires also increased during periods of adverse bushfire weather.

**Number of fires:** A number of mitigating factors negate the possibility of any one-to-one correlation between SOI and rainfall, or between rainfall and frequency and area burned. Such mitigating factors include variations in the number of fires started by each cause, which may or may not be governed by climatic factors, and the presence of more localised weather conditions that are more distantly related to global climatic conditions. Human actions also have a bearing on these relationships, including factors that impinge upon the capacity of firefighting resources to suppress fires (such as location or access), variations in the preventative measures enacted before fires occur, and previous fire and growth histories that govern available fuel resources, etc.

Overall, the DSE attended a greater number of fires during years associated with El Niño events, than in years not associated with El Niño events (Figure 125). On average, the DSE attended 780 fires in years associated with El Niño events from 1991–92 to 2003–04 as compared with an average of 589 in years not associated with El Niño events. Even greater disparities become evident when the number of fires during an El Niño event is compared with those recorded in neighbouring years. On average 490 fires occurred in years that occurred before or after an El Niño event.

Nevertheless, there were exceptions. High fire numbers occurred in years where there was no associated El Niño event, for example in 1979–80, 1980–81 and 1990–91. There were several months of very low rainfall in either spring or summer in all three years. Conversely, not all El Niño events were associated with high numbers of fires, for example, 1993–94. This reflects the fact that at El Niño event is unique; both the extent and distribution of drought effects varies even though comparable values of the SOI may be observed.

**Lightning fires:** The difference between the number of fires occurring during years associated with an El Niño event and other years is almost entirely due to greater numbers of fires started by lightning. There was an average of 212 lightning fires in El Niño years compared with 122 in non-El Niño years, representing an increase of 74 percent. Overall, there was an exponential relationship between the number of fires documented as having started from lightning strikes and the total number of fires the DSE attended in a given year (Figure 126). That is, as the number of lightning strikes increased, natural fires accounted for an increasing proportion of fires that occurred during that year. The greatest number of fires resulting from lightning strikes recorded from 1991–92 to 2003–04 occurred in 1994–95, 1997–98 and 2002–03 all of which were associated with El Niño events. However, negative SOI in the early 1990s were not associated with an increased number of fires started by lightning strikes.

### Lightning fires during El Niño events

A number of difficulties present when attempting to document and interpret statistics on fires started by lightning. Not all lightning strikes are observed or suppressed, as those occurring in remoter areas may be extinguished naturally under all but the most adverse weather conditions, and not all fires resulting from lightning strikes may be identified as such. An increased number of fires started by lightning do not necessarily reflect an increase in the amount of lightning per se. Drier conditions and a lack of precipitation associated with electrical storm activity increases the probability that resultant natural ignitions are not doused by rainfall.

**Deliberate fires:** Overall, a strong linear relationship existed between the number of deliberate fires and total number of fires in a given year ( $r=.88$ ;  $p<.001$ ; Figure 127). Hence, the total number of deliberate fires also tended to be greatest in years characterised by higher numbers of fires overall, which given the above was commonly years associated with greater numbers of lightning strikes. Nevertheless, the increase was, on average, comparatively minor. Only eight percent more fires were lit during years associated with an El Niño event than in other years. Moreover, the number of deliberate fires in 1996–97 was comparable to that in 1997–98 and the number of deliberate fires in 2003–04 was greater than in 2002–03.

Although comparatively high numbers of deliberate fires occurred in 1994–95, 1997–98 and 2002–03, there was no consistent agent responsible for this increase. Data show that no single group was responsible for higher numbers of deliberate fires during particularly adverse years, hence:

- Virtually every agent group, except farmers, recorded a greater number of fires during the 1994–95 El Niño event compared with bracketing years.
- No single group was characterised by a peak in 1997–98, with respect to neighbouring years, yet collectively they combined to yield a peak in the total fire frequency during this year.
- During 2002–03, 'other causes' and travellers were the only groups to experience a noticeable peak, but increased numbers of residents conducted deliberate fire setting relative to the previous year. This was particularly evident for the North East region. The numbers of fires started by children were comparative low in 2002–03 when compared with much of the 1990s, a statistic that coincides with comparatively low numbers of child fires in the Bendigo region in that year.

**Other causes:** On average, greater numbers of fires of other causes occurred during El Niño events, including escaped burn offs (23% higher), and escaped campfires and barbecues (20% higher). Greater numbers of smoking-related fires were also documented but this primary occurred in the early 1990s. No differences were evident later in the observation period. There was a comparatively poor correlation between the number of accidental fires and the total number of fires in a given year ( $r=.66$ ;  $p<.05$ ).

**Area burned:** A similar but less rigorous relationship existed between the total area burned and El Niño events. The largest total area burned in fires in Victoria during the observation period occurred in 1982–83 and 2002–03. Both were associated with severe drought conditions facilitated by El Niño events. Similar arguments could be raised in relation to 2006–07.

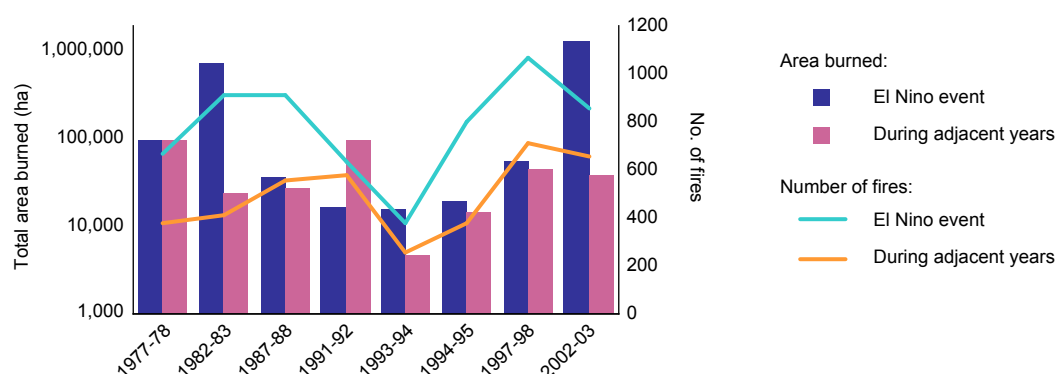
Nevertheless, large tracts of land were also burned during 1980–81, 1984–85 and 1990–91 which were not associated with a strongly negative SOI. As noted above, the relationship between the area burned in fires and weather is complex, and some caution should be exercised when interpreting temporal data. Commensurate changes in bushfire management, preparedness, and suppression have likely affected the total area burned during subsequent bushfires. It may therefore not be valid to compare the total area burned in the early 1980s with that burned in this century, as an indicator of bushfire severity. It is evident from Figure 125 that the total area burned in any one year on or near public lands in Victoria has remained low since the early to mid 1980s, and that 2002–03 was an anomaly. That is, effective fire management

enabled fires to be controlled and suppressed during most El Niño events. It was only in 2002–03, when fires burned in inaccessible terrain in the northeast, under adverse weather conditions, and high levels of drought that large areas of land were burned.

In summary, there appears to be close relationship between vegetation fires and El Niño events in Victoria. The relationship between the two is not correlative or predictive; rather it is one of probabilities. There is a greater probability that fire agencies will attend natural fires during El Niño events. There is also a greater probability that bushfire agencies will need to intensify their efforts during more adverse bushfire weather. Not all El Niño events will lead to disastrous consequences, as the intensity has to reach a certain threshold in order to exceed the capabilities and resources afforded by fire services and management. The continued elimination of preventable causes (such as fires pertaining to public utilities) and good fire management and suppression practices will effectively mean that large areas of land will be burned only under conditions where widespread and highly adverse bushfire conditions exist (as evidenced for 1982–83 and 2002–03).

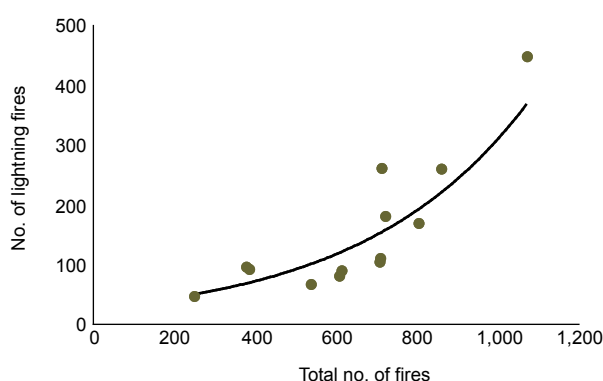
There is a greater probability that widespread drought will arise during an El Niño event. That such a relationship is comparatively strong for public lands in Victoria is consistent with the observation that the link between SOI and rainfall is strongest during the winter and spring periods in southeastern Australia, and that Victoria relies on that winter–spring rainfall to mitigate against early curing before the hot dry summer.

**Figure 125: Number of fires and area burned in El Niño events, as compared with neighbouring non-El Niño years**

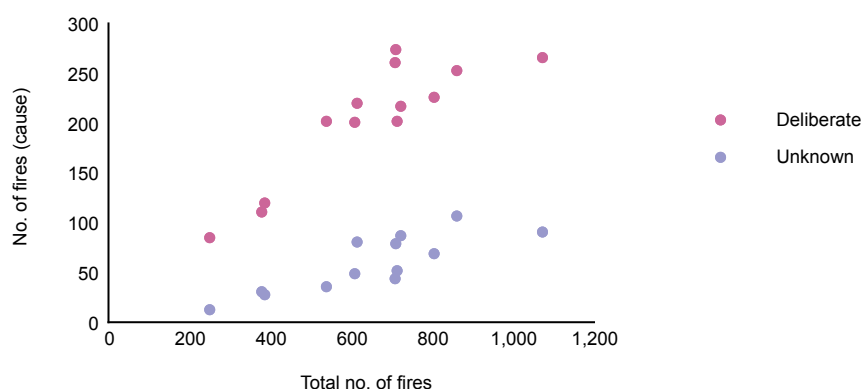


Source: DSE 1993–94 to 2003–04 [computer file]; Davies 1997

**Figure 126: Natural fires and total vegetation fires each year (number)**



Source: DSE 1993–94 to 2003–04 [computer file]; Davies 1997

**Figure 127: Relationship between deliberate and total fires the DSE attended each year (number)**

Source: DSE 1993–94 to 2003–04 [computer file]; Davies 1997

## Summary

**Number of vegetation fires:** Australian Productivity Commission reports indicate there are typically between 5,800 and 8,000 landscape (vegetation) fires per year, with the average for 2001–01 to 2004–05 of 6,900 (this is marginally lower than the average of 7,700 calculated from the data used in the report), accounting for 28 to 33 percent of all fire incidents attended by Victorian fire services (APC 2006). With respect to individual agencies:

- **MFB** attended 9,543 fires from 1997–98 to 2001–02; accounting on average for one-quarter of all vegetation fires attended in Victoria each year; numbers attended each year were comparatively stable, with the highest number occurring in 2000–01.
- **CFA** attended 25,693 vegetation fires from 1999–2000 to 2003–04, accounting on average for two-thirds of all vegetation fires attended in Victoria each year; numbers attended each year were comparatively stable, with the highest number occurring in 2000–01 and 2002–03.
- **DSE:** 8,355 vegetation fires from 1991–92 to 2003–04; accounting on average for nine percent of all vegetation fires attended in Victoria each year; actual attendances ranged between 247 in 1992–93 and 1,070 in 1997–98.

**Type of incident:** The types of incident attended both within and across fires agencies, depending on the nature of the lands over which they had jurisdiction, is summarised as:

- **MFB:** Principally small fires in urban areas, but may include some bushfires. Specifically, 28 fires burned 10 ha or more, two burned between 1,500 and 2,000 ha, 63 percent were classified as small vegetation fires, 18 percent as grassfires, nine percent as mixed scrub, bush, grassfires, and nine percent as other vegetation/outside fires that were not classified or insufficient information to classify.
- **CFA:** Fires occurred in a range of environments from the outer suburbs of metropolitan Melbourne, in and around major regional centres, to rural and remote locations. As the CFA also helps the DSE fight fires on public lands, many fires may be duplicated across these two agencies. Hence, fires attended varied from small vegetation fires in urban environments to large bushfires, 31.5 percent were small vegetation fires, 46.1 percent were grass fires, 8.9 percent were scrub, bush, mixed grass fires, 11.5 percent other vegetation and other outside fires (not classified or insufficient information to classify), and 1.8 percent were forest or wood fires (greater than 1 ha).

The proportion of grassfires and mixed scrub, bush, and grass fires (with or without forest/wood fires [greater than 1 ha]) was relatively similar across regions. The proportion of deliberate fires was comparatively uniform across incident types, although deliberate fires accounted for a higher proportion of fires in nurseries/vineyards/orchards, and a lower proportion of grain/crop fires.

- **DSE:** The DSE principally attends fires in its jurisdiction (public lands, including state forests and conservation area), but approximately one-quarter all fires attended occurred on private property.

Cause of fires in Victoria are summarised in Table 6 and outlined in further detail below.

- **Deliberate fires** comprised 21 to 32 percent of all fires attended, and 31 to 41 percent of known causes, for individual agencies. On an agency-weighted basis, deliberate fires accounted for at 30 percent of all fires attended, representing 38 percent of known causes of vegetation fires in Victoria (Table 6). The proportion and number of deliberate fires the CFA and MFB attended remained comparatively stable over the five years analysed; the number and proportion of deliberate fires the DSE attended appears to have increased since the mid 1970s, although the proportion of deliberate fires has remained comparatively stable since the early 1990s (this figure may reflect improved fire investigation skills). Deliberate fires involving burning vehicles accounted for 15 percent of deliberate fires the DSE attended between 1993–94 and 2003–04.
- **Natural fires** accounted for 16 percent of all fires the DSE attended, but just 10 percent of fires the CFA attended and less than two percent of fires the MFB attended (Table 6); however, only 12 percent of fires the MFB attended and 46 percent of fires the CFA attended were definitively attributed to lightning, so actual rates of natural fires may be even lower for rural and urban brigades than has been stated.
- **Smoking-related fires:** proportions varied markedly between agencies, accounting for 31 percent of MFB fires, but just two percent of fires attended in regional areas. For the MFB, the number of smoking-related fires was significantly positively correlated with the total number of vegetation fires each year ( $r=.94$ ;  $p<.01$ ), and the total number of vegetation fires within each statistical subdivision (SSD;  $r=.94$ ;  $p<.01$ ).
- **Fires started by children:** Non-deliberate child fires accounted for 15.5 percent of all MFB fires but only 1.6 percent of CFA fires. The MFB recorded greater numbers of fires lit by 13 to 16 years olds, whereas the CFA recorded the reverse; 0 to 5 year olds accounted for a very small proportion of all vegetation fires lit by children. Both agencies reported a high number during 2001–02. For the MFB, non-deliberate child fires are significantly correlated with the total number of vegetation fires each year ( $r=.89$ ;  $p<.01$ ); this relationship is less rigorous for the CFA data. Seventy percent of fires attributed to children were recorded as deliberately lit; 13 percent were smoking-related
- **Inadequate control of an open fire,** vehicle fires, leaving fires unattended and abandoned, and discarded material comprised almost two-thirds of all accidental fires the CFA attended.
- The number of **escapes from campfires** the DSE attended increased slightly over the observation period (this may reflect increased usage), while the number of escapes from burn offs and smoking-related fires decreased.
- Apart from malicious activity most deliberate fires the CFA attended were associated with on-road vehicle/transportation, activity not classified, no activity, with a small number associated with commercial land-based activity, and outside activities (unclassified). Comparison of the activity variable and ignition factor variable highlight fundamental difficulties and inaccuracies in attempts to identify the extent of deliberate fire setting.
- Human-caused fires the DSE attended were relatively evenly spread between recreational users (10%), residents (8%), other (8%), farmer/grazer (7%) and children (7%); the highest percentage of deliberate causes was recorded for children, travellers, other agents and unknown agents.

**Table 6: Fire cause**

Agency	% Incendiary	% Suspicious	% Deliberate (known)	% Natural	% Child fires	% Smoking-related fires	% Rural burns
MFB	1.5	21.4	31	1.8	15.5 <sup>a</sup>	30.6	unknown
CFA	0.5	32.4	41	9.5	1.6 <sup>a</sup>	2.1	unknown
DSE	31.8		35	24.4	6.5	2.1	

a: refers to non-deliberate child fires only

**Location:** CFA and MFB data combined indicate that approximately 40 percent of all vegetation fires attended occurred in the Melbourne region. Regional areas that experienced the greatest numbers of fires included the Gippsland, Bendigo–Loddon, Peninsula, Melbourne East, Goulburn and Western regions. Within the Melbourne region, the greatest density occurred in the Western Melbourne, Hume City, Northern Outer Melbourne and Northern Middle Melbourne SSDs. The number of fires the DSE attended was comparatively uniform across regions; the lower numbers in the Port Phillip region reflected the DSE's less extensive tenure in that region.

Individual postcodes in Victoria recorded between one and 1,000 fires per 10,000 people per year. On average, the total numbers of fires per person decreased with increasing population size (possibly a sampling issue), but were comparatively stable for populations in excess of 1,000 people. Inner and most southern and eastern Melbourne, areas that recorded low numbers of fires overall, were typically characterised by one to 10 fires per 10,000 people per year; areas in the outer north and west of the metropolitan area had rates comparable to regional postcodes.

Collation of causal data across region was hampered by:

- differing regional structures
- differing years available for analysis
- marked variations in causes of fires across jurisdictional boundaries. The CFA recorded appreciably higher rates of deliberate fires than did the MFB, and higher rates of non-deliberate fires, the MFB documented, reflected higher contributions from smoking-related and non-deliberate child fires.

**Deliberate fires**, in summary:

- the greatest number and proportion of deliberate fires tended to be observed in those areas that documented the greatest numbers of vegetation fires generally, with higher numbers and proportions of deliberate fires commonly associated with outer metropolitan areas and major regional centres (that is highly populated regions)
- regions with the highest proportions of deliberate fires included Melbourne, Peninsula, Geelong and Ballarat
- within the Melbourne region, the highest number and proportion of deliberate fires occurred in the Western Melbourne, Hume City, Northern Outer Melbourne and Northern Middle Melbourne SSDs
- deliberate fires are heterogeneously distributed within individual regions; high numbers of deliberate fires were observed in several postcodes within the Melbourne, Bendigo–Loddon, Geelong, Peninsula, Goulburn, Ballarat and to a lesser extent Gippsland and Murray East regions; these postcodes typically accounted for a high proportion of fires in the region; in regional Victoria, these postcodes were associated with major regional centres
- for the DSE, the greatest numbers of deliberate fires occurred in the South West and North West regions, although high proportions of deliberate fires also occurred in the Port Phillip region; children were an important contributor to deliberate fires in both the North West and Port Phillip regions



- individual postcodes recorded between 0.1 and 100 deliberate fires per 10,000 people per year; maximum rates remained uniform across postcodes with highly contrasting population sizes; areas in outer north and west of Melbourne recorded higher rates of deliberate fires per person than areas in the centre, east and south of the city, but these figures were comparable with those typically observed in regional Victoria.

**Natural fires** comprised the highest proportion of fires the CFA attended in the Grampians, Murray East, Lakes, Wimmera and High Country regions; regions that overall observed the lower number of fires. The DSE attended high numbers of natural fires in the Gippsland, North East and to a lesser extent South West regions.

**Recreationists** contributed to the greatest proportion of fires in the North East and North West of the state.

**Fires started by children:** Significant correlation existed between the number of non-deliberate child fires and total number of fires in individual regions of Victoria (CFA,  $r=.92$ ); a less rigorous correlation was observed for individual SSDs within the Melbourne region (MFB,  $r=.81$ ), but a high correlation existed within the Melbourne region for individual postcodes (MFB,  $r=.91$ ). The highest number of non-deliberate child fires occurred in the Melbourne region (particularly the Hume City, Western Melbourne, Northern Outer Melbourne and Northern Middle Melbourne SSDs). This cause was also responsible for a high proportion of fires in the Moreland City SSD.

**Smoking-related fires:** Within the Melbourne region (MFB data only), there was significant correlation between the number of smoking-related vegetation fires and the total number of vegetation fires within each SSD, although some dispersion in the data was evident at moderately high frequencies. The greatest number of smoking-related fires occurred in the Western Melbourne, Northern Melbourne and Eastern Middle Melbourne SSDs, but smoking-related fires accounted for the highest percentage of all fires in the Inner Melbourne (53%), Boroondara City (43%), and the Southern, Eastern Middle and Northern Middle Melbourne (37 to 40%) SSDs; that is, in more centrally located metropolitan areas where the total number of vegetation fires is low. Individual postcodes in the Melbourne region recorded between 0.2 and 25 smoking-related vegetation fires per year.

**Type of complex:** Most vegetation fires the CFA and MFB attended occurred on open land and fields (35% MFB; 57% CFA), roads/parking complexes (31% MFB; 30% CFA); 12 percent of MFB fires also occurred on railway property; seven CFA-attended fires occurred in scrub, bush and woods. The MFB data indicated comparatively uniform rates of deliberate fires (25 to 30%) across most areas that experienced more than 10 vegetation fires in five years, although somewhat lower rates occurred for roads/parking lots and on railway property, owing to higher contributions from accidental causes. Although most vegetation fires the CFA attended occurred in the above location, a high proportion of fires were deliberately lit along railways, at vacant structural sites, and along means of egress. MFB records indicated that the diversity of locations where non-deliberate child fires occurred increased with the age of the child, and the proportion of fires lit at single dwellings decreased.

**Timing:** Important aspects of the timing of vegetation fires in Victoria are summarised in terms of the time of the year, day of the week and the time of day at which they occurred.

*Week of the year:* Important points about distribution of fires throughout the year are summarised as:

- The principal timing of fires varied subtly between agencies; MFB, mid November and late March; CFA, mid November to mid May; DSE, mid September and late April, but the temporal distribution of fires varied markedly between years.
- Peak numbers of deliberate fires typically occurred between mid December and the end of January, being coincident with both school holidays and the peak in natural fires.

- For the MFB, there were strong parallels between the timing of non-deliberate and deliberate fires.
- For the CFA, fires associated with malicious activity and on-road vehicles/transport had very similar temporal distributions.
- The greater length of the bushfire season and difference between non-deliberate and deliberate fires for the CFA and DSE principal reflected the significant contributions from fuel reduction burning/rubbish clearing, which peaked just before and just after the bushfire danger season.

*Day of the week:* More vegetation fires in Victoria occurred on weekends than on weekdays, but the extent of this increase was cause-specific.

The MFB recorded 29 to 34 percent more deliberate vegetation fires on weekend days than on the average weekday, compared with 10 percent more accidental fires. For the CFA, 30 to 40 percent more deliberate fires occurred on weekends. However, the MFB and CFA also observed that 20 to 40 percent more accidental fires occurred on weekends, relative to the average weekday. This was observed for fuel reduction burning and clearing of land, heaps and windrows, but fires relating to camping, picnicking and barbecues were more than twice as likely on weekends. The MFB recorded that between 75 and 100 more non-deliberate child fires occurred on Saturday and Sunday, whereas for the CFA 22 percent more fires occurred on Saturday but only 10 percent more fires occurred on Sunday.

*Time of day:* Both the MFB and CFA observed substantial differences between the timing of deliberate and non-deliberate fires, although some differences also existed in metropolitan and regional areas. These findings are summarised below:

The peak in non-deliberate fires preceded the peak in deliberate fires. The CFA observed the greatest number of accidental fires from 2 to 3 pm; with the greatest number of natural fires occurring between 2 and 4 pm. The MFB attended peak numbers of non-deliberate fires from 4 to 5 pm. The latter is somewhat later than in other jurisdictions and for the CFA and may reflect the comparatively high proportion of non-deliberate child fires.

The peak in deliberate fires was later than for non-deliberate fires. The CFA and MFB observed peak numbers of deliberate fires at 4 to 6 pm and 5 to 6 pm, respectively. The number of deliberate fires the MFB attended remained elevated until midnight; and for the CFA, the number of deliberate fires decreased by 6 pm but remained high until midnight. CFA data clearly indicated later times were evident for weekdays than for weekends.

A high proportion of deliberate fires in Victoria occurred after normal working hours; the MFB and CFA attended 60 and 45 percent, respectively, of deliberate fires that occurred between 6 pm and 6 am. In comparison, only 41 percent of non-deliberate MFB-attended fires and 23 percent of CFA-attended accidental fires occurred within this timeframe. For the MFB, high numbers of deliberate fires at night occurred on all nights of the week but increased frequencies, between midnight and 4 am, were most evident on Saturday and Sunday. For the CFA, the proportion of night fires varied between regions, being high in some remote regional areas (such as the Wimmera, Central Murray, and Mallee regions) but also in densely populated areas like Geelong.

*Children:* Overall, peak numbers of fires were observed around 4 to 6 pm (principally a weekday phenomena); patterns for 13 to 16 year olds most closely approximated the trends observed for deliberate fires; and 6 to 12 year olds tended to light a smaller proportion of fires at night. For the MFB, 65 percent of fires lit by 13 to 16 year olds occurred between 6 pm and 6 am; 11 percent of fires were lit between midnight and 6 am.

**Area burned:** Most vegetation fires, irrespective of the fire service that attended or the cause of the fire, were small. Nevertheless, differences were noted; natural fires comprised higher proportions of larger fires the DSE and CFA attended. For these agencies, deliberate fires typically accounted for a decreasing



proportion of fires as fire size increased. This was not evident of the MFB data, where fire size was overall smaller; deliberate fires accounted for a high proportion of the largest fires.

The total area burned was governed by the largest fire events. For both the CFA and DSE the data were dominated by the large natural fires that occurred in 2002–03 (approximately 70 percent for CFA-attended fires and 80 percent for DSE-attended fires), whereas, for the MFB the largest area was burned in 2000–01.

Overall:

- 5,800 ha was burned in fires the MFB attended from 1997–98 to 2001–02; 45 percent was burned by deliberate fires; six percent was burned by smoking-related fires
- 1,206,627 ha was burned in fires the CFA attended from 1999–2000 to 2003–04; only 1.4 percent was by deliberate fires
- 1.7 million ha in total was burned from 1993–94 to 2003–04; of that area, 0.5 percent was burned by deliberate fires.

**Fire danger rating:** Most deliberate fires the MFB attended occurred under moderate fire danger conditions, with the number of deliberate fires attended decreasing as fire danger increased. In addition:

- deliberate fires and fires started by an open flame accounted for a decreasing proportion of fires as the fire danger increased
- smoking-related fires account for an increasing proportion of fires as fire danger increased
- the greatest numbers of deliberate fires that occurred under very high to extreme conditions were located in those areas that experienced the greater numbers of fires.

Most fires the CFA attended occurred when fire restrictions, but not total fire bans, were in place; deliberate fires comprised a lower proportion of fires when a total fire ban was in place, than when no total fire ban was in place.

**Fires and climate:** The DSE was the agency most strongly affected by natural fire events as it documented the greatest proportion of natural fire events; years accompanied by El Niño events were commonly characterised by higher numbers of fires (particularly higher numbers of natural fires) and/or larger areas burned than in those years in which such climatic conditions are not present. Increased numbers of fires (particularly natural fires) were present early in the year. In the case of the DSE, greater numbers of deliberate fires are also evident in such year, although no single agent could be pinpointed. For the CFA, large areas may be burned in El Niño years, but there does not appear to have been a large increase in the total number of fires attended, or in the number or proportion of deliberate fires. Fires the MFB attended appear to show the least relationship with large-scale climatic variables.

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