South Australia

Contents

The first part of this chapter provides **contextual information** on South Australia, including basic information regarding its climate, geography, land use and population. It also provides an outline of the bushfire regimes, historically important bushfire events, and overview of fire services in South Australia. The second part represents an **analysis of data** provided by the South Australian Metropolitan Fire Service, the South Australian Country Fire Service and the Department of Environment and Heritage. Although some agencies may attend many types of fire incidents, and that data may have been supplied, this analysis exclusively refers to vegetation fires only, unless otherwise indicated.

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

Introduction

South Australia is the fourth largest of Australia's states and territories, covering a total area of 984,377 square km. It is located in the central south of mainland Australia, sharing borders with all other states and territories except Tasmania and the Australian Capital Territory.

Geography

The state is of generally low relief, with approximately 50 percent being less than 150 m above sea level, and 80 percent being less than 300 m. The River Murray, which drains one-seventh of Australia's landmass, enters the state on its eastern border, but falls less than 22 m in altitude in the 642 km before entering the Southern Ocean via the heavily silted river mouth at Lake Alexandrina and Lake Albert (Figure 1). The Mount Lofty–Flinders Range system is the most notable mountain range in South Australia, extending 800 km from Cape Jervis in the south to Lake Torrens in the north, but nowhere does the range exceed 1,200 m. In the western portion of the state the sparsely inhabited Nullarbor Plain directly fronts the cliffs of the Great Australian Bight. To the south lies Kangaroo Island, South Australia's most prominent island, at 4,350 square km.

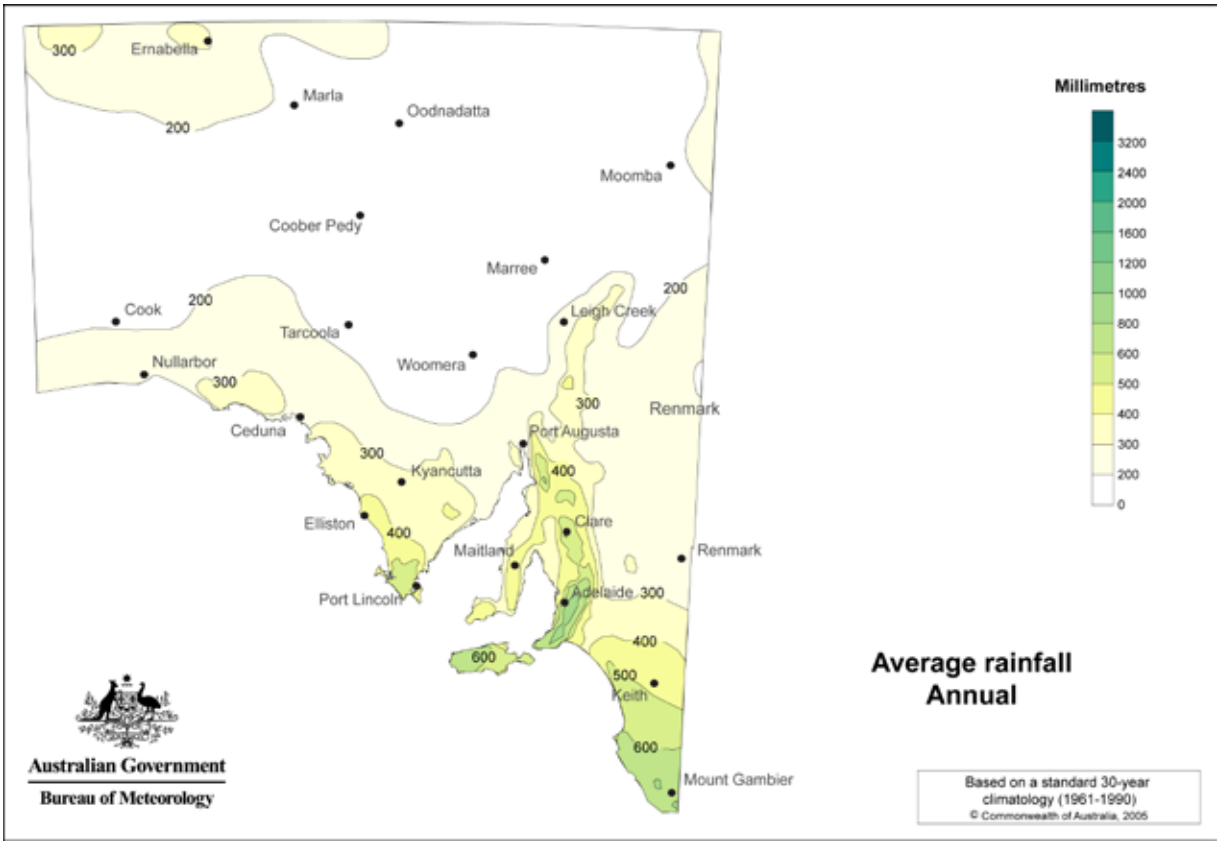
Figure 1: Map of South Australia

Climate

South Australia's climate is characterised by hot, dry summers with relatively mild nights, and cool but not severe winters. The average maximum temperature is 29°C in January and 15°C in July. Overall, the average maximum temperature increases northwards. In January, the average daily maximum ranges from 21°C to 24°C in the south to more than 36°C in the state's far north, but daily temperatures in parts of the state may be as high as 48°C (Australian Bureau of Meteorology, 2007a).

Overall, rainfall is low, with four-fifths of the state normally receiving less than 250 mm of rain annually. Most rainfall occurs during the late autumn and winter. The highest annual average rainfall typically occurs along the Flinders and Mount Lofty Ranges and near the southern coast, but drops to less than 250 mm within 150 to 250 km of the coast (Figure 2). Much of the inland areas are covered by featureless plains, or sand and gibber deserts (Australian Bureau of Meteorology, 2007b).

Figure 2: Average annual rainfall

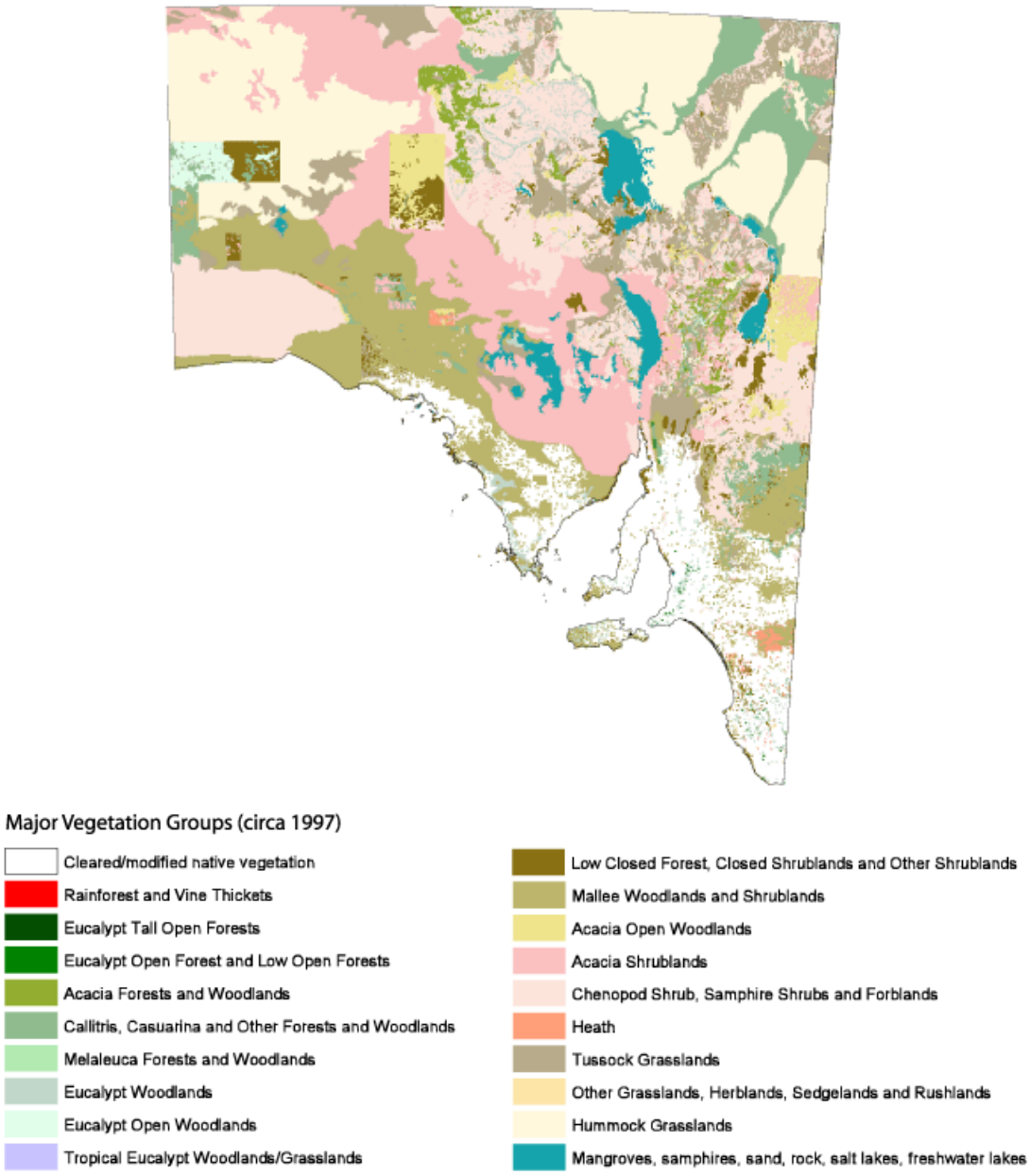


Source: Australian Bureau of Meteorology 2007b

Native vegetation

Extensive areas of mallee, chenopod (saltbush, bluebush), shrublands, acacia shrublands (mulga and myall) and hummock grasslands cover the arid and low rainfall portions of the state's north (Figure 3). Small areas of eucalypt open forest and woodland occur in the southeast of the state. However, little native vegetation remains in the wetter areas of state's southeast, owing to extensive clearing or modification for agricultural purposes (Australia. Department of Environment and Heritage 2001b).

Figure 3: Major vegetation groups (c. 1997)



Source: Australia. Department of Environment and Heritage 2001b

Land use

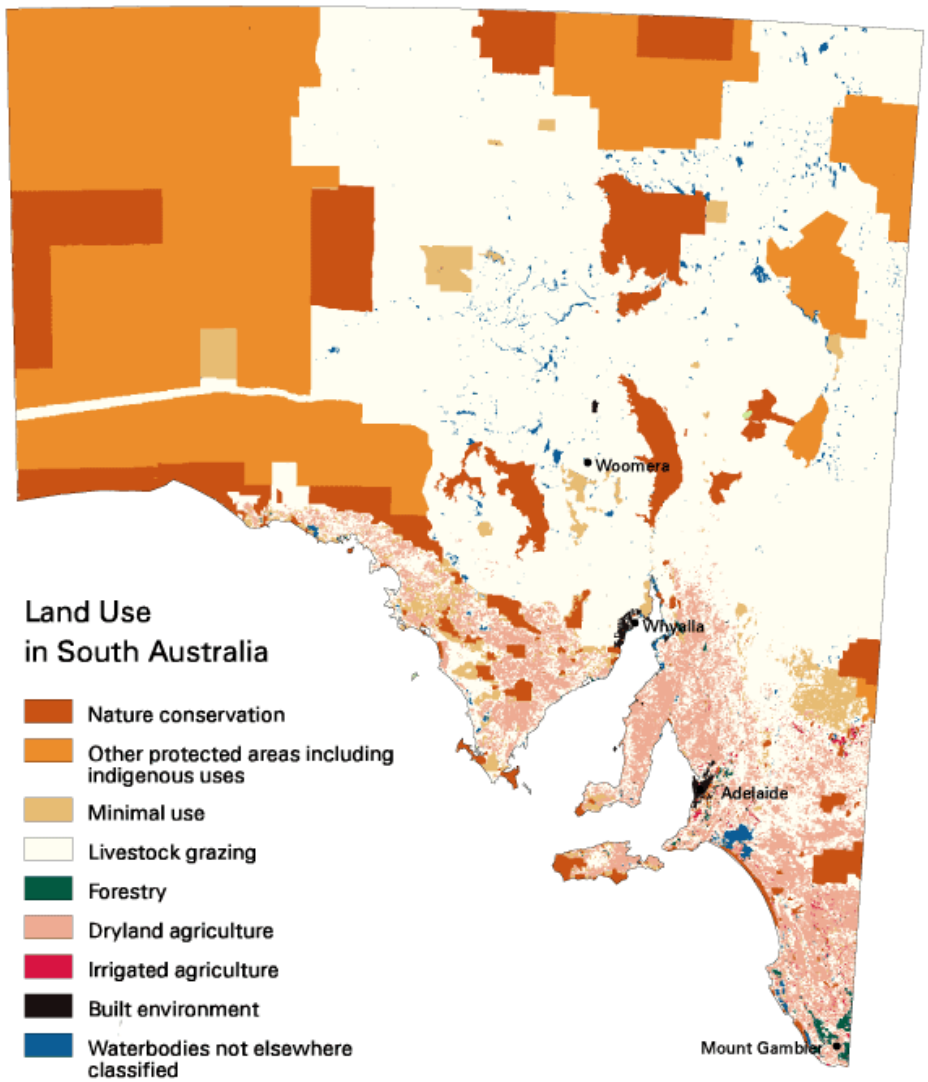
As of 1996–97, dryland agriculture occurred in six percent of the state, principally in the higher rainfall areas along the southeast coast (Figure 4). Small isolated pockets of irrigated agriculture occur along the Murray, but are less extensive than those occurring in New South Wales and Victoria. Cropping mostly includes cereal crops (wheat, barley and oats), but also oilseed and grain legume crops. Many types of temperate vegetables and orchard crops are grown in the Adelaide Hills, the northern Adelaide Plains, the southeast and the Riverland. Extensive vineyards, principally for winemaking occur throughout the Barossa and Clare Valleys, the Riverland, Southern Districts and Coonawarra.

In 1996–97 livestock grazing accounted for 51 percent of the state's area. Livestock are primarily sheep (commonly for wool production), but beef cattle are raised in the Adelaide Hills, the lower southeast and far north districts. Dairying principally occurs around Adelaide, and the lower southeast and lower Murray districts.

As of 1996–97, 28 percent of the state was retained for nature conservation. Just over half of this is in nature reserves. International Union for the Conservation of Nature and Natural Resources (IUCN) category wilderness areas and national parks collectively accounted for a further 36 percent of nature conservation in the state. 'Other protected areas including indigenous uses' cover 11 percent of the state. Areas retained for nature conservation occur throughout the state but large areas of the arid west and north fall within these categories.

Forestry is minor in South Australia owing to the low rainfall. Most forestry occurs in the moister areas around Mount Gambier in the State's southeast (Australia. Department of Environment and Heritage 2001a).

Figure 4: Land use (c. 1996–97)



Source: Australia. Department of Environment and Heritage 2001a

Population

As of June 2006, the resident population of South Australia was 1,554,700, accounting for 7.5 percent of Australia's population (ABS 2006). Almost three-quarters of the state's population reside within the Adelaide statistical subdivision, with most of the remainder residing in the fertile region along the southeastern coast of the River Murray. Major regional urban centres include Mount Gambier, Port Pirie, Murray Bridge, Port Augusta and Whyalla.

As of June 2005 South Australia had the highest median age (the age at which half the population is older and half is younger) of all states and territories in Australia, at 38.8 years, compared to the national average of 36.6 years (ABS 2005a). Only 18.4 percent of the state's population was under 15 years of age, the lowest recorded by any state or territory. The highest proportion of children of this age occurred in the Eyre statistical subdivision, and in the local government areas of Roxby Downs, Anangu Pitjantjatjara, Ceduna and Playford.

Bushfire regimes

Severe bushfires are not uncommon in South Australia owing the hot dry conditions that characterise summer. Bushfires commonly occur from October through to May, but historically the most devastating have occurred in January and February. Some variation in fire regimes occurs northwards owing to lower and less reliable rainfall away from the coast (Figure 5). Fires shift from spring- and summer-dominant in the north of the state, to summer-dominant in the centre, through to summer- and autumn-dominant in the south (Eyre Peninsula and the far south east corner around Mount Gambier (Lindesay 2003).

Figure 5: Timing of bushfire seasons in Australia

Source: Australian Bureau of Meteorology 2007c

Bushfire history

South Australia has experienced a number of devastating bushfires. A compilation of the most significant bushfire events and seasons is outlined in Table 1; the fires during the 1939, 1955, 1983 and 2005 seasons discussed in greater detail below.

1939: Black Tuesday – 10 to 14 January – Exceptionally high temperatures (up to 46.1°C in Adelaide) and strong winds (up to 45 km per hour in Adelaide) fanned fires around Adelaide and the Mount Lofty Ranges (Adelaide Hills). Six thousand volunteers attempted to battle blazes with branches and wet bags as the fires that had originated near forested areas, subsequently spread into open farmlands. Firefighters, residents and property owners battled to save the townships of Mount Torrens, Macclesfield and Meadows. No lives were lost, but 90 houses and other building were destroyed in Crafers, Stirling and Upper Sturt and from Mount Osmond to Glen Osmond. The cost was estimated at £650,000. During the same period fires burned extensive areas of grassland and 1,000 hectares of pine forest were destroyed near Naracoorte, Penola and Mount Gambier, in the state's southeast, resulting in the death of one child (South Australia Central 2007).

1955: Black Sunday – 2 to 3 January – on a day with extreme temperatures (43°C in Adelaide at 1 pm), low humidity and strong winds (gusts of 100km per hour), 13 major fires broke out with multitudes of fires burning in the Adelaide Hills, Jamestown and Waterloo in the state's north, and Kingston and Millicent in the southeast. The fires resulted in the deaths of two firefighters, and £2 million (1955 values) damage to property including the governor's summer residence at Marble Hill. Source: CFS (2005b) and EMA (2006a)

1983: Ash Wednesday – 16 February – Fires sparked by exceptionally adverse bushfire weather broke out in both South Australia and Victoria. In South Australia, major fires burned to the west of Clare in the mid north, in at least four separate areas in the Mount Lofty Ranges, as well as in the lower southeast of the state. Fanned by strong winds, the fires burned about 1,600 square km, destroyed 385 houses, burned 10,000 km of farm fencing, and destroyed 500 vehicles and two timber mills. Three-quarters of the total area was burned in the southeast. Sixty percent of the houses lost were in the Mount Lofty Ranges. Twenty-eight people died, with a further 67 hospitalised. Livestock losses were estimated at between 257,000 and 300,000 head. Financial losses were estimated at $200 million to $400 million. Source: DSE 2007, EMA 2006b, South Australia Central 2007.

2005: Black Tuesday – 11 January – On a day where temperatures higher than 40°C were reached by 11 am and there were winds of more than 100 km per hour, 16 separate fires broke out across the state. The most devastating of these occurred at Wangarry on the Lower Eyre Peninsula. Fires rapidly spread, consuming 77,000 ha of land, and trapping people in their cars as they attempted to escape. Nine people died, including two firefighters. A further 110 people sustained injuries; at least 93 houses and 237 sheds were destroyed with damage to at least another 11 homes and numerous commercial properties. The Wangarry fire resulted in the loss of 46,780 head of livestock, and 6,300 km of fencing. Emergency Management Australia estimated the insurance cost at $27,700,000, but the Country Fire Service indicated the total cost was likely to exceed $100,000,000 (CFS 2005a; 2005b).

Table 1: Bushfire history of South Australia

Date	No. of deaths	Area of fire (ha)	Losses	Location(s)
1938–39a	1		90 houses and numerous other buildings; £650,000	Adelaide Hills; Naracoorte, Penola Mount Gambier
1943–44				Adelaide Hills
1948–49	1			Bridgewater, Gawler, One Tree Hill, Mount Barker, near Wilmington, Port Lincoln
1950				Mount Lofty and grass fire north of Morgan and east of Burra
1951 December	5 fire fighters	450,000	Stock, feed, fencing	Adelaide Hills, Woodside, Stirling, Lenswood, and districts in the southeast
1954–55 January	2 fire fighters	>40,000	Houses, timber	Mount Lofty Ranges
1957–58 January	8 fire fighters	1,370	413 ha of pine forest	Mount Gambier
1959	1	104,000	$1,500,000	Kongorong, Wudinna
1960		114,000	'Lots of damage'	Northern part of Yorke Peninsula, Wirrabara, Tintinara
1961				Wilpena Pound
1968–69		900,000	Feed, stock, fences	West of far north region, Murdinga
1974–75		16,000,000		North-west of state (arid and semi-arid zones)
1980			35 houses; $6 million	Adelaide Hills
1983	28	160,000	383 homes, forest plantations, conservation parks, >200 buildings	Mount Osmond, Mount Gambier, South Barwon
1985				Adelaide Hills
1998				Flinders Ranges (70% of Wilpena Pound burned)
2001			Approx. 20 buildings	Tulka
2005b	9	77,132	More than 93 houses; 11 homes damaged; numerous other buildings; 46,780 livestock lost; 6,300 km of fencing; Cost of probably more than $100,000,000	Lower Eyre Peninsula; Mount Osmond

a: data from South Australia Central 2007

b: data from CFS 2005a; 2005b

Source: Modified from Ellis, Kanowski & Whelan 2004

Fire services

Four major agencies provide fire services in South Australia. They are the South Australian Metropolitan Fire Service, the South Australian Country Fire Service, the SA Department of Environment and Heritage and Forestry SA.

The **South Australian Metropolitan Fire Service** (SAMFS) provides a broad range of emergency services – fires, road crash rescue, gas leaks, chemical spills, rescues, structural collapse, animal rescue, storm damage, lockouts, flooding, and smoke alarms and private alarms – to approximately 95 percent of the state's population. As of 2002–03 the SAMFS comprised 782 permanent and 236 retained firefighters working from 35 fire stations. For further information see http://www.samfs.sa.gov.au.

The **South Australian Country Fire Service** (SACFS) is a community-based fire and emergency service that operates in rural and semi-urban South Australia. It is staffed by 85 full-time equivalent employees and over 15,500 volunteers, with 434 brigades. The SACFS attends bushfires, hazardous material spills (specialised service), structural and motor vehicle fires, and provides fire protection at road crashes and

performs road crash rescue. The SACFS also provides support for the SAMFS and assists local government in fuel removal and bushfire prevention and in community and fire safety investigation (CFS 2005c).

The **South Australian Department of Environment and Heritage** (SADEH) is responsible for on-the-ground management of the state's public land – including land held in the conservation reserve system and as Crown lands. This incorporates approximately 330 reserves that cover 21.7 percent of the state. The department is responsible for protecting life, property and biodiversity values, and helps the SACFS minimise the risk associated with fire in natural bushland. For further information see http://www.environment.sa.gov.au.

Forestry SA manages 125,000 hectares of state-owned forest resources in South Australia. This consists primarily of softwood plantation but also includes 23,900 ha of Native Forest Reserves for nature conservation. Forestry SA lands are principally located in the Green Triangle Region (southeast coastal region), the Mount Lofty Ranges and the Mid North Regions. For further information see http://www.forestry.sa.gov.au.

The SAMFS and SACFS, together with the SA State Emergency Services, are members of the South Australian Fire and Emergency Services Commission, a government organisation established to improve communication and coordination across the various emergency service sectors. For further information see http://www.safecom.sa.gov.au/.

The South Australia analysis is based on data provided by the Metropolitan Fire Service, Country Fire Service and the SA Department of Environment and Heritage only.

South Australian Metropolitan Fire Service analysis

Background about the SAMFS dataset and its analysis

Important information regarding the SAMFS dataset and the methodology employed to analyse it is outlined below.

- The data were sourced from the South Australian Metropolitan Fire Service (SAMFS).
- The SAMFS analysis differs fundamentally from that conducted for other agencies as it does not represent an analysis of all vegetation fires; rather the database provided only included those vegetation fires were the activity in the area was identified as malicious (hereafter referred to as malicious vegetation fires).
- The database used the Australian Incident Reporting System (AIRS) classification codes
- The database supplied included both malicious vegetation and rubbish fires; vegetation (AIRS wildfires = Type of Incident code 160 to 179) fires were extracted from this dataset.
- In rare instances, the analysis draws on the combined 'grass [vegetation] and rubbish' fire data, from SAMFS annual reports and the dataset provided, as this is the only means to make very rough estimates about the total number of vegetation fires and the proportion of deliberate vegetation fires the SAMFS attended, and thereby provide a comparison for other South Australian and Australian fire agencies.
- The database includes data from 1997–98 to 2005–06; although the data for 1998–99 to 2000–01 are variably incomplete due to industrial actions (see Methodology chapter).

- Information pertaining to form of heat of ignition and ignition was supplied.
- For the purpose of the SAMFS, all cases in the database, that is, all vegetation fires where the activity in the area was classified as malicious were said to be deliberate. This differs fundamentally to the analysis conducted for other agencies that use AIRS database codes, where the cause of the fires is defined on the basis of the ignition factor codes; the two systems do not directly correspond; not all fires classified as having malicious activity are classified as incendiary or suspicious or vice versa (see Methodology and the Victorian Country Fire Authority analysis, the Victoria chapter.
- Includes information pertaining to the type of incident.
- Smoking-related fires were classified on the basis of 'form of heat of ignition'='heat from smokers' materials' (AIRS form of heat of ignition codes 300 to 390).
- The interpretation of child fires is complex and does not represent a complete analysis of vegetation fires started by children in urban South Australia. Notably, the database only included fires where the ignition factor code was identified as children playing, and where the activity in the area was identified as malicious. This is likely a very small subset, as in many cases, fires started by children where the activity in the area was deemed malicious, would be classified simply as incendiary or suspicious within the ignition factor code (as per AFAC (AIRS) guidelines). Moreover, the analysis will not include any accidental fires started by children, where the activity in the area was not malicious.
- The definition of regions used in the SAMFS analysis is based on tourism regions as defined by the Australian Bureau of Statistics (ABS 2005b) for South Australia. Assignation to a tourism region was based on the postcode, which was derived from the suburb name provided. There is not an exact concordance between the postcode and tourism regions. The ABS defines tourism region based on smaller statistical areas so ABS tourism regions potentially crosscut suburbs and postcodes. In this study, assignation 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.
- A rough estimate of the breakdown of the type of property was made based on the information provided within the 'premises' variable supplied. The categories defined included education, business, reserve/park, recreation/sport complex, vacant/Crown land, mass transport, road complex, scrub/grassland, walkway/bike path, residential, near non-marine water, other open space, beach/marine/wharf, community centre, hotel, other organisation, medical centre/hospital, religious facility, government organisation, other community facility, child care, dump/rubbish, aged care, cemetery, construction/demolition, correctional facilities, and unknown. Note however, information about the type of premises was only available in 31 percent of cases.
- The dataset does not include area burned; this would typically have been small. There is only one forest or woods fire recorded as having burned more than 1 ha, but there may have been grass fires than burned similar area.

For more detail about these methodologies see the Methodology chapter.

Overview

Fires attended by the SAMFS can be summarised as follows.

- SAMFS records indicate that between 1997–98 and 2005–06 the service attended 2,926 vegetation fires where the activity in the area was identified as malicious. This figure represents a minimum value as the records were affected by industrial action.

- It is impossible, based on the data provided and the available published information, to ascertain the exact number of vegetation fires the SAMFS attended in any one year. Based on the information presented in annual reports, the SAMFS attended between 2,347 and 2,925 'grass and rubbish' fires (only combined information is available; Figure 6). In this usage the term grass is used loosely, being equivalent to the term wildfire (AIRS codes), landscape fire (Australian Productivity Commission) or vegetation fire (this study). Unfortunately, there is insufficient information to determine what proportion of all 'grass and rubbish fires' were actually vegetation fires. If it is assumed that the ratio of malicious vegetation fires to malicious rubbish fires (information provided) accurately reflects the ratio of vegetation fires to rubbish fires generally in a given year, it is likely that SAMFS attended somewhere between 800 and 1,800 vegetation fires in any given year.
- The SAMFS is an urban service, and the types of vegetation fires attended reflect that environment. The principal types of fires attended were small vegetation/grass fires, with only one fire occurring in forest/woods (greater than 1 ha), and 1.8 percent occurring in mixed scrub, bush, grass settings. Vegetation fires in urban environments may include fires in the local park or reserve, but will also include fires along road verges, in access ways, as well as hedge fires, single tree/bush fires, fires on the local oval etc. It is unclear to what extent the SAMFS may attend the same incidents as the SACFS and SADEH. Overall, the number of fires that were or had the potential to be bushfires is likely to be comparatively low.
- It is impossible, on the basis of the data provided, to ascertain the percentage of vegetation fires that were likely to have been deliberately lit, but the value is likely to have been somewhere between 15 percent and 30 percent.

Cause

The actual number of malicious vegetation fires attended ranged between a low of 165 in 1998–99 and a high of 436 in 2001–02 (Figure 6). The average number attended was 325 (SD=90).

As the exact number of vegetation fires the SAMFS attended in any one year is unclear, it is difficult to ascertain the proportion of those fires that may have been associated with malicious activity. Nevertheless, some broad estimates can be made based using the rough numbers of vegetation fires (all causes) calculated above. Using this 'broad-brush' approach it is estimated that somewhere between 15 and 30 percent of vegetation fires the SAMFS attended were associated with malicious activity (Figure 6), a figure that is broadly consistent with the proportion of deliberate vegetation fires the SACFS attended.

Specific ignition factors

Form of heat of ignition: Almost 60 percent of malicious vegetation fires resulted from an open flame or spark (Figure 7). Twenty-six percent involved a hostile fire, 6.6 percent a fuel-powered object and 1.4 percent explosives or fireworks (Figure 7). There were 16 recorded instances where incendiary devices were used. A match was the factor most frequently recorded within the open-flame category (approximately 50%), followed by other factors, and lighters (Figure 8).

Overall, the proportion of fires relating to each category remained stable over the observation period. The notable exception was in the increased number and proportion of vegetation fires attributed to fuel-powered objects since 2000–01 (Figure 9).

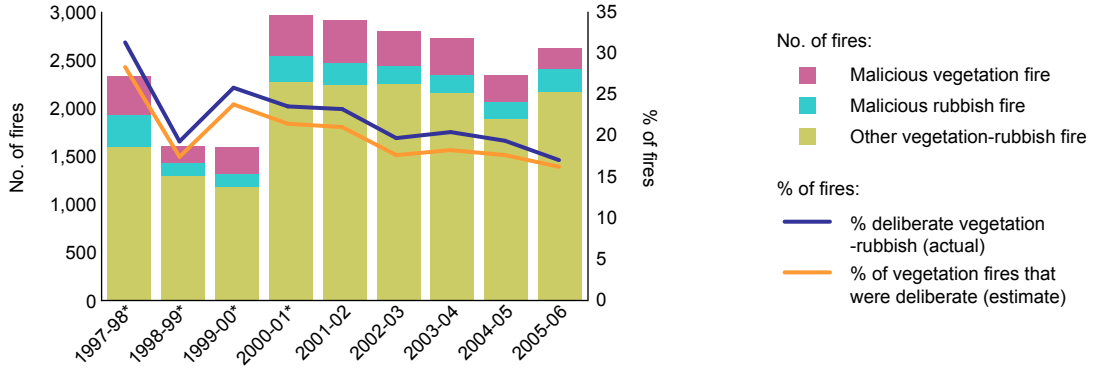
Fires started by children: There were 137 instances where malicious activity was combined with a 'children playing' category in the ignition factor code. This represents 4.7 percent of all malicious vegetation fires. This does not represent all incidents where a child was responsible for a fire, as this dataset only comprises fires where the activity in the area was malicious. Nor does it include all cases

where the child was responsible for a malicious fire that was categorised as incendiary or suspicious in the AIRS ignition factor codes, where there would be no indication that a child lit the fire.

In most instances the age of the child was unknown. Notably, there were only four malicious fires for which the age of the child was assigned. All were in the 6- to 12-year-old group.

Smoking-related vegetation fires: Two percent (n=57) of all malicious vegetation fires the SAMFS attended were smoking-related, ranging between one and three percent in any one year. Although the proportion of smoking-related fires was in the realm of values observed for many other, particularly regionally based, fire agencies, it is highly probable that these figures do not in any way accurately reflect either the incidence or proportion of smoking-related vegetation fires the SAMFS attended. Notably, for most agencies, the overwhelming majority of smoking-related fires are not considered incendiary or suspicious, and hence are much less likely to appear in this dataset, which only refers to fires where this was malicious activity in the area.

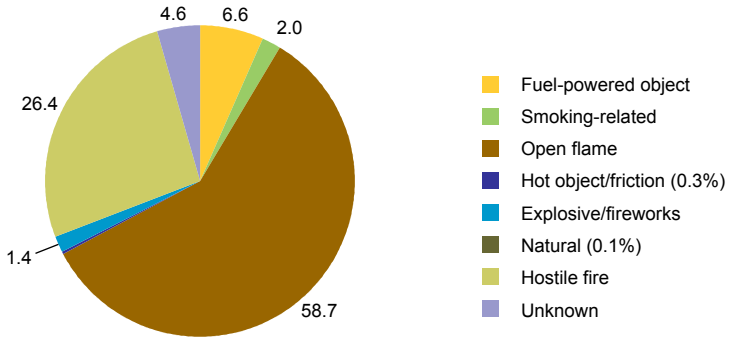
Figure 6: Cause of malicious fires by year[a]



Source: SAMFS 1997–98 to 2005–06 [computer file]; SAMFS, published (annual reports; references) and unpublished (pers. comm.) data

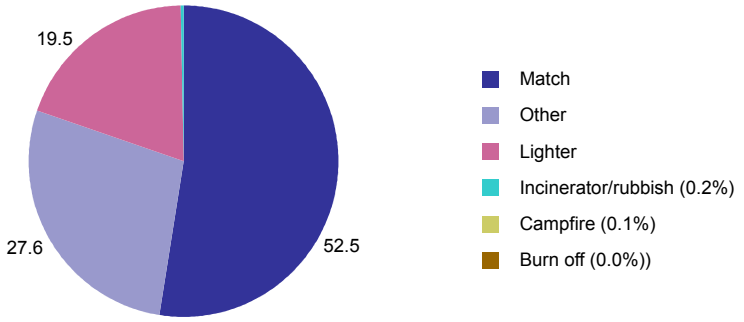
a: asterisk indicates years affected by industrial action

Figure 7: Form of heat of ignition (percent)



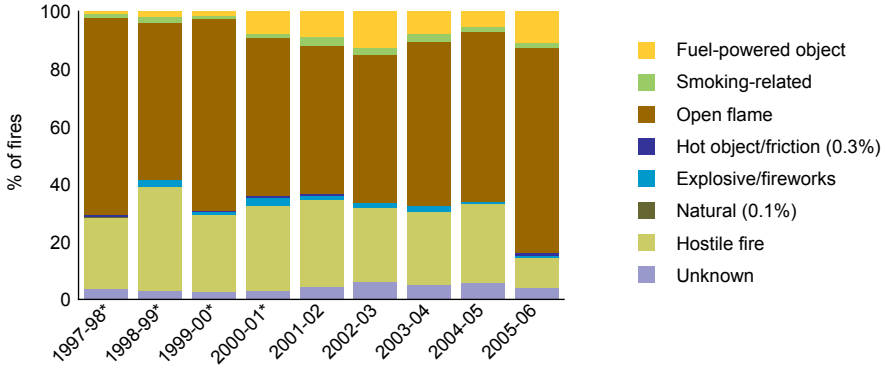
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 8: Form of heat of ignition for fires within the 'open flame-spark' category



Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 9: Form of heat of ignition by year



Source: SAMFS 1997–98 to 2005–06 [computer file]

Location

Information about the location of fires includes the regional distribution of fires as well as details about the type of complexes where fires occurred.

Region

The fire data have been classified according to 2005 ABS tourism regions (Figure 10). Approximately 83 percent of all SAMFS malicious vegetation fires from 1997–98 to 2005–06 occurred in the Adelaide region (Figure 11); followed by Flinders Ranges (9.6%), Eyre Peninsula (4.3%), Riverland (1.9%) and Limestone Coast (0.6%).

This analysis also used combined vegetation and rubbish fire (rubbish – vegetation fires) data from SAMFS annual reports to enable a more detailed analysis of fire distributions. A more detailed analysis for 1999–2000 to 2002–03 from SAMFS annual reports, combined with the causal data supplied for malicious vegetation and rubbish fires reveals marked variations in the number and cause of vegetation fires between stations. (Note: 1999–2000 to 2002–03 was the only period for which detailed information was available in online annual reports at the time of analysis). Within the Adelaide region, the Elizabeth and Salisbury stations attended the greatest number of vegetation fires, followed by Christie Downs, Oakden, Adelaide and O'Halloran Hill (Figure 12). The highest number of rubbish – vegetation fires in regional South Australia from 1999–2000 to 2002–03 occurred in the large urban centres of Port Augusta, Whyalla and Port Pirie (Figure 12).

Overall, there was a strong correspondence between the total number of rubbish – vegetation fires attended by stations and the number of such fires associated with malicious activity ($r=.95$; $p<.001$; for all South Australian urban fire stations), for the period 1999–2000 to 2002–03. Hence, it is not surprising that in the Adelaide region, the Salisbury and Elizabeth stations attended the greatest number of malicious rubbish – vegetation fires (combined) (Figure 12). Other stations to record high numbers of malicious rubbish – vegetation fires included Christie Downs, O'Halloran Hill and Angle Park. For these stations, 26 to 34 percent of all rubbish – vegetation fires were associated with malicious activity. This contrasts with values of the eight to 10 percent in Ridgehaven, Prospect and Adelaide stations.

The number of malicious rubbish – vegetation fires in regional South Australia was comparatively smaller than for metropolitan Adelaide brigades. The greatest number of malicious rubbish – vegetation fires were recorded for the Port Augusta (n=132), Port Pirie (n=72) and Whyalla (n=70) stations (Figure 12). In Port Augusta and Port Pirie 54 and 46 percent of all rubbish – vegetation fires were associated with malicious activity, whereas in Whyalla, Port Lincoln and Mount Gambier the value was 16 to 23 percent.

The proportion of all malicious rubbish – vegetation fires that were actually vegetation fires was typically greater than 50 percent, but varied quite markedly between stations (Figure 12). Three stations that reported a high number of rubbish – vegetation fires – Elizabeth, Salisbury and Christie Downs – were characterised by a higher proportion of malicious vegetation fires relative to malicious rubbish fires when compared with other metropolitan Adelaide stations. The proportion of vegetation fires, as opposed to rubbish fires, within the malicious category varied even more markedly for regional stations.

The number of malicious rubbish – vegetation fires that occurred in the Adelaide region decreased in between 2001–02 and 2005–06 (Figure 13). In contrast the number of malicious rubbish – vegetation fires in most non-metropolitan regions remained stable over the same period. Hence, the Adelaide region contributed lower proportions of malicious vegetation fires as progressed.

In relation to specific ignition factors:

- Five of the 16 instances were an incendiary devices was used occurred in the Elizabeth area, with a further four fires each being recorded by the Ridgehaven and Christie Downs stations.
- There has been an increase in the number and proportion of malicious fires associated with fuel-powered machines since 2000–01. This principally reflects increased numbers of such fires in the Salisbury–Elizabeth area.
- 97 percent of all cases where child-lit fires were documented as having been associated with malicious activity occurred in the Adelaide region.
- Smoking-related fires accounted for the highest proportion of all malicious vegetation fires the Adelaide and Gawler (11%) and Angle Park (6.7%) brigades attended, although overall frequencies were very low.

Complex

Information about the type of premises at which fire occurred was available for 31 percent of malicious vegetation fires between 1997–98 and 2005–06. Of these, fires most typically occurred in reserves or parks (20% of where the premises was known) and at educational institutions (19% of known premises), followed by vacant or Crown land (11% of known premises) and on scrub/grassland (10% of known premises; Figure 14). Although some caution is needed in extrapolating these results to malicious vegetation fires generally, they are broadly consistent with trends described elsewhere.

Educational institutions: There were at least 171 instances where malicious vegetation fires occurred at an educational institution, representing 19 percent of all cases where the type of premises was identified for malicious vegetation fires. Approximately 80 percent of these occurred at educational institutions in

the Adelaide region, with a further 11 percent in the Flinders Ranges region (Port Augusta and Port Pirie stations), and five percent in the Eyre Peninsula region (Whyalla and Port Lincoln; Figure 15). This regional distribution is comparable with the general distribution of malicious vegetation fires.

Fifty-seven percent of all malicious vegetation fires at educational institutions (where identified) occurred at primary schools, with a further 25 percent of fires occurring at high schools (Figure 16). The frequency of vegetation fires at tertiary educational institutions was very small, as were the number of vegetation fires occurring at kindergartens and preschools.

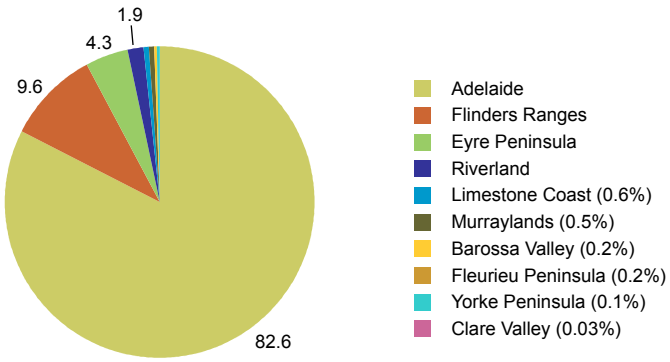
Some school grounds were clearly the sites of malicious vegetation fires more frequently than others. A cursory examination of the data indicates a high frequency of vegetation fires within the general vicinity of such schools (for example, on the same street). In these instances vegetation fires on school grounds may be a subset of malicious fires that occurred within the neighbourhood, rather than educational institutions being the specific target.

Business premises: Approximately, four percent of malicious vegetation fires (n=37), where the type of premises was identified, occurred at or near a business. Of these, approximately 14 percent occurred at a supermarket or shopping complex, 11 percent were at restaurants or takeaways, and three percent (n=1) were at petrol stations.

Figure 10: Australian Bureau of Statistics tourism regions of South Australia, 2005

Source: ABS 2005b

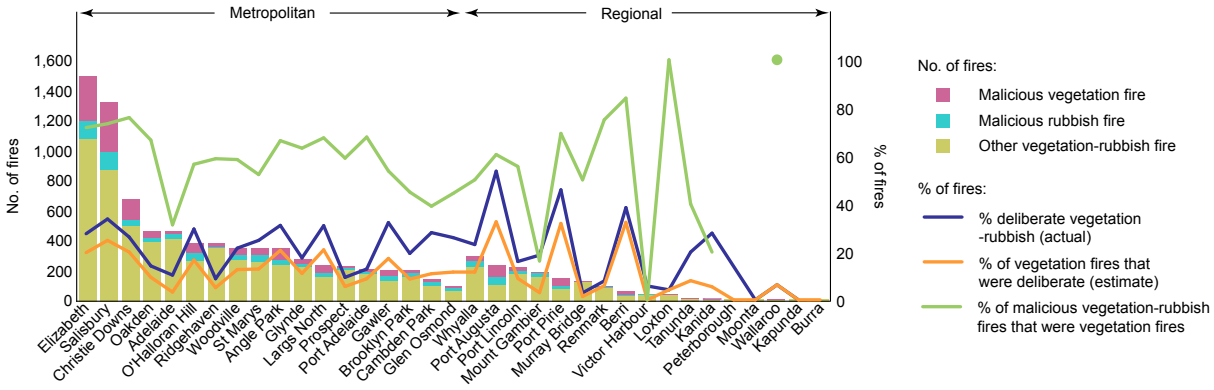
Figure 11: Malicious vegetation fires by region[a] (percent)



a: Fire stations included within each region are: Adelaide (Adelaide, Glynde, Woodville, Port Adelaide, Largs North, Oakden, Ridgehaven, Salisbury, Elizabeth, Gawler, Angle Park, Prospect, St Mary, Camden Park, O'Halloran Hill, Christie Downs, Glen Osmond, and Brooklyn Park stations), and regional urban centres in the Flinders Ranges (Port Augusta, Port Pirie), Eyre Peninsula (Whyalla, Port Lincoln), Riverland (Berri, Renmark, Loxton), Limestone Coast (Mount Gambier), Murraylands (Murray Bridge), Barossa Valley (Tanunda, Kapunda), Clare Valley (Burra), Fleurieu Peninsula (Victor Harbor), and Yorke Peninsula (Kanida, Wallaroo, Moonta)

Source: SAMFS 1997–98 to 2005–06 [computer file]

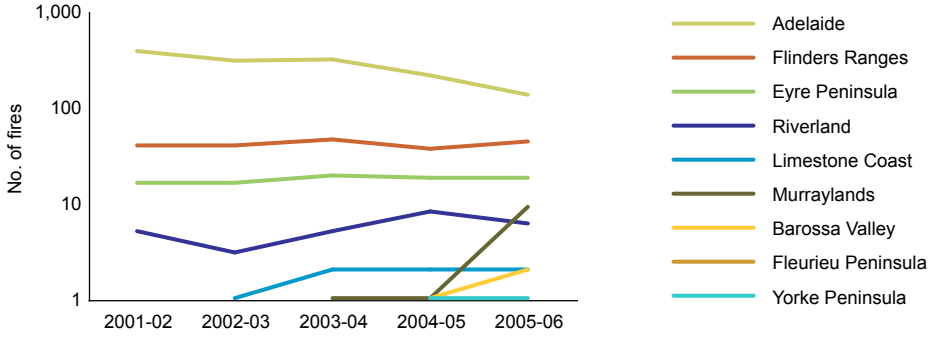
Figure 12: Malicious and non-malicious rubbish–vegetation fires[a] attended by station



a: Also shown is the proportion of all rubbish–vegetation fires that were malicious (% malicious (vegetation + rubbish); the percentage of all rubbish–vegetation fires that were malicious vegetation fires (% malicious vegetation); and the percentage of all malicious fires that were vegetation fires (% vegetation)

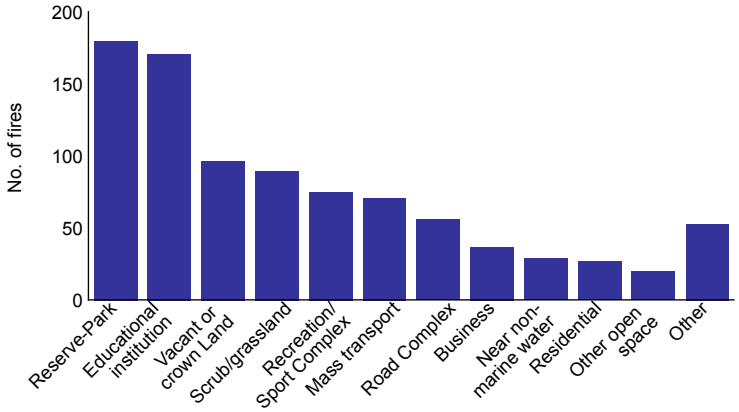
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 13: Malicious vegetation fires in each region by year



Source: SAMFS 1997–98 to 2005–06 [computer file]

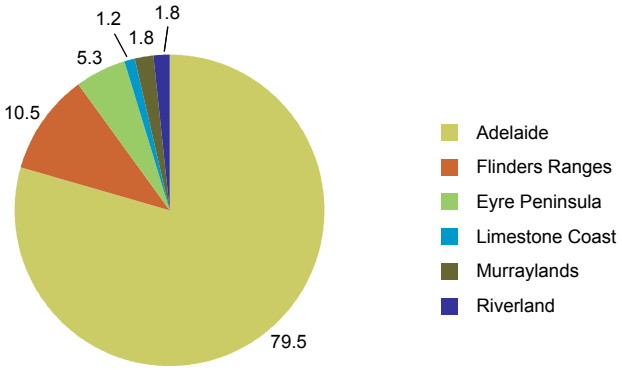
Figure 14: Malicious vegetation fires by premises type[a]



a: premises type known for 31 percent of malicious vegetation fires

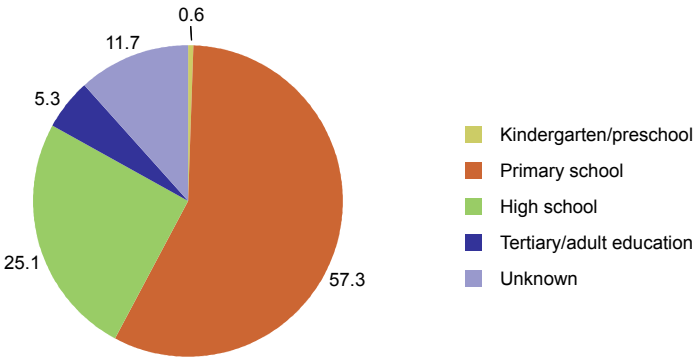
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 15: Malicious vegetation fires at educational institutions by region (percent)



Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 16: Malicious vegetation fires by type of educational institution (percent)



Source: SAMFS 1997–98 to 2005–06 [computer file]

Timing

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

Week of the year

The majority of malicious vegetation fires occurred between week 44 (early November) and week 15 (mid April), the interval of greatest bushfire danger. However, detailed analysis shows the observed pattern varied between years (Figure 17):

- In 2001–02, there was a large spike in activity between weeks 47 and 52 (late November and December).
- In 2002–03, increased frequencies occurred in late August, coincident with the dry winter and spring in that year.
- In 2003–04, fires extended into late April; coincident with an absence of late summer early autumn rains.
- In 2004–05 and 2005–06 there were two concentrated spikes in fires, eight to ten weeks apart in late spring and summer.

Overall, there was a strong link between rainfall and the timing of fires.

Malicious vegetation fires at educational institutions occurred throughout the year. However, the greatest number coincided with the bushfire danger season, from week 46 (mid November) to week 12 (mid to late March; Figure 18).

Day of the week

There was a much greater propensity for vegetation fires to occur on weekends in urban South Australia than during the week. Approximately 1.4 to 1.5 times more malicious vegetation fires occurred on Sunday and Saturday respectively than on the average weekday. However, the proportion of fires that occurred on weekends varied between regions. In the Adelaide region, 1.36 and 1.41 times more malicious fires occurred on Sunday and Saturday respectively than on the average weekday (Figure 19). This was lower than the state average. In the Flinders Ranges (Port Augusta and Port Pirie), malicious vegetation fires were 1.7 and 2.2 more likely on Sunday and Saturday, respectively. Similarly, fires in the Eyre Peninsula region (Port Lincoln and Whyalla) were 2.7 and 2.5 times more likely to occur on Sunday and Saturday than on a weekday (Figure 19).

The overwhelming majority of malicious vegetation fires at educational institutions occurred outside of school hours, being 1.6 times more likely to occur on Sunday and 2.2 times more likely to occur on Saturday than on a weekday (Figure 20). Malicious vegetation fires were also three times more likely to occur at businesses on Sunday than on a weekday (Figure 20), but the number of fires on Saturday was significantly different. Note: the overall number of fires at businesses is small, and may not be genuinely representative of malicious vegetation fires at businesses generally.

Time of the day

The time a malicious vegetation fire occurred was recorded in approximately 60 percent of cases. The available data define two overlapping peaks; one during the afternoon and one at night. Combining these frequency distributions yields two maximums; at 5 pm to 6 pm and 10 pm to 11 pm (Figure 21).

A high proportion of all malicious vegetation fires in the Adelaide region were lit outside normal business hours, with 54 percent of cases where the time was known occurring between 6 pm and 6 am (night fires). The extent of night fires was variable at a local scale. For most stations, between 50 percent and 70 percent of all malicious vegetation fires occurred between 6 pm and 6 am. However, values as high as 74 percent to 75 percent were observed for the Glynde and Brooklyn Park stations and as low as 36 and 47 for the Gawler and Prospect stations.

Although 'nighttime' fires were a feature of most days of the week in the Adelaide region, a greater numbers of fires occurred on Friday night – Saturday morning and Saturday night – Sunday morning (Figure 22). This was most evident for the interval between midnight and 6 am. Approximately, 26 percent of all malicious vegetation fires on Saturday and Sunday occurred between midnight and 6 am, whereas only 14 percent and 19 percent (average of 17%) occurred during these times on weekdays.

The proportion of fires occurring within the midnight to 6 am window varied between stations. Typically, 20 to 35 percent of all malicious vegetation fires (where time was recorded) attended by each station occurred between midnight and 6 am, but for Brooklyn Park and Glen Osmond the values were 42 percent and 40 percent, respectively. Although Salisbury and Elizabeth recorded more malicious vegetation fires at night than any other station the proportion of fires that occurred from midnight to 6 am was comparatively low, at 16 percent to 17 percent (Figure 23). The Adelaide and Largs North stations also attended comparatively few malicious vegetation fires during the early morning hours before 6 am.

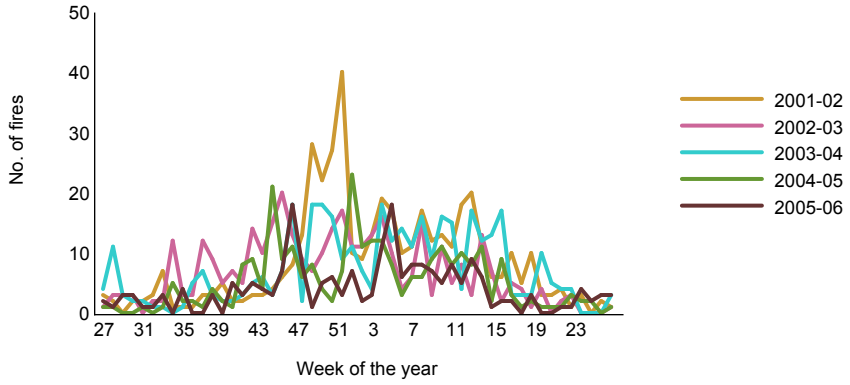
A high number and proportion of fires in major regional urban centres also occurred at night. Between 48 percent and 54 percent of all vegetation fires in the Flinders Ranges, Eyre Peninsula and Riverland regions occurred between 6 pm and 6 am (Figure 24). Approximately 14 to 20 percent of all malicious vegetation fires in these regions (where time was recorded) occurred between midnight and 6 am. This is similar to the values documented for metropolitan stations.

The time at which malicious vegetation fires occurred at educational institutions paralleled that recorded for malicious vegetation fires generally. High numbers of vegetation fires occurred between 3 pm and 6 pm (although in many cases this was on weekends rather than weekdays). However, approximately 60 percent (where time was recorded) of malicious vegetation fires at educational institutions occurred between the hours of 6 pm and 8 am (Figure 25). There was a spike in the number of fires at around 3 to 4 pm, but 19 out of the 25 fires that occurred between 2 pm and 6 pm were on weekends, not on school days.

The combined temporal data suggest that most malicious vegetation fires that occur at educational institutions occur outside normal school hours, including the period in which one might expect children to be making their way home. The timing of fires at educational institutions implies that many malicious vegetation fires occurred when a person visited the school out of hours (school holidays, weekends and at night), rather than by students committing the offence en route to or from school. A high proportion of fires occurred at primary schools so children attending those schools cannot be discounted, however, the timing of many of those fires implies that the people lighting the fires may have been older than primary school age (6–12 years).

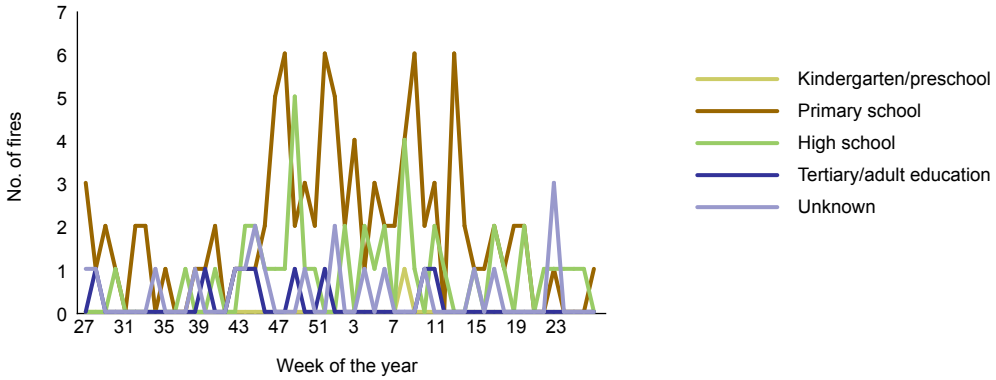
There was also a high propensity for malicious vegetation fires at businesses to occur during the night (Figure 25). However, given the low number of cases where the time was known this might not be representative of such fires generally.

Figure 17: Fires each year by week of the year



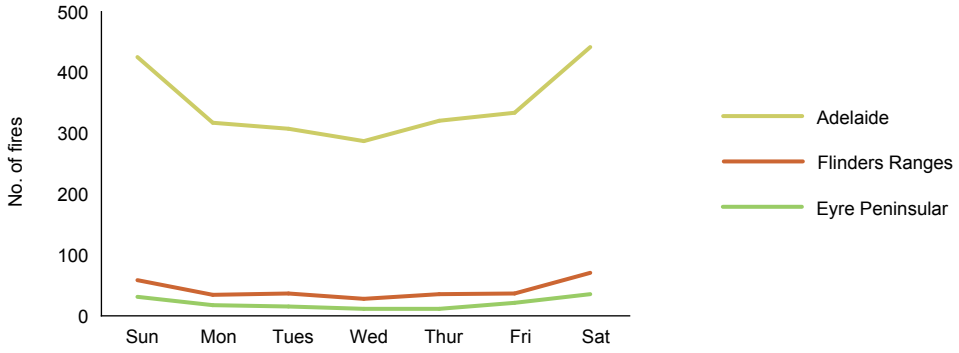
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 18: Vegetation fires at educational institutions by week of the year



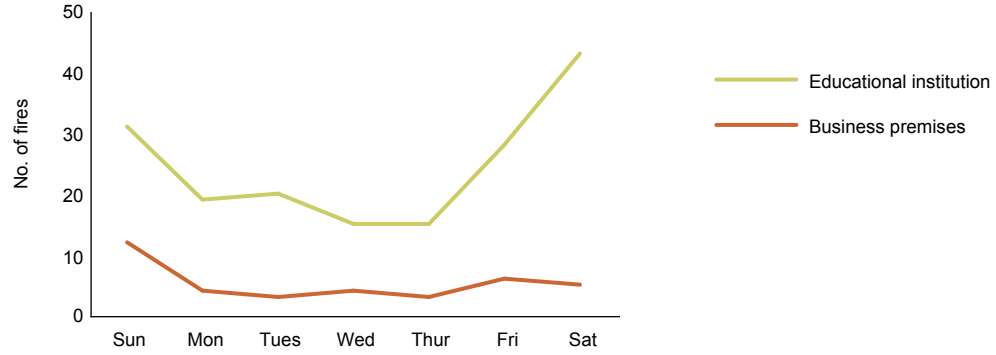
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 19: Malicious vegetation fires in selected regions by day of the week



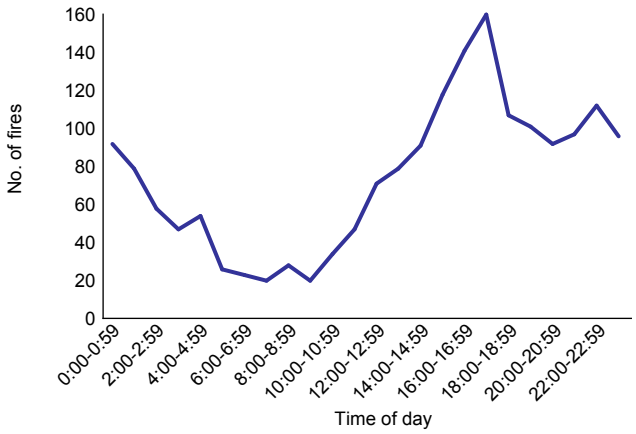
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 20: Malicious vegetation fires at educational institutions and businesses by day of the week



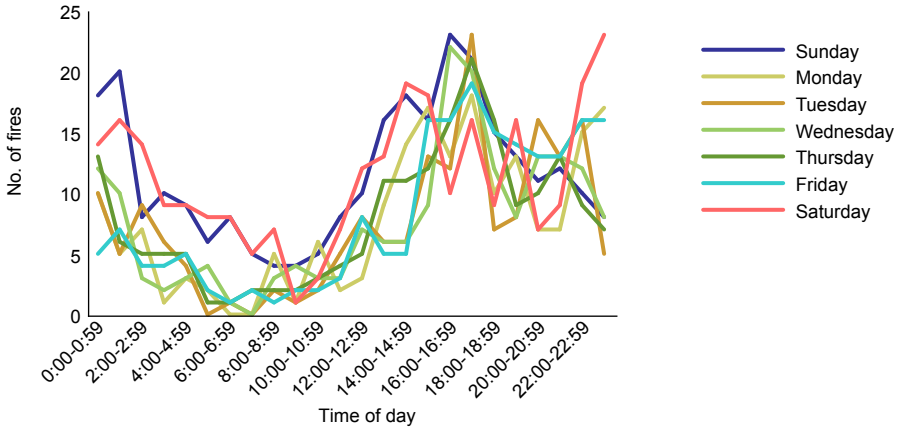
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 21: Time of day for malicious vegetation fires



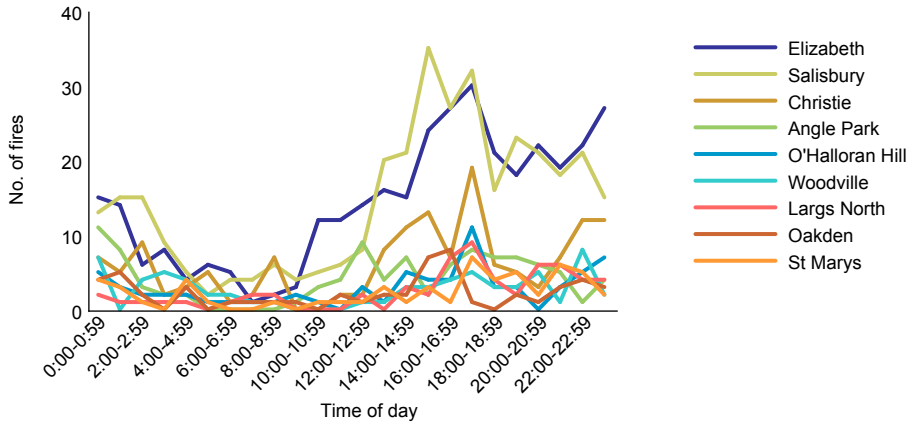
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 22: Malicious fires in the Adelaide region by day of the week and time of the day



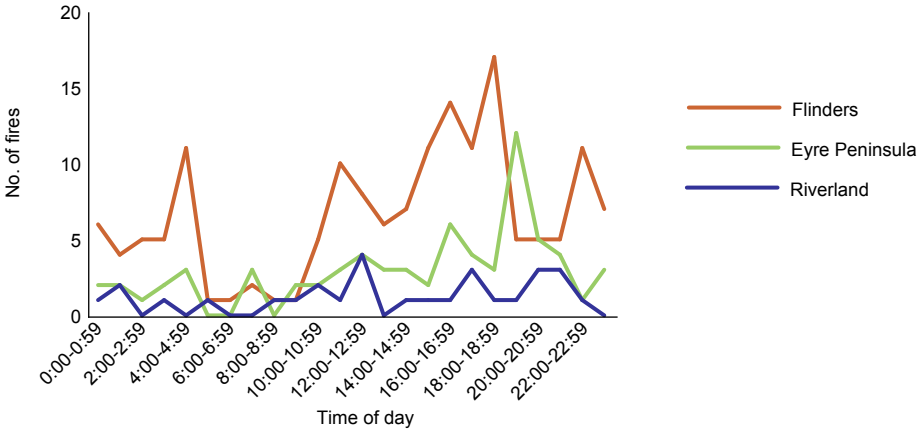
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 23: Malicious fires at specific Adelaide stations by time of day



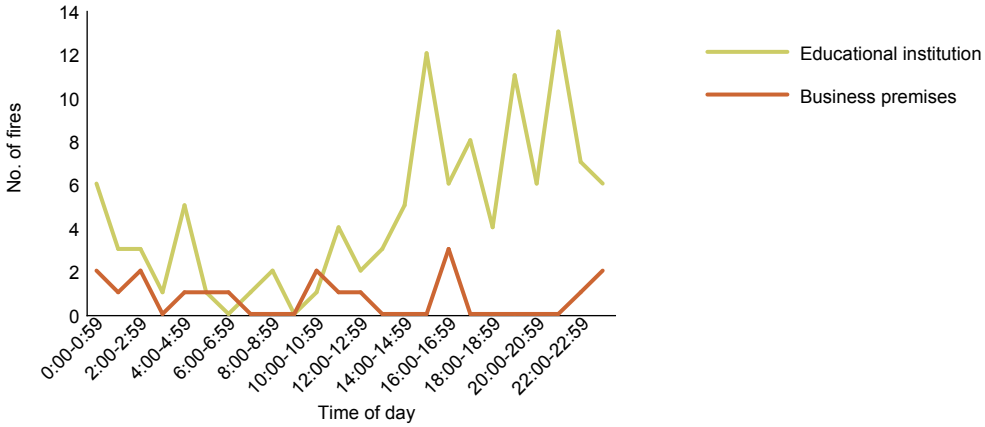
Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 24: Malicious fires in the Flinders, Eyre Peninsula and Riverland regions by time of the day



Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 25: Malicious vegetation fires at educational institutions and businesses by time of the day



Source: SAMFS 1997–98 to 2005–06 [computer file]

Area burned

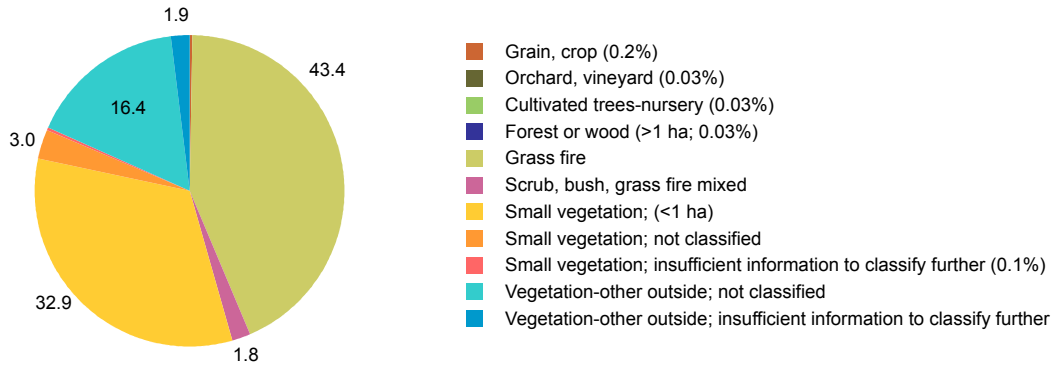
No information is available regarding the area burned.

Type of incident

Forty-three percent of malicious vegetation fires the SAMFS attended were classified as grassfires, with another 36 percent being small vegetation fires (Figure 26). The majority of the latter were identified as small vegetation fires less than 1 ha. Vegetation and other outside fires, either not classified or having insufficient information to classify, accounted for a further 18.3 percent of fires. There was only one incident where the SAMFS attended a malicious vegetation fire in forest or woods (greater than 1 ha; 0.03%) and 54 cases (1.8%) of malicious vegetation fires occurring in mixed scrub, bush or grass. Collectively, the proportion of malicious vegetation fires the SAMFS attended in areas used for agriculture, viticulture, orchard and/or nursery settings was less than one-quarter of one percent.

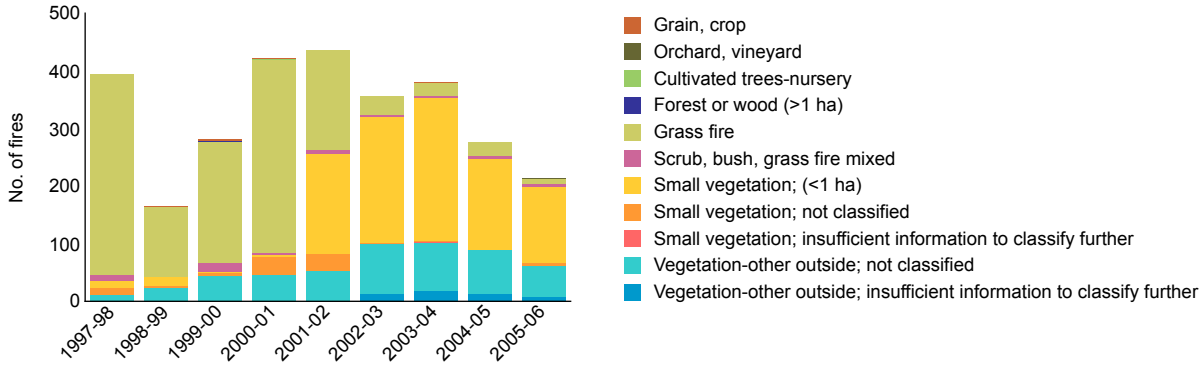
Some caution is required, however, in the interpretation of these results as there were substantive changes in the way fires were classified within the observation period. Worthy of note, is the substantive decrease in grass fires and the marked increase in the number of 'small vegetation fire', and 'vegetation and other outside fire' categories post-2001–02 (Figure 27). These results imply that many fires now classified as small vegetation fires or other outside fires had previously been classified as grass fires. The predominance of grass fires over forest, woods, or mixed scrub, bush and grass fires, are a feature of South Australian fires generally (see SACFS) but also reflects the predominant environments that occur within or near urban centres.

Figure 26: Incident type (percent)



Source: SAMFS 1997–98 to 2005–06 [computer file]

Figure 27: Incident type by year



Source: SAMFS 1997–98 to 2005–06 [computer file]

South Australian Country Fire Service

Background about the SACFS dataset and its analysis

Important information regarding the SACFS dataset and the methodology employed to analyse it follows.

- The data was sourced from the South Australian Country Fire Service (SACFS).
- The dataset provided only included vegetation fires, crop and grain fires, and rubbish fires; only vegetation fires were included within this analysis. Hence, in the following discussion it can be assumed that any reference to a fire is referring to a vegetation fire.
- The dataset included vegetation fires from 1997–98 to 2003–04.
- Substantial changes in classification of fire causes and other documentation occurred during the analysis, meaning that the methodology adopted for the SACFS analysis was unique.
- Fire cause was defined based on the 'additional factor' and 'fire cause' variables.
- The database included information about the type of incident.
- Fires were classified as incendiary in all instances where the additional factor was coded incendiary, deliberate or malicious.
- Fires were classified as suspicious in all instances where the additional factor was classified as 'suspicious circumstances'; refer to the Methodology details regarding causal attributions.
- The term deliberate in this analysis refers to all fires identified as incendiary or suspicious.
- Natural fires comprised fires classified as have resulted from lightning (56.9%) and heat from natural sources (29.3%).
- Some information about the form of heat of ignition was supplied in the database.
- Smoking-related fires fell within two categories: cause='matches, smoking devices, candles, lanterns' and cause='heat from smokers materials'; based on the causal classification scheme adopted, 16.8% fires were accidental; 30.5% were incendiary; 5.3% were suspicious; 46% were classed as other.
- In this analysis all fires attributed to children were classified in the other category; no information was available regarding either whether the fires were considered malicious or about the age of the child.

- Regions used in the SACFS analysis are based on tourism regions defined by the Australian Bureau of Statistics (ABS 2005b). Assignation to region was based on the location provided. There was not an exact concordance between the location and tourism regions. The ABS define tourism region based on smaller statistical areas. Hence, ABS tourism regions potentially crosscut suburbs and postcodes. In this study, assignation was based on the highest levels of concordance between suburbs and tourism regions. Hence, there is not an exact correspondence between tourism regions used in this analysis and ABS tourism regions.
- The dataset included information pertinent to the area burned, but did not include information about the status of fire restrictions/total fires bans, fire danger index or tenure.
- The SACFS attends many SADEH fires, and there is likely a high degree of overlap between data for these two services.

For further detail refer to the Methodology.

Overview

Fires attended by the SACFS can be summarized as follows:

- The SACFS attended 8,603 vegetation fires (excluding crop, grain and rubbish fires) during 1997–98 to 2003–04. The minimum number of fires attended in any one year was 756 in 1999–2000 (Figure 28). The maximum occurred in 2002–03 (n=1,494), although this is not substantially different from the previous year (n=1,478). The number of fires exceeded 1,300 for the last four years of the observation period. The lack of markedly higher numbers of fires in 2002–03 is somewhat surprising given the severity of that bushfire season but may reflect active attempts to reduce the incidence of arson and promote bushfire awareness during that bushfire danger season.
- The SACFS is principally a rural fire service, although many smaller urban centres that do not have an urban-based fire service fall under its jurisdiction. Hence, the SACFS may potentially attend a diverse range of vegetation fire incidents, ranging from large bushfires to small, urban incidents. The SACFS indicates that 53 percent of the fires attended were grass or stubble fires, 38 percent, scrub and grass fires, with a further 7.1 percent being tree fires. Only 1.7 percent of fires the SACFS attended were forest fires.
- Collectively, 20.2 percent of vegetation fires attended by the SACFS were deliberately lit (15.9% suspicious; 4.3% incendiary).
- 144,686 ha were burned in SACFS-attended fires from 1997–98 to 2003–04; 5.9 percent of this was burned in incendiary or suspicious fires.

Cause

The majority of fires the SACFS attended originated from non-deliberate causes with 27.3 percent being accidental, 7.6 percent natural, and 10.9 percent resulting from other non-deliberate causes (Figure 29). Just over four percent of all fires were classified as incendiary, with a further 16 percent classified as suspicious. Collectively deliberate causes (incendiary and suspicious combined) were responsible for 20.2 percent of all fires and 30.6 percent of all fires where the cause was attributed (that is, not unknown).

Changes in the structure of the database during 1999–2000 and 2000–01 make assessments of long-term changes in cause difficult (see Specific ignition factors below), so the following analysis is restricted to 2001–01 to 2003–04. Between 200 and 300 deliberate fires occurred every year from 2001–01 to 2003–04, with the maximum (n=299) occurring in 2001–02. The proportion of deliberate fires remained comparatively uniform throughout this period ranging from a low of 19 percent in 2000–01 to a high of 24 percent in 2001–02.

The greatest number of natural fires occurred in 2002–03 (Figure 28), with high proportions of natural lightings occurring in both 1997–98 and 2002–03. However, the number of natural fires in 1997–98 was not substantially different from that observed in other non-El Niño years.

Specific ignition factors

Ignition factor: Changes in the types of information recorded in the SACFS database prevents a detailed comparison of how the ignition factors have changed across the entire interval (Figure 30), and for the purposes of consistency only the 2000–01 to 2003–04 data are discussed herein.

The specific ignition factor was not ascertained or recorded for almost half of fires (Figure 30), with the proportion of unknown ignition factors increasing from 39 to 52 percent from 2000–01 to 2003–04 (Figure 31). Burning-off was the greatest identifiable cause of SACFS-attended fires, followed by other causes, fires relating to machinery and vehicles, natural and other causes (principally rekindled fires and other unspecified causes).

The proportions of each ignition factor remained comparatively stable over the period. The notable exception was the increased frequencies of natural fires that occurred during 2002–03 and to a lesser extent 2000–01. Some caution should be exercised when interpreting these results. The comparatively high degree of unknown causes may mask genuine temporal variations. Moreover, the ‘known’ group may not be representative of the total as some types of ignition are more readily identifiable or attributable than others.

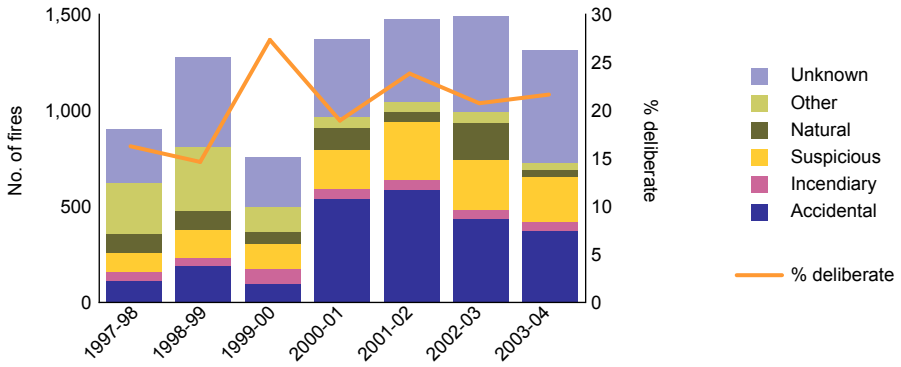
The ignition factor responsible for deliberate vegetation fires was unknown in 80 percent of cases (Figure 32). Burning-off accounted for a high proportion of deliberate lightings where the ignition factor was listed. Two-thirds of burn offs that were classified as malicious were lit without a permit.

Fires started by children: Children were identified as being responsible for 208 vegetation fires; that is, 2.4 percent of fires the SACFS attended between 2000–01 and 2003–04. There were between 39 and 59 fires in any given year, comprising between two percent and four percent of all fires each year (Figure 33). These statistics represent a minimum, as the causal category requires the child to be observed at the scene of the fire. Note: all fires started by children fall within the ‘other’ causal category. No judgement was available within the database as to whether the fires were maliciously lit.

Smoking-related fires: It is difficult to accurately assess the number of smoking-related vegetation fires as such fires have been amalgamated with fires resulting from matches, candles and lanterns since 2000–01. Before this, data were in separate categories.

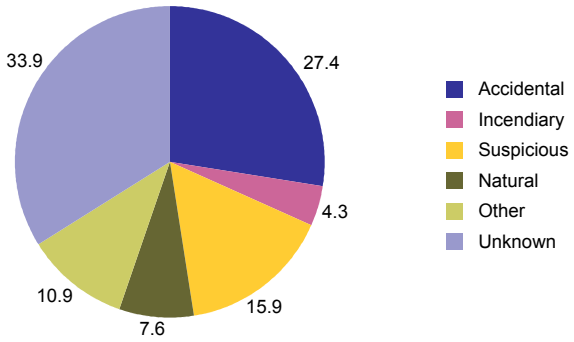
Before 2000–01 the SACFS attended up to 26 smoking-related fires per year. Since 2000–01 there have been 30 to 44 fires started by matches, smoking-related materials, candles and lanterns each year (Figure 34). Overall, smoking-related fires comprised between two and three percent of all vegetation fires the SACFS attended each year.

Figure 28: Cause of fires each year



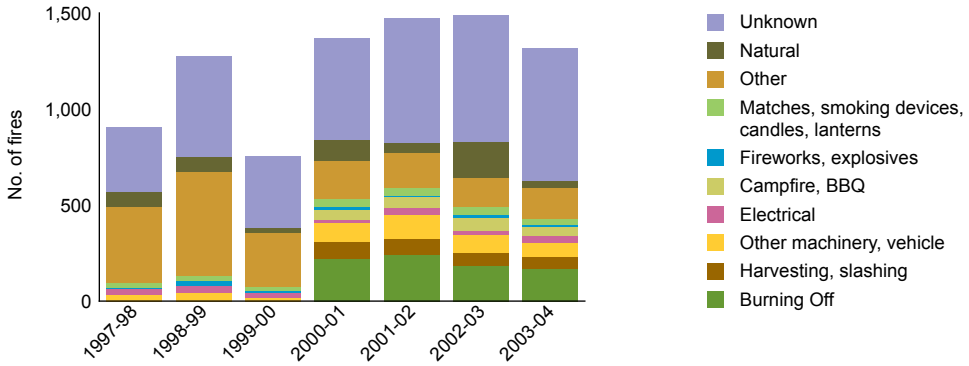
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 29: Fire cause (percent)



Source: SACFS 1997–98 to 2003–04 [computer file]

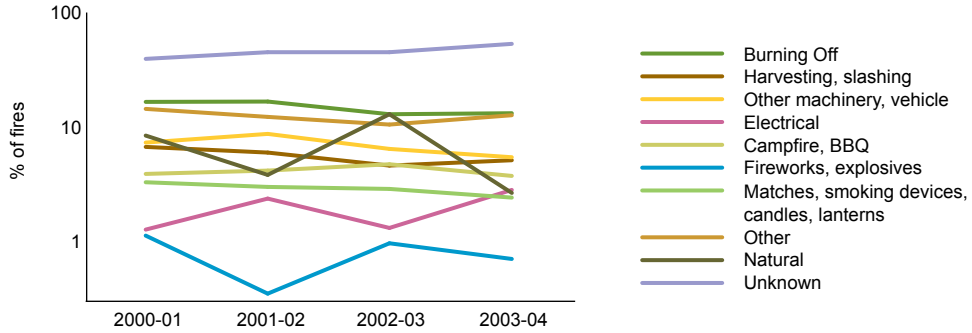
Figure 30: Ignition factor by year[a]



a: The abrupt change in the proportion of many factors at the end of 1999–2000 is consistent with a change in how causes of fires were encoded and documented

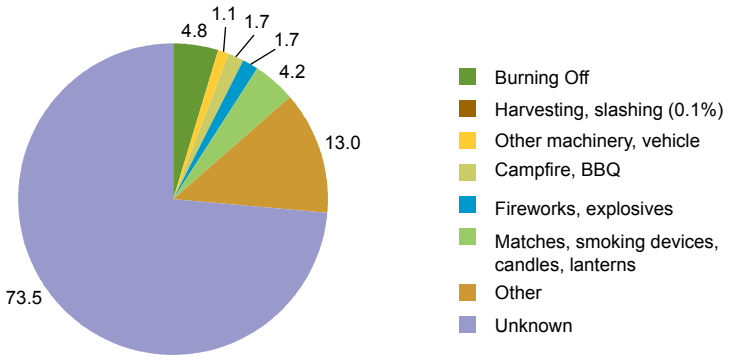
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 31: Ignition factor each year for 2000–01 to 2003–04 (percent)



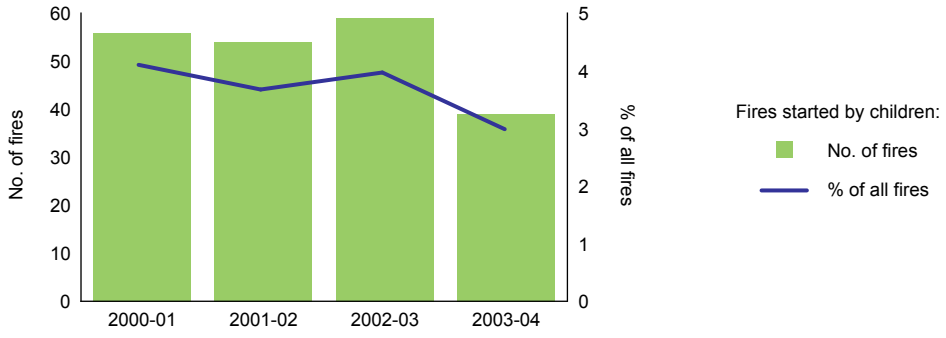
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 32: Ignition factor in deliberate fires



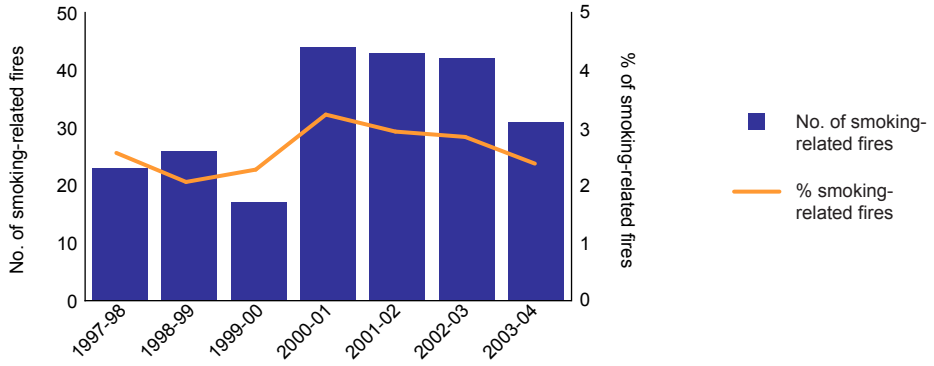
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 33: Fires lit by children, 2000–01 to 2003–04



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 34: Smoking-related fires (1997–98 to 1999–2000) and fires arising from 'matches, smoking devices, candles, lanterns (2000–01 to 2003–04)



Source: SACFS 1997–98 to 2003–04 [computer file]

Location

This section examines the regional distribution of vegetation fires generally and by cause.

Region

Thirty percent of all vegetation fires the SACFS attended occurred in the Adelaide (17%) and Adelaide Hills (13%) regions (Figure 35). A further 10 percent of fires occurred each on the Limestone Coast and Fleurieu Peninsula regions. Between four percent and seven percent of fires each occurred in the Yorke Peninsula, Eyre Peninsula, Murrylands, Flinders Ranges and Riverlands regions.

The greatest number of deliberately lit vegetation fires occurred in Adelaide, Fleurieu Peninsula, and Adelaide Hills regions (Figure 36). The proportion of deliberately lit fires was highly variable between regions, accounting for 41 percent of fires in the Adelaide region and 28 percent in the Fleurieu Peninsula and Riverland regions. In the Adelaide Hills, Limestone Coast and Yorke Peninsula regions, 20, 15 and 13 percent of fires were deliberately lit, respectively. Although a high proportion of fires in the Outback region were deliberately lit (40%), the number of fires was exceptionally low. Notably, only 0.7 percent of all SACFS-attended fires occurred in the Outback region.

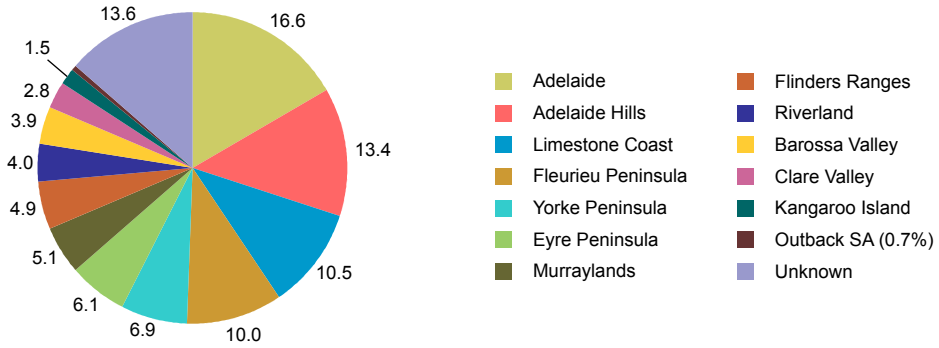
Other causal variations included:

Natural fires: The highest proportion of natural fires occurred in the Eyre Peninsula (18%), Limestone Coast (12%) and Flinders Ranges (12%) regions (Figure 36).

Child fires: Marked variations were evident in both the number and proportion of vegetation fires attributed to children in each region for the period 2000–01 to 2003–04 (Figure 37). The greatest number of child fires occurred in the Adelaide (n=66) and Fleurieu Peninsula (n=28). The highest proportions of fires attributed to children occurred in the Yorke Peninsula (5.4%), Barossa Valley (4.8%) and Adelaide (4.6%). A comparatively low proportion (1% to 1.5%) of fires in the Adelaide Hills and the Limestone Coast regions were attributed to children. Despite this variability there was, overall, a strong correlation between the numbers of fires set by children and total vegetation fire frequencies across regions ($r=.80$; $p<.001$).

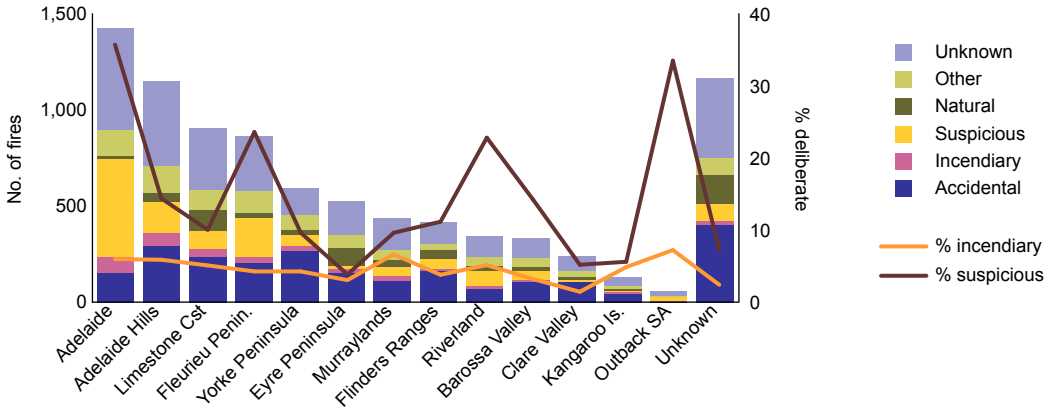
Smoking-related fires: The majority of fires started by matches and other smoking related materials, candles and lanterns occurred in the Adelaide (23%), Adelaide Hills (13%) and Fleurieu Peninsula (12%) regions (Figure 38). Fires attributed thus were responsible for the highest proportion of all fires in the Outback South Australia (5.3%), Murraylands (3.7 %), Adelaide (3.6%), Riverland (3.5%), and Fleurieu Peninsula (3.2%) regions.

Figure 35: Regional distribution (percent)



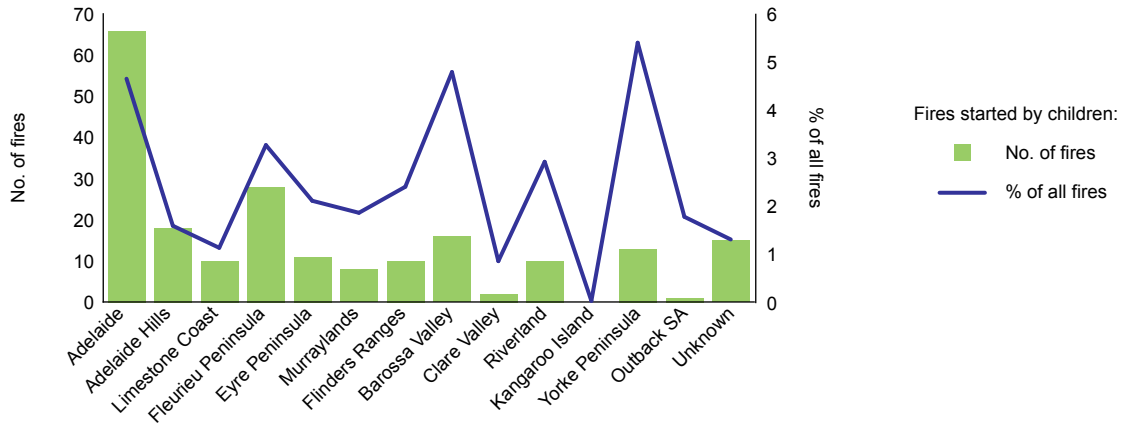
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 36: Cause of vegetation fires in each region (1997–98 to 2003–04)



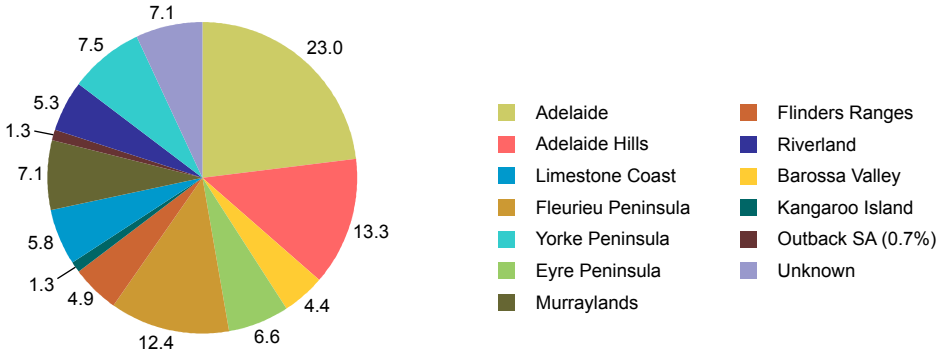
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 37: Child fires by region



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 38: Fires started by matches, smoking-related materials, candles and lanterns by region



Source: SACFS 1997–98 to 2003–04 [computer file]

Timing

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

Week of the year

The period of greatest bushfire danger in South Australia typically occurs from November–December through to late March–mid April. The vast majority of fires the SACFS attended occurred within this interval. Namely, the number of fires increased sharply in late October, typically peaking in January, and remained elevated until the end of the bushfire danger season, in March or April (Figure 39).

Although this general pattern occurred for both deliberate and non-deliberate causes, it is evident that deliberate fire 'season' tends to be marginally shorter than that for non-deliberate fires. Most deliberate fires occurred between weeks 44 and 17 as opposed to weeks 40 to 20 for non-deliberate fires. This difference principally reflects the high contribution that burn offs make within the non-deliberate fire category. Burn offs peak just before (commonly up to late November–early December) and just after (commonly after late March to early April onwards) the period of greatest bushfire danger (Figure 40).

Subtle differences were evident between the temporal distributions of other fire causes as well:

- Natural fires were typically restricted to the summer months (Figure 40). The rather spiky pattern for natural fires reflects evidence that a front of thunderstorm activity moving across the state generates multiple fires in the same week. Such weeks of intense weather activity tend to be erratically distributed within and between bushfire danger periods.
- Fires resulting from harvesting and slashing peaked in November and December, but remained elevated until late March.
- High numbers of escapes from campfires and barbeques occurred in September and April (Figure 40), being largely coincident with school holidays, when greater numbers of people are likely to be camping and less stringent or no fire restrictions are in force.
- Although fires started by children occurred throughout the year, the greatest number coincided with the peak in vegetation fires generally (Figure 41). The highest number occurring in December and in week 5, coinciding with the start of the school holiday and resumption of the school year. A high number of fires were also recorded in mid April, which may have coincided with the Easter school holidays. Child fires typically comprised less than four percent throughout the bushfire danger period but up to 10 to 18 percent in some weeks during winter.

The regularity with which the bushfire season commences each year (Figure 42), while shaped by the patterns of burning-off, ultimately reflects the consistent decrease in rainfall during the same period for all years for central (such as the Mount Lofty ranges) and northern South Australian latitudes (Figure 43). The decrease in rainfall is less systematic for the Lower Southeast, where there may be late spring or early summer rainfall (Figure 44).

While this is the general pattern, early spikes in fires were evident in week 44 (early November) and to a lesser extent week 37 (mid September) of 2002–03. Fires in week 37 primarily related to burn offs and suspicious causes, the large spike in week 44 principally arose from the 147 fires started by lightning in that week (Figure 42). Ignition of a large number of natural fires in 2002–03 was markedly earlier than in other years. However, in 2002–03, low rainfall, possibly arising from the El Niño weather patterns, was felt most strongly in the more northerly portions of the state. Average annual rainfall during spring and summer was comparable to that observed in other years.

The number of fires from January to April tended to vary substantially between years, reflecting the more erratic nature of rainfall in this interval from year to year. The rainfall distribution during late summer to autumn became more erratic northwards (Figure 43 and Figure 44), and would therefore have had a greater impact on northern than on southern regions. This erratic nature was more evident for non-deliberate causes compared to deliberate, supporting the contention that changes in bushfire danger may play a greater part in generating high numbers of fires than do specific changes in the actions of people.

It is not surprising that a large number of fires occurred in 2000–01 in light of the exceptionally low rainfall recorded in most parts of the state from November to February.

Day of the week

Overall, 33 percent more fires occurred on Saturday, but higher numbers of fires were not observed on Sunday compared to any other day of the week. Deliberate was the only cause of fire where the number of fires on both Saturday and Sunday exceeded those observed on weekdays (Figure 45). Incendiary fires were 50 to 60 percent more likely to occur on a weekend than during the week. In contrast, fires categorised as suspicious were 60 and 30 percent more likely to occur on Saturday and Sunday relative to the weekday average, respectively. A propensity for increased numbers of fires is also evident for ‘other’ fires, which includes fires started by children, fires relating to misuse of heat of ignition or material

ignited and other unspecified causes. More accidental fires occurred on Tuesday and Saturday than on other days of the week.

Differences were also noted in the tendency for weekend fires between regions. In the Adelaide and Adelaide Hills regions, 24 percent and 16 percent more fires occurred on Sunday and 78 percent and 60 percent more occurred on Saturday than on the weekday average (Figure 46). In contrast, on the Fleurieu Peninsula 71 percent more deliberate fires occurred on Sunday and only 40 percent more fires occurred on Saturday relative to the weekday average, respectively. The Murraylands and Kangaroo Island regions documented much greater numbers of fires on Sunday relative to Saturday or the average weekday (300% to 500% of the weekday average) although absolute numbers of fires were lower, particularly for the Kangaroo Island region.

There is a strong tendency for children in regional and rural areas of South Australia to light more fires on weekends. Seventy and 40 percent more child fires occurred on Saturday and Sunday relative to the weekday average, respectively (Figure 47).

Time of the day

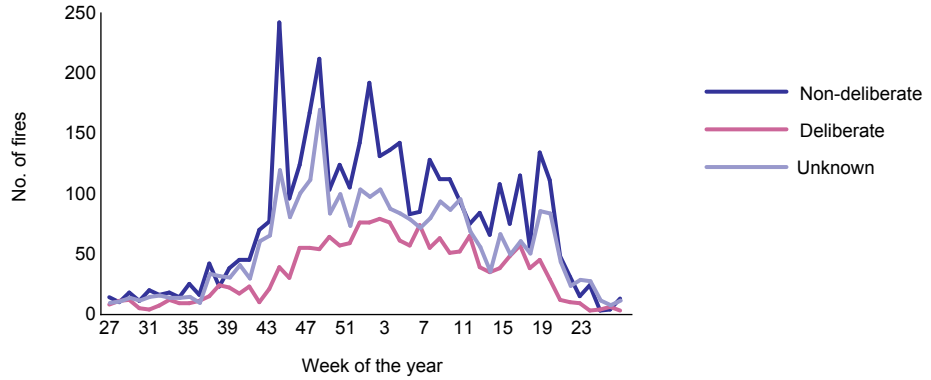
The vast majority of vegetation fires the SACFS attended were detected during daylight hours, but the distribution of fires throughout the day was highly dependent on cause. Non-deliberate vegetation fires mostly occurred between 10 am and 8 pm, irrespective of the day of the week, typically with peak frequencies occurring between 2 and 3 pm (Figure 48). The majority of deliberate fires also occurred between 10 am and 8 pm, although there was a tendency for maximum frequencies to occur slightly later, with the peak somewhere between 3 and 5 pm (Figure 49).

As observed elsewhere, greater numbers and proportion of deliberate fires occurred during the night, reaching a maximum during the early hours of the morning. Forty-three percent of all deliberate fires occurred between 6 pm and 6 am with 26 percent of deliberate fires occurring between midnight and 6 am. The spike in fires at night was most evident for Friday night–Saturday morning and for Saturday night–Sunday morning. Notably, 41 percent of fires between 6 pm and 6 am occurred on these two nights. Only five percent of non-deliberate fires were reported between these times.

Night fires were not a feature of all regions. Fifty-two percent of all deliberate fires in Adelaide occurred between 6 pm and 6 am, with 22 percent of deliberate fires in this region occurring between midnight and 6 am (Figure 50). Other regions to record a high proportion of deliberate fires between 6 pm and 6 am included the Flinders Ranges, Barossa Valley and Clare Valley regions (46% to 47% of fires occurred within this timeframe). However, with the exception of the Barossa Valley and Outback South Australia, where the total number of fires were low, the only other area outside of the Adelaide region to record a high proportion of fires between midnight and 6 am was the Fleurieu Peninsula (20%) and, to a lesser extent, the Adelaide Hills and Flinders Ranges regions (both 15%).

Regional differences in the propensity for deliberate vegetation fires at night may reflect differences in patterns of socialising. The dual peak pattern that is manifest in the Adelaide regions was also a feature of deliberate fires in the Perth region in Western Australia. Combined, the SAMFS and SACFS suggest deliberate night fires are a feature of more densely populated, principally urban areas, but such fires can potentially account for a high proportion of all fires that occur in some regional areas, even though the total number of fires was low. Fires on Friday and Saturday nights and the following mornings played an important role in generating greater numbers of fires on weekends relative to weekdays. This is, however, not a suitable explanation for an increased number of child fires on weekends relative to weekdays. Comparatively few fires started by children occurring between midnight and 9 am. Children lit most fires between 4 and 6 pm (Figure 51).

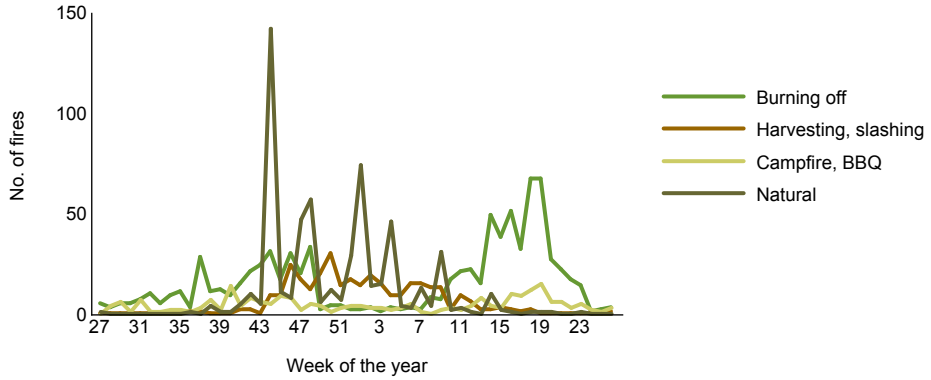
Figure 39: Week of the year[a] fires occurred by cause



a: Week 1 corresponds to the first week of January

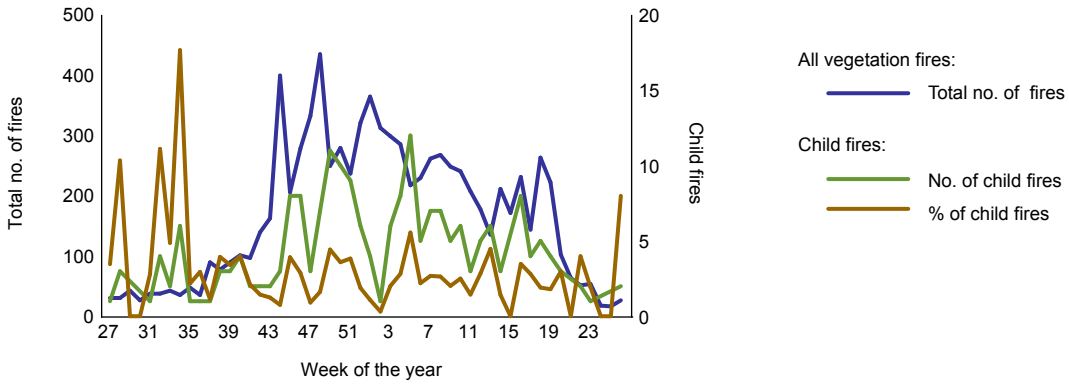
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 40: Week of the year that specific fire causes occurred



Source: SACFS 1997–98 to 2003–04 [computer file]

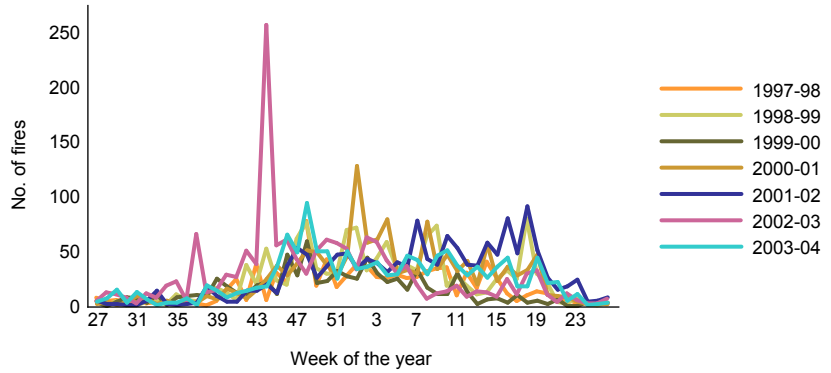
Figure 41: Child fires by week of the year



Note: Total refers to all fires of all causes and % Child is the percentage of all fires that occurred in that week that were attributed to children

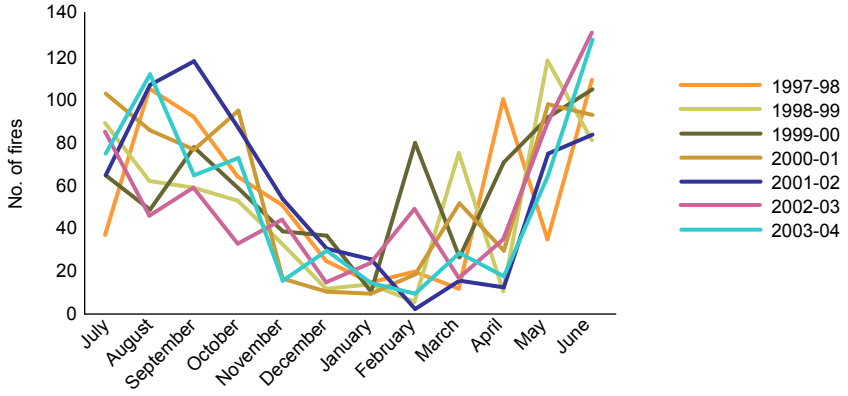
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 42: Week of the year by year for fires of all causes



Source: SACFS 1997–98 to 2003–04 [computer file]

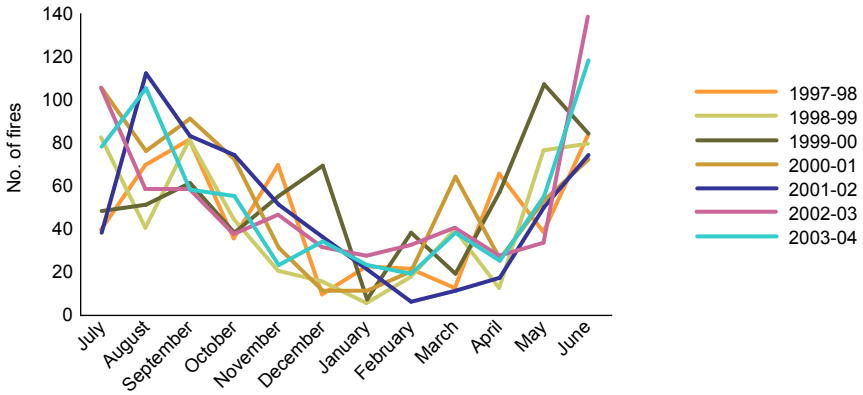
Figure 43: Mount Lofty Ranges – district rainfall average[a], 1997–98 to 2003–04



a: Data in this figure is based on monthly gridded rainfall data

Source: Australian Bureau of Meteorology [computer file]

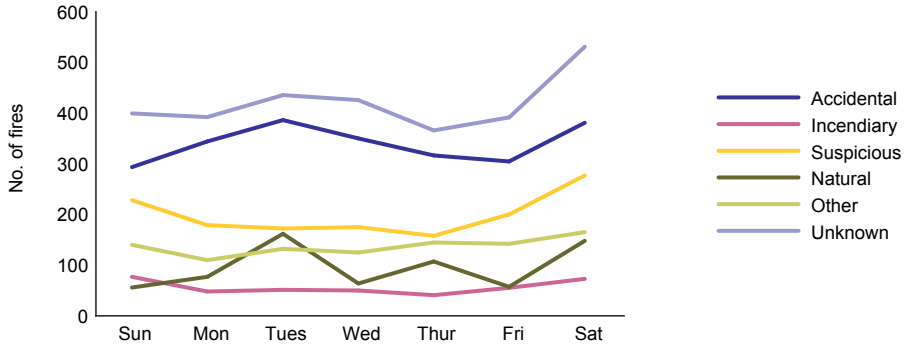
Figure 44: Lower Southeast South Australia –district rainfall average[a], 1997–98 to 2003–04



a: Data in this figure is based on monthly gridded rainfall data

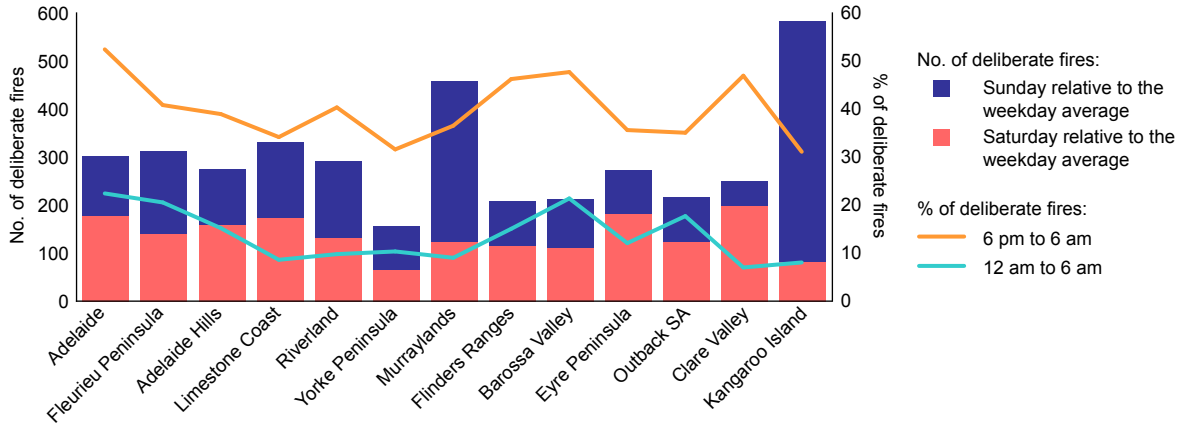
Source: Australian Bureau of Meteorology [computer file]

Figure 45: Day of the week by cause



Source: SACFS 1997–98 to 2003–04 [computer file]

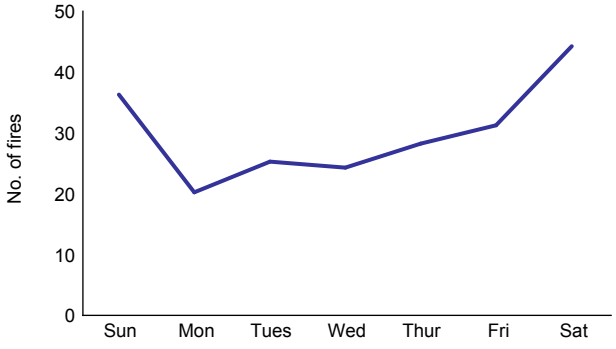
Figure 46: Deliberate fires on weekend and at night by region[a]



a: Sun and Sat rel to WDA, is the percentage of deliberate fires that occurred on Sunday and Saturday relative to the weekday average in each region. 6 pm to 6 am and 12 am to 6 am refer include data from all days of the week

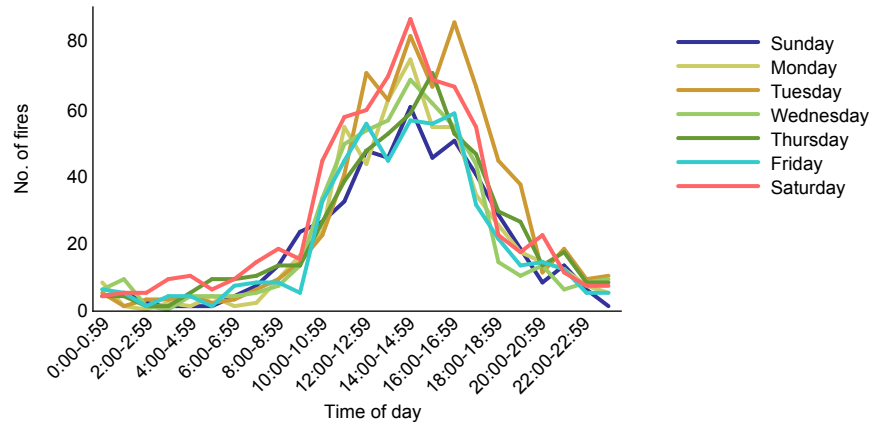
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 47: Child fires by day of the week



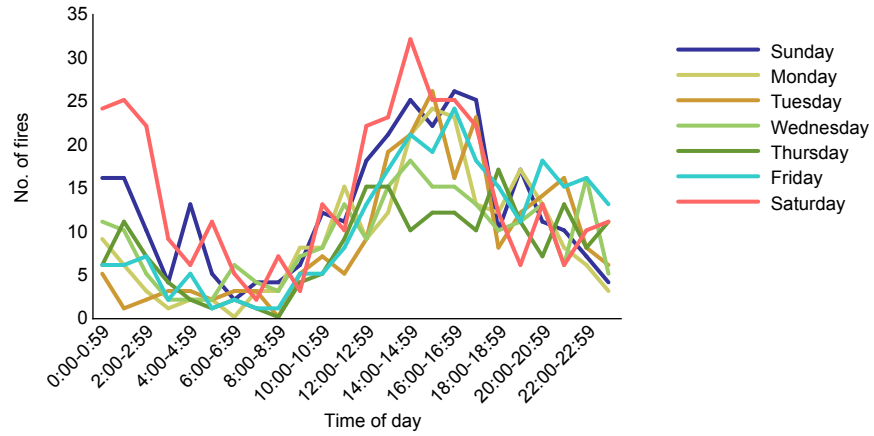
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 48: Non-deliberate fires by day of the week and time of day



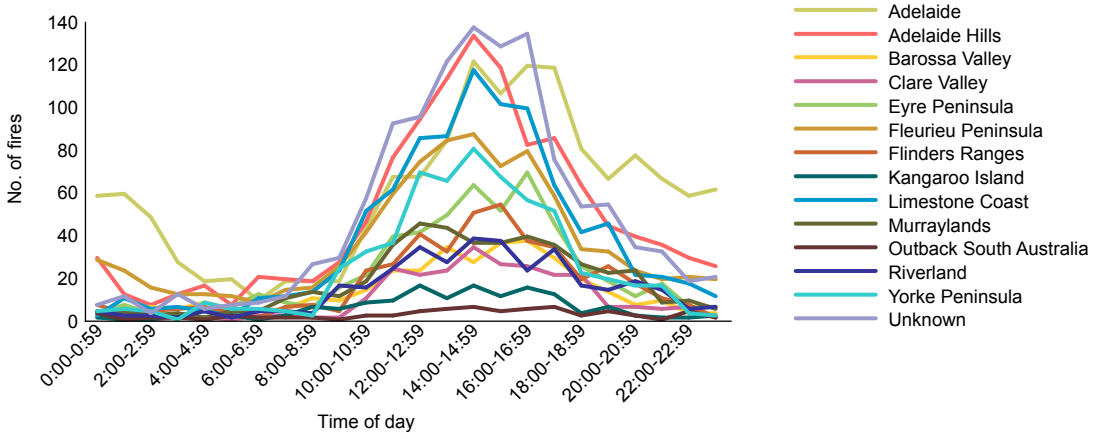
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 49: Time of the day at which deliberate vegetation fires were detected



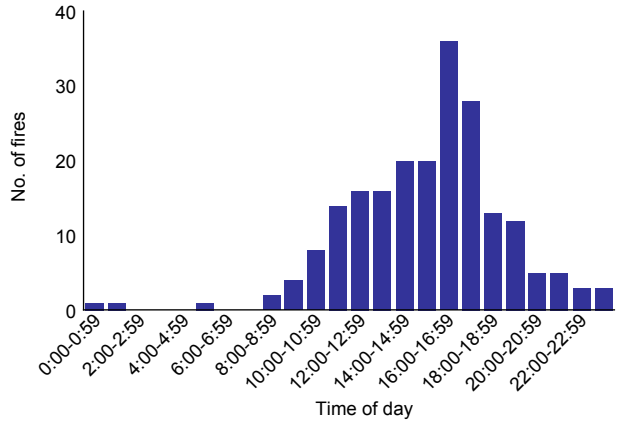
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 50: Time of day for all fires, by region, 1997–98 to 2003–04



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 51: Time of the day for child fires



Source: SACFS 1997–98 to 2003–04 [computer file]

Area burned

The number of fires decreased with increasing fire size, but with a characteristic 'hump' for fires in the 10 to 49.9 and the 100 to 499 ha ranges (Figure 52). This trend occurred for all fire cause categories, although there was a tendency for deliberate fires to comprise a small proportion and natural fires to comprise a greater proportion of each size category as fire size increased (Figure 53). The rigorousness of this relationship breaks down for larger area categories, owing to the lower number of large fires.

Nevertheless, two suspicious fires burned 1,000 ha or more during 2002–03 and 2003–04. These included a suspicious fire than burned 1,186 ha in the Adelaide region in 2003–04 and another that burned 1,000 ha in the Flinders Ranges region during 2002–03. The large incendiary fire recorded in the 2,000 to 4,999 ha category in Figure 53 resulted from the rekindling of a previous fire. It is unclear from the database if the previous fire was suspicious, or this represents one of the cases of classification inconsistencies (see Methodology chapter).

The occurrence of large fires largely governs the amount burned in any one year. As large fires are not a frequent occurrence, they were unevenly distributed both spatially and temporally. The largest area was burned in 2002–03, followed by 1997–98 and 1998–99 (Figure 54). Natural causes were the greatest known contributor to the total area burned during the 1997–98 and 2002–03 El Niño events. Five natural fires burning 1,000 ha or more occurred during 1997–98. The largest burned 8,900 ha and 3,220 ha in the Murraylands and Eyre Peninsula regions, respectively. Collectively, fires in these two regions accounted for 60 percent of the total area burned in South Australia that year.

In 2002–03, two fires started by lightning strikes burned 6,800 ha on Kangaroo Island and a further 2,000 ha in an unspecified location. However, the cause of the two largest fires in 2002–03, fires that burned 15,000 ha and 18,000 ha in the Eyre Peninsula and Limestone Coasts regions respectively, was unknown. These two fires were the largest recorded during the seven-year period. The 2002–03 fire season was remarkable for the SACFS in that large fires (exceeding 1,000 ha) occurred in at least four separate regions of the state. Owing to the location of the large fires, the greatest total area burned in 2002–03 occurred in the Limestone Coast, Eyre Peninsula and Kangaroo Island regions.

Accidental causes were singly the largest contributor to the total area burned during non-El Niño years, contributing to between 45 and 67 percent of the total area burned in all years with the exception of 1999–2000. In 1998–99, two accidental fires burned 2,000 ha and 9,000 ha on the Limestone Coast and Eyre Peninsula, respectively. These fires resulted from design–installation deficiencies and the failure–

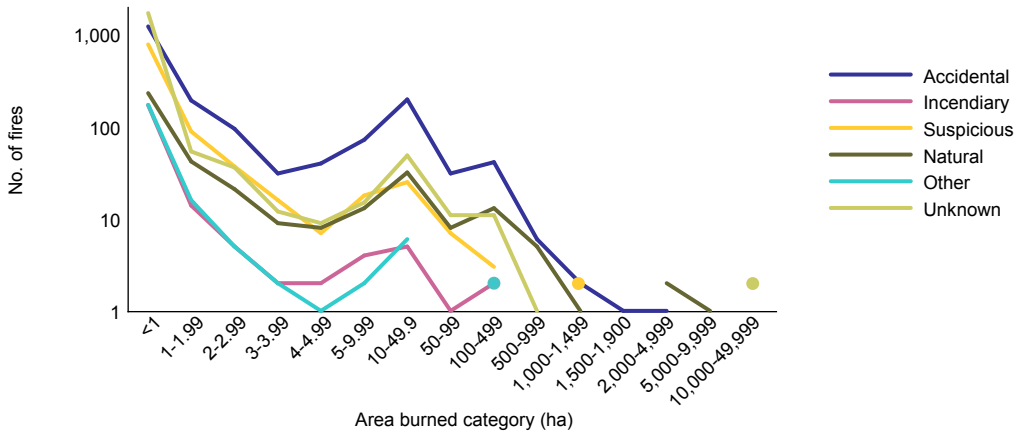
malfunction of fuel-powered machinery, respectively. In 2000–01, one accidental fire burned 1,200 ha on the Fleurieu Peninsula. No accidental fires in 2001–02 exceeded 1,000 ha, but 10 burned 100 ha or more. In 2003–04, three fires burned 1,100 ha (Yorke Peninsula), 1,500 ha (unknown location) and 4,285 ha (Limestone Coast). All resulted from electrical problems, the largest being related to power lines.

Collectively, deliberate causes were responsible for just 5.9 percent of the total area burned in SACFS fires (including the large of dubious origin, which accounted for one-fifth of the total areas burned by deliberately lit fires). Deliberate fires typically constituted a small proportion of the total area burned in SACFS-attended fires in any one year. In four of the seven years deliberate fires were responsible for four percent or less of the total area burned. Higher proportions were evident in 1999–2000 (21%), in a year when the total area burned was very low, in 2000–01 (16%) due to the inclusion of the 2,000 ha rekindled fire (discussed above), and in 2003–04 (10.5%).

Due to the density of larger fires, the greatest total area was burned on the Eyre Peninsula and on the Limestone Coast, with these regions accounting for 27 and 23 percent of the total area burned in South Australia, respectively (Figure 55). A comparatively high proportion also occurred in the Kangaroo Island (9%), Murraylands (8%) and the Yorke Peninsula (5%) regions. Just 2.9 percent and 0.9 percent were burned in the Adelaide and Adelaide Hills regions respectively. As noted, the total area burned in a region is dominated by large fire events. Many different factors can affect fire size, including location, accessibility, vegetation, weather conditions, fire-fighting resources, and the extent to which these fires are useful in terms of other fire management strategies.

The majority of fires lit by children are small. Approximately, 83 percent were less than one hectare. This compares to 76 percent for all fires (Figure 56). The largest fires lit by children burned 100 ha and 300 ha each. Both occurred in the Adelaide region. The total area burned by children for the four years incorporating 2000–01 to 2003–04 was at least 590 ha, being dominated by the two described events.

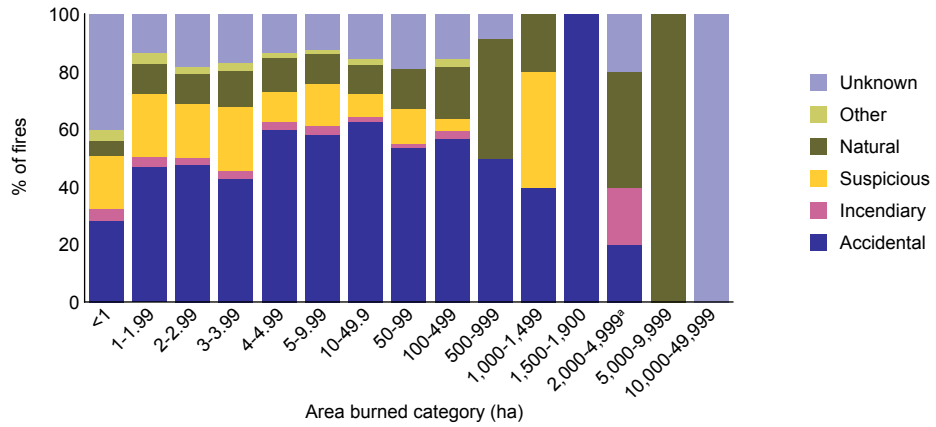
Figure 52: Area burned category by cause[a] (number)



a: Area data was available for 99.4 percent of fires

Source: SACFS 1997–98 to 2003–04 [computer file]

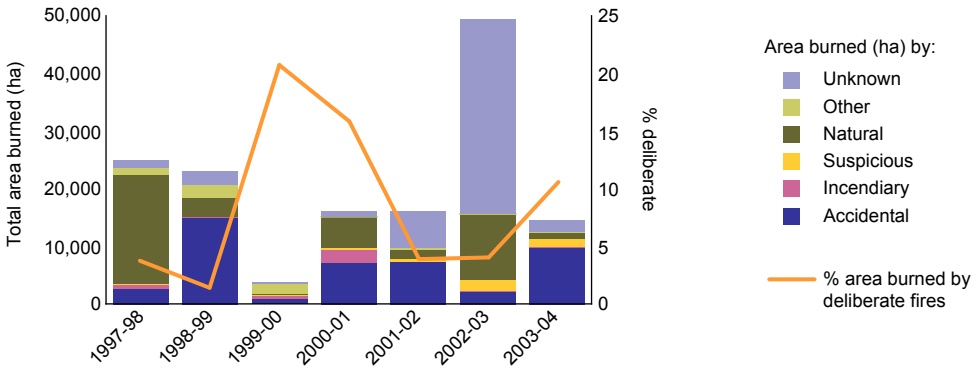
Figure 53: Area burned category by cause (percent)



a: The incendiary fire in the 2,000–4,999 ha category is listed as a malicious rekindle. See Methodology section for a discussion of issues pertaining to the classification of some data

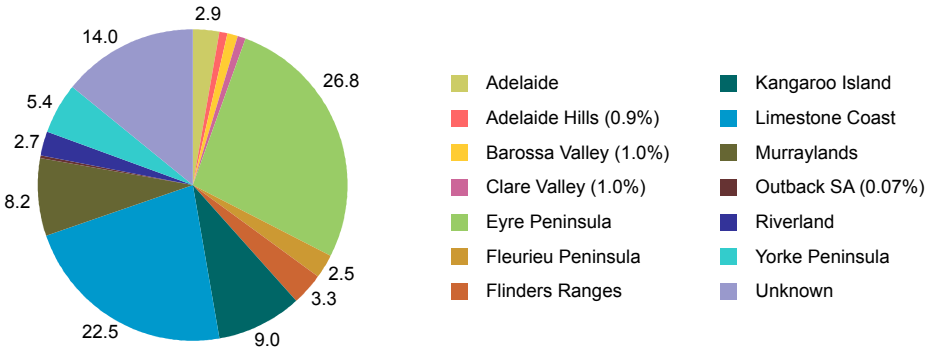
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 54: Area burned (ha) each year by cause



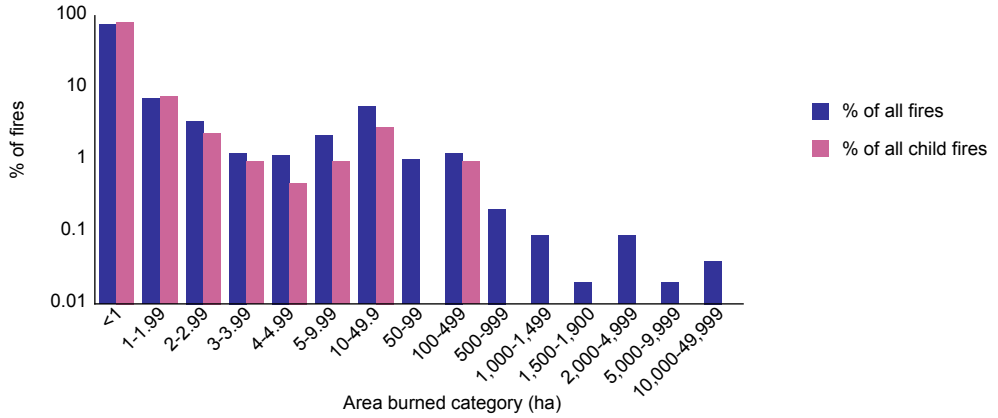
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 55: Area burned by region (percent)



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 56: Child fires by area burned category (percent)



Note: the size distribution of all vegetation fires is shown for comparison

Source: SACFS 1997–98 to 2003–04 [computer file]

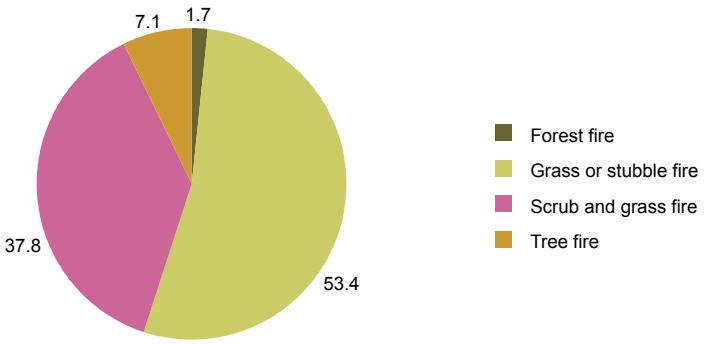
Type of incident

Fifty-three percent of all fires the SACFS attended were grass or stubble fires, with a further 38 percent being scrub and grass fires (Figure 57). Only seven percent were tree fires, with a further 1.7 percent being forest fires.

The proportion of deliberate fires was comparatively constant across all incident types, comprising 17 to 22 percent of each incident category (Figure 58). The proportion of accidental causes increased with increasing numbers of fires, being lowest for forest fires and highest for grass or stubble fires. The reverse was the case for natural fires, with fires resulting from natural causes comprising the greatest proportion of all forest fires, but a lower proportion of grass or stubble fires.

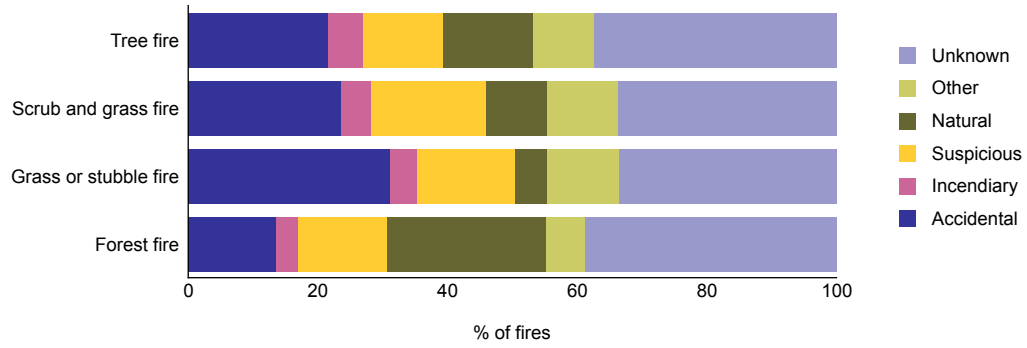
The dominant types of fires varied subtly across South Australian regions. For example, a lower proportion of grass or stubble fires occurred in the Adelaide Hills, Kangaroo Island, Riverland, Outback and Eyre Peninsular regions (Figure 59). These were areas characterised by a higher proportion of scrub and grass fires. Forest fires accounted for the highest proportion of fires in the Limestone Coast (7%) region, a finding that is not surprising given that most of the state's forests occur in that region.

Figure 57: Type of incident (percent)



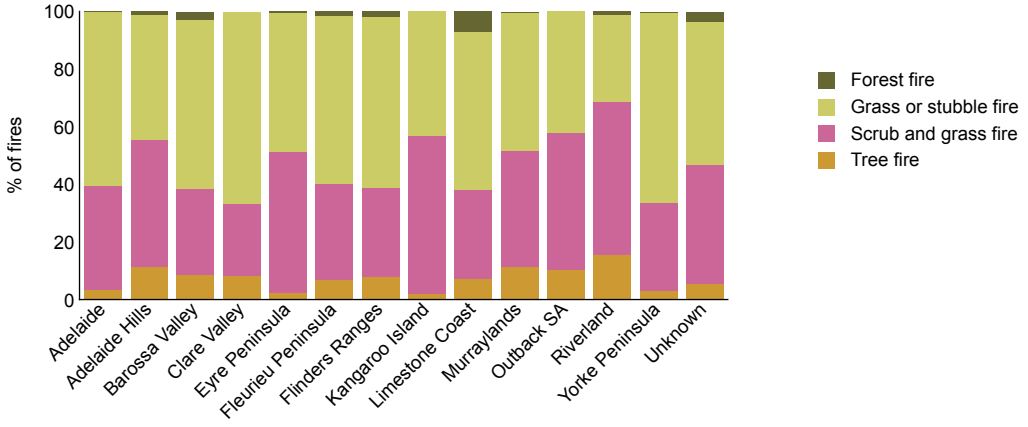
Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 58: Incident type by cause (percent)



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 59: Type of incident in each region (percent)



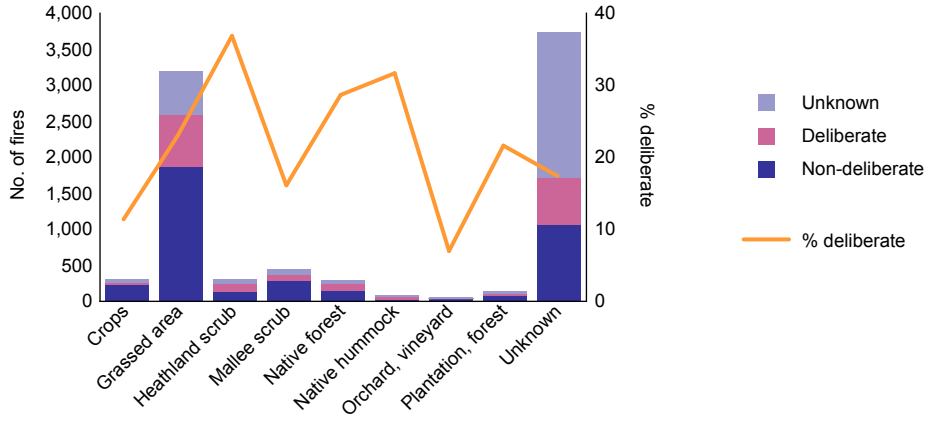
Source: SACFS 1997–98 to 2003–04 [computer file]

Vegetation

The type of burned was known in 57 percent of cases. Of these, the majority took place in grassland (including grazing) areas (Figure 60). Vastly smaller numbers of fires occurred in mallee scrub, heathland, crops and native forest.

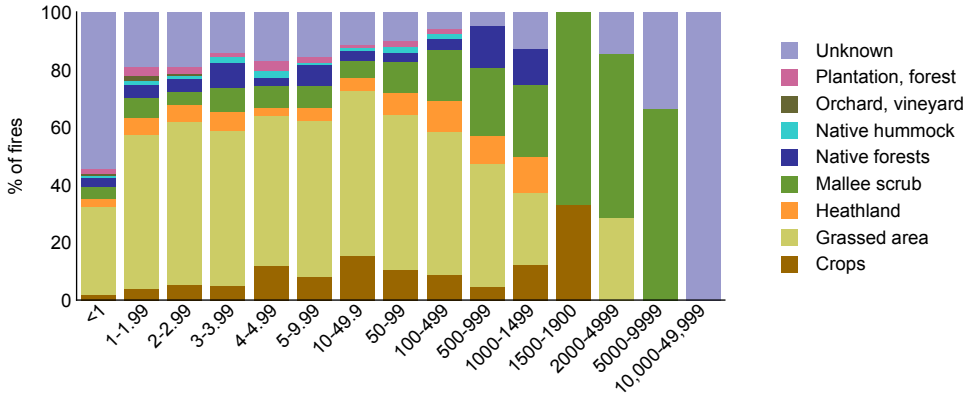
Deliberate causes constituted the highest percentage of fires that occurred in heathland (37%), native hummock grasslands (32%), and native forest (28%; Figure 60). Fires in mallee scrub accounted for an increasing proportion of fires as fire size increased. It appears that grassland fires accounted for a decreasing proportion of larger fires, in fire categories exceeding 100 ha (Figure 61). However, this is counter-balanced to a certain extent by the greater proportions of fires for which the vegetation type was listed as unknown. No fires in plantation or native forests exceeded 500 ha and 1,500 ha respectively.

Figure 60: Vegetation type by cause



Source: SACFS 1997–98 to 2003–04 [computer file]

Figure 61: Area burned category by vegetation type



Source: SACFS 1997–98 to 2003–04 [computer file]

South Australian Department of Environment and Heritage

Background about the SADEH dataset and its analysis

Important information regarding the SADEH dataset and the methodology employed to analyse it is summarised below.

- Data was sourced from the South Australian Department of Environment and Heritage.
- Dataset provided only included vegetation fires. Hence, all references to ‘fire’ in this analysis are vegetation fires.
- Fires occurred between1975–76 and 2003–04. This included fires from two separate datasets; 1975 to 2001 and 2001 to 2004. The variables used in these two datasets were not identical. Hence, the analysis is primarily restricted to variables in common.
- Cause was defined on the ‘cause’ and ‘comment’ (1975–2001) and ‘fire cause’ (2001–2004) variables.

- All fires where the cause was listed as arson have been classified as incendiary within the seven-fold classification scheme used in the analysis (accidental, incendiary, suspicious, natural etc.), as deliberate within the deliberate versus non-deliberate classification scheme and as arson, when the analysis specifically deals with the SADEH cause variable.
- The 1975 to 2001 subset in some cases included a descriptor in the comment section that indicated arson was suspected, although in the cause category it was indicated that the cause was unknown. The 2001–04 subset did not include this sub-category. For all fires within the 1975 to 2001 dataset, where the comment variable = 'Original cause description (July 2003): Suspected arson' have been classified as suspicious within the seven-fold causal classification scheme, and as deliberate within the deliberate versus non-deliberate classification scheme.
- Hence, in this analysis the term *deliberate* refers to all fires classified as either incendiary or suspicious.
- All fires classified as natural resulted from lightning.
- Information pertaining to smoking-related fires was only available for the 1975 to 2001 subset.
- No information was available about the role of children in lighting fires.
- District and region information used in the SADEH analysis are based on the fields provided by the SADEH.
- The dataset only includes the area burned in the 2001–04 subset.
- The dataset included information pertinent to the area burned, but did not include information about the status of fire restrictions/total fires bans, fire danger index or tenure.

Further detail regarding the analysis is outlined in the Methodology.

Overview

Important features of SADEH fires are summarized below.

- SADEH records indicate attendance at 1,534 fires from 1975–76 to 2003–04. This represents an average was 52.9 per year, but actual fire attendances ranged from a minimum of 18 in 1992–93 to a maximum of 86 in 1982–83 (Figure 62).
- Greater numbers of vegetation fires most commonly occurred in very low rainfall years (that is, 1982–83, 1984–85, 1994–95). Lower numbers of fires occurred in higher rainfall years (such as 1992–93). However, the long wavelength changes in the number of fires do not appear to reflect longer-term variability in summer rainfall patterns (Figure 63). Notably, fire frequencies were comparatively low during the 1990s, despite a number of those years (such as 1994–95) having very low rainfall. It is unclear to what extent these low values reflect inherent differences of bushfire danger versus changes to bushfire management strategies, greater targeting of bushfire arson or other factors. However, it is also evident from Figure 62 that the number of vegetation fires has subsequently begun to rise again in the 21st century.
- As the SADEH is a land management agency, it is reasonable to assume that a high proportion of all fires attended were either bushfires or had the potential, under adverse weather conditions, to develop into bushfires.
- Many of the fires included within the SADEH were also likely to have been attended by the SACFS.
- Arson was considered to have been the cause of 30 percent of all fires the SADEH attended.
- Over 7 million hectares was burned in SADEH fires from 2001–02 to 2003–04. This figure is dominated by several large fires in 2002–03, and hence does not provide an accurate guide to the total area burned by bushfires in South Australia each year, or the extent to which deliberate causes contribute to the total area burned each year.

Cause

Incendiary fires were responsible for at least 16.7 percent of fires SADEH attended in the period 1975–76 to 2003–04, with a further 7.3 percent being suspicious in origin (Figure 64). Hence, collectively, deliberate fires accounted for at least 24 percent of all SADEH-attended fires.

The number and proportion of deliberate fires varied substantially during that period, ranging from a low of two deliberate fires in 1992–93 to a high of 28 in 2002–03 (Figure 62). In any one year, deliberate fires were responsible for between seven and 38 percent of all fires. The greatest proportions of deliberately lit fires occurred in the last five or six years of the observation period. From 1999–2000 to 2003–04 deliberate fires accounted for 30 percent of all fires, ranging from 23 percent to 39 percent of fires in any one year (Figure 62).

However, caution is needed before assigning any meaning to this observation. Not only were there changes in the database structure, but also in the proportion of unknown causes. Unknown causes comprised 20 to 30 percent of fires up until the mid 1990s, but less than 10 to 15 percent of fires since then (Figure 65). Overall, deliberate causes comprised 31 percent of all fires where the cause was known, ranging from nine percent to 53 percent for any given year. There is no evidence for a longer-term change in the proportion of deliberate fires as a function of known causes (Figure 66).

Natural fires were responsible for 17 percent of fires from 1975–76 to 2003–04, early higher rates have been evident from the early 1990s (Figure 62). There are two distinct reasons for this increase. In the 1990s the number of natural fires was comparable to those observed previously, but owing to the low number of fires arising from other causes, natural cause accounted for a higher proportion of all fires. The higher proportion of natural fires since the turn of century reflects genuinely higher numbers of natural fires (Figure 62). In 2002–03 and 2001–02 natural fires were responsible for 42 to 43 percent of fires the SADEH attended. Natural fires comprised 30 percent of all SADEH-attended fires from 1999–2000 to 2003–04. However, again some caution is needed when interpreting these results owing not only to changes in the proportion of unknown causes, and changes in the database structure but also to potential changes in the way officers made causal attributions level of training available for officers.

Specific ignition factors

Other causes: Detailed information was available about the specific cause of fires within the ‘other causes’ category for the period 1975 to 2001, based on information available in the comment category. Comments were available for 92 percent of instances of fires from 1975 to 2001, where the cause variable was indicated as other (excludes fires where the comment variable was listed as rekindle, a possible rekindle or a suspicious fire which have already been re-allocated).

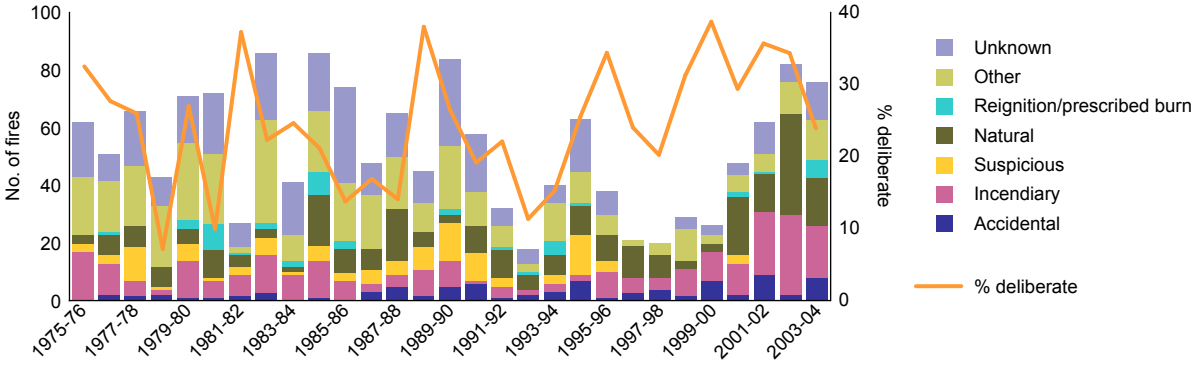
Of fires within the ‘other’ category, just over one-third was indicated as resulting from other causes, and no further information was available (Figure 67). In just over half (56%) of cases, the cause could have reasonably been listed as accidental. This includes fires started by agricultural machinery, power tools, power lines, escapes from neighbouring properties, barbeques, rubbish–incinerator fires, fires started by children, cigarettes or matches, exhausts, fires started by trains, and other specified causes.

Fire resulting from neighbours burning-off stubble and scrub constituted 16 percent of ‘other’ causes, children constituted 12 percent (includes cases of ‘possibly children’), and sparks from machinery and exhausts, including agricultural machinery, comprised a further 14 percent.

Although some caution is needed, given the low number of fires, there appears to have been an appreciable decrease in the number of fires started by children and/or resulting from neighbours burning over the observation period (Figure 68). This decrease, combined with the decrease in fires of unspecified ‘other’ causes, contributed to the overall decrease in the number and percentage of ‘other’ causes in

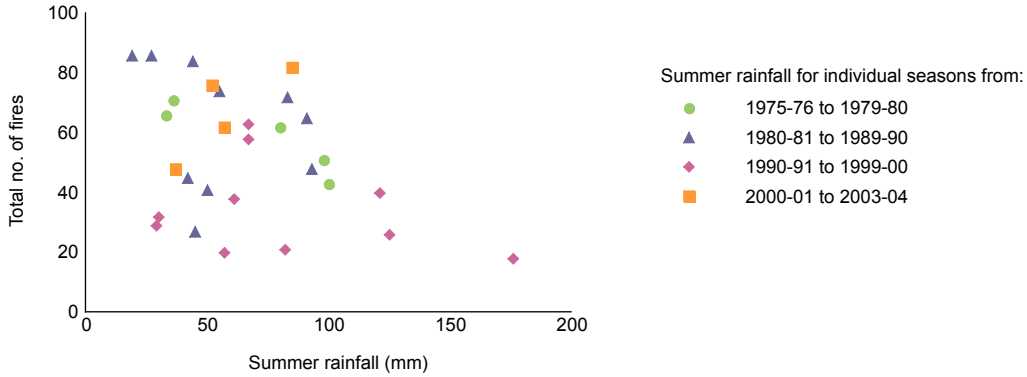
Figures 62 and 65. The number of smoking-related fires was small, and no apparent trend is evident in the temporal distribution of these fires.

Figure 62: Cause of fires by year



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

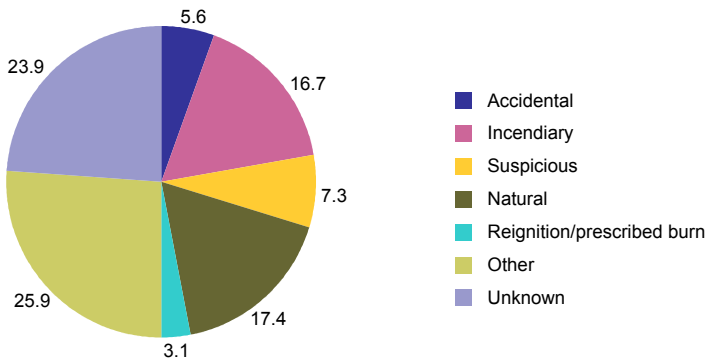
Figure 63: Yearly variation in the number of fires and summer rainfall[a], by decade



a: Data in this figure is based on the monthly gridded rainfall for the Mount Lofty Ranges district

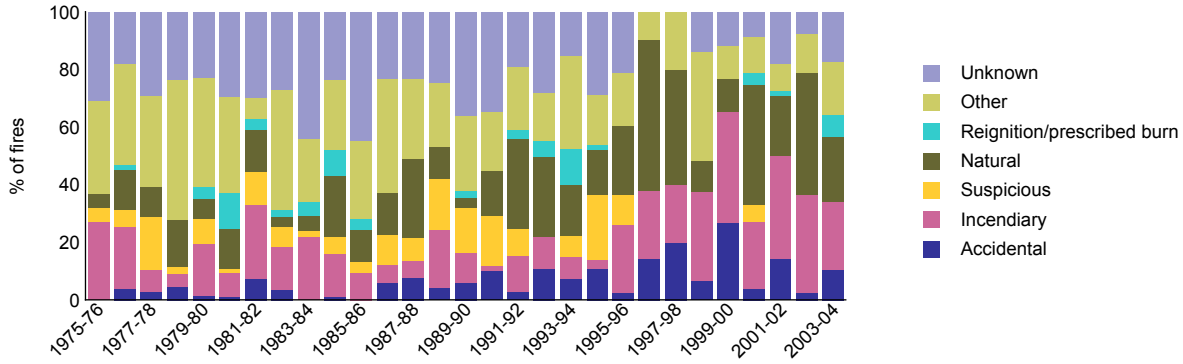
Source: Australian Bureau of Meteorology [computer file]

Figure 64: Fire cause (percent)



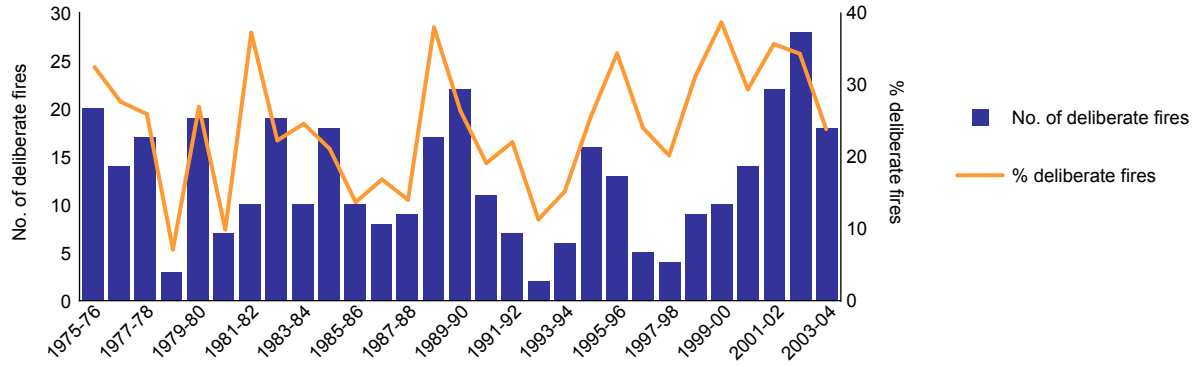
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 65: Year by fire cause (percent)



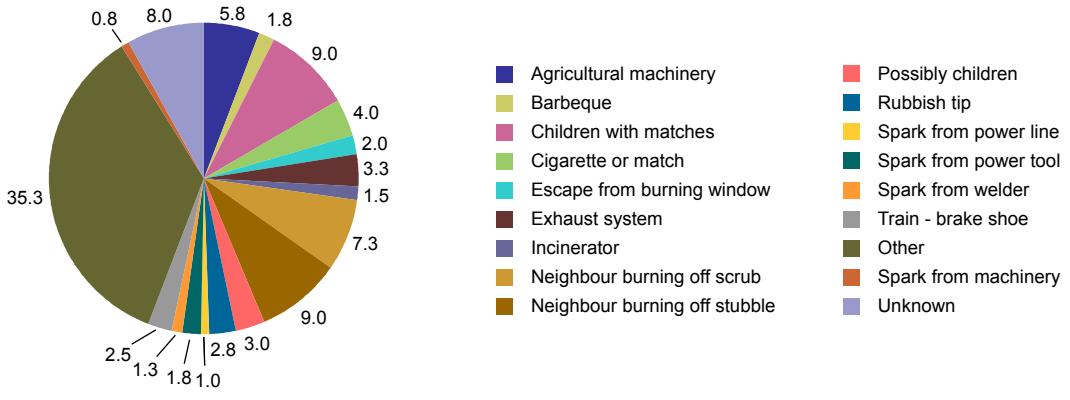
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 66: Deliberate fires each year



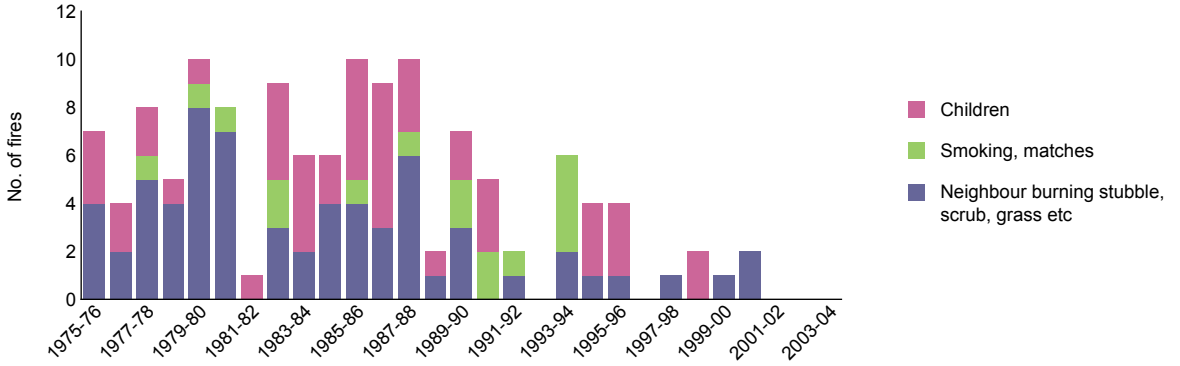
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 67: Specific fire cause (percent)



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 68: Fires resulting from neighbours burning, smoking or matches, and children, each year



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Location

The location of fires is described in terms of the region and reserve in which the fires occurred, and the point of origin and containment relative to SADEH land boundaries.

Region

The region structure adopted for this analysis is based on Australian Bureau of Statistics tourism regions (Figure 10), based on the name of the reserve. The correlation between reserve and tourism region was obtained from the SADEH, and is outlined in the Methodology chapter.

Almost one-third of all fires (33%) the SADEH attended occurred in the Adelaide region, with a further 20 percent being located in the Adelaide Hills (Figure 69). Other regional areas that accounted for comparatively high proportions of all SADEH-attended fires included the Limestone Coast (11%), Flinders Ranges (7%), and Eyre Peninsula (7%).

The principal causes of fires on SADEH-controlled land varied markedly between regions. The three regions characterised by the greatest number of fires – Adelaide, the Adelaide Hills and the Limestone Coast – also had a greater proportions of deliberate fires (23% to 36%; Figure 70). A high proportion (22% to 29%) of fires in the Clare Valley, Fleurieu Peninsula and Riverland districts were also deliberate, although the actual number of deliberate fires was low.

In contrast, the majority of fires, from 1975–76 to 2003–04, in Outback South Australia (71%), the Eyre Peninsula (59%), Riverland (46%), Flinders Ranges (43%), and Murraylands (75%) regions resulted from lightning strikes (Figure 70). Roughly one-third of all fires in SADEH-controlled reserves on Kangaroo Island were also the result of natural causes. Other causes were a significant factor in fires in the Yorke Peninsula (56%), Clare Valley (40%), Limestone Coast (38%), and Kangaroo Island (37%) regions.

Some subtle differences were evident in the principal causes of fires in individual regions during the period 1999–2000 to 2003–04 (Figure 71), when compared with the longer period of 1975–76 to 2003–04 (Figure 70); this reflects the temporal changes in fire causes outlined above. Proportionally, more fires occurred in the Eyre Peninsular region than in the Adelaide Hills, Limestone Coast and Flinders Ranges regions and fewer fires in the Murraylands region were deliberately lit. Deliberate causes remain the principal cause of fires in the Adelaide, Adelaide Hills (approximately 60% deliberate) and to a lesser extent the Fleurieu Peninsula (22% deliberate) regions.

Fires attributed to children principally occurred in the Adelaide and Adelaide Hills regions, and comprising seven percent and three percent of all fires attended by the SADEH in those regions from 1975–76 to 2000–01, respectively. Fires attributed to children were also responsible for 4.4 percent of fires in the Fleurieu Peninsular region and 2.7 percent of fires on Flinders Island.

Fires resulting from neighbours burning-off contributed to the greatest number of fires in the Adelaide Hills, Kangaroo Island, Adelaide and Limestone Coast regions. However, the total number of fires resulting from this cause did not exceed 18 in any one region.

Almost one-third of all fires that resulted from campfires between 1975–76 and 2002–03 occurred in the Adelaide region, which probably reflects the greater visitation rates afforded to parks by their accessibility. A further 13 percent of campfires occurred in the Limestone region, 11 percent in the Yorke Peninsula, nine percent in the Riverland and eight percent on the Eyre Peninsular (Figure 72).

Reserves

Three reserves – Belair, Onkaparinga River and Cleland – experienced between 100 and 130 fires (Figure 73) between 1975–76 and 2002–03. From 30 to 65 fires occurred on a further 11 reserves and 18 reserves experienced 10 to 29 fires. The six reserves that recorded the greatest number of fires in total all occurred either in the Adelaide or Adelaide Hills regions.

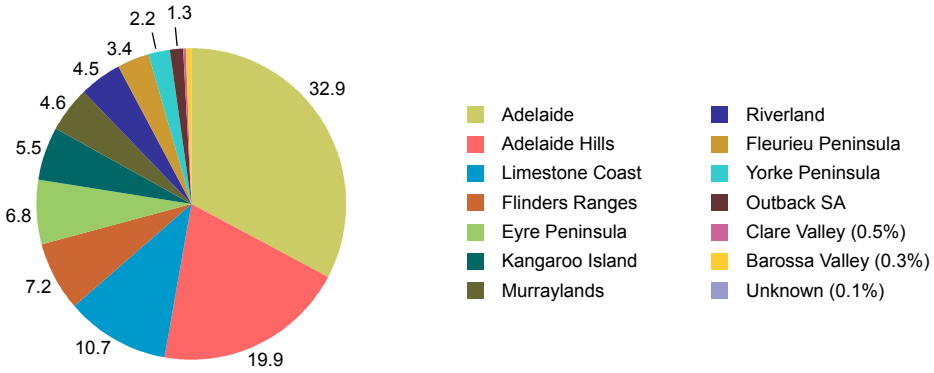
Higher numbers of deliberate fires were observed in all reserves that recorded in excess of 40 fires in total in the 29-year period, with the exception of Mount Remarkable (Figure 73). Higher numbers of deliberate fires were also recorded in the Cobbler Creek, Scott Creek, Murray River, Shepherds Hill and Sturt Gorge. Belair, Onkaparinga River and Anstey Hills recorded between 31 and 42 deliberate fires in 29 years. Black Hill, Cleland and Canunda recorded from 20 to 25 deliberate fires, and Morialta, Cobbler Creek, Scott Creek, Parra Wirra, Shepherds Hill and Murray River between 10 and 20 deliberate fires, in 29 years. With the exception of the Murray River and Canunda Reserves, all of the reserves with high numbers of deliberate fires occurred in the Adelaide and Adelaide Hills region.

The percentage of fires that arise from deliberate causes was highly variable across individual reserves, even among reserves that recorded higher numbers of deliberate fires (Figure 73). In parks documented above as having higher numbers of deliberate fires, typically between 20 and 70 percent of fires were deliberate. However, it is noted that in parks like Belair, Onkaparinga and Cleland the cause of a high proportion of fires was unknown and actual rates are likely to be much higher.

The largest number of natural fires occurred in the Ngargkat, Danggali Flinders Chase, and Mount Remarkable reserves, but this cause was also an important factor in the Billiatt, Coffin Bay and Hincks reserves.

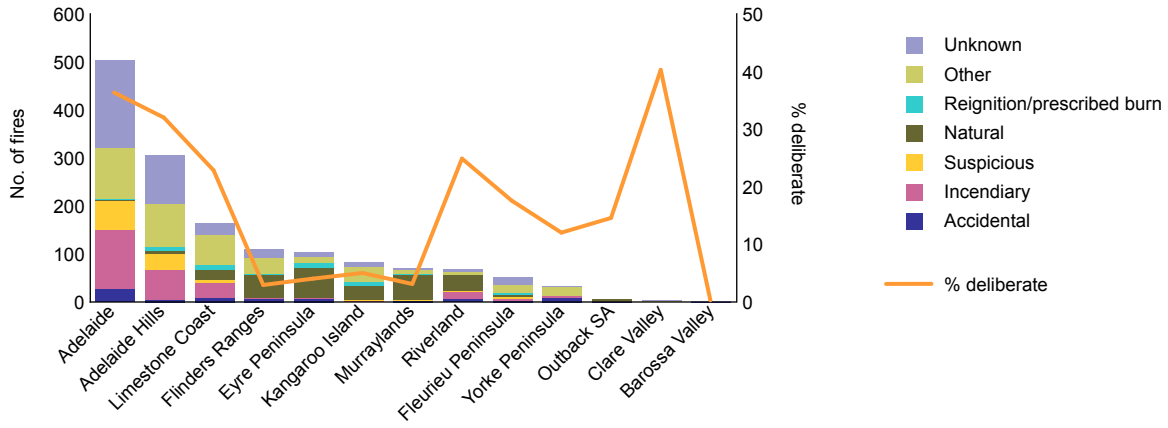
That generalised temporal trends are not necessarily an accurate guide to trends on a local scale is evident in the comparison of data from the Belair (Figure 74) and Onkaparinga River (Figure 75) reserves. Both reserves experienced a high number of fires generally and deliberate fires specifically. For the Onkaparinga River reserve activity, this principally occurred during the last six years of the observation period, reaching a maximum during 2001–02; it slowly began to increase in the late 1980s. In contrast, the majority of fires in the Belair reserve occurred in the 1970s and 1980s, with comparatively few fires occurring in the 1990s and 2000s. There was a clear spike in deliberate fires within this park in the mid to late 1970s. Deliberate fires have remained the principal cause of fires within the park, but absolute numbers of fires are very much lower. The decrease in the number of fires in accessible parks like Belair during the 1990s very much contributed to the decrease in the total number of fires the SADEH attended during the 1990s. Apart from Onkaparinga River, other reserves to record higher numbers of deliberate fires since 2000 include Cobbler Creek, Anstey Hill, Cleland and to a lesser extent Moana Sands.

Figure 69: Region fires occurred



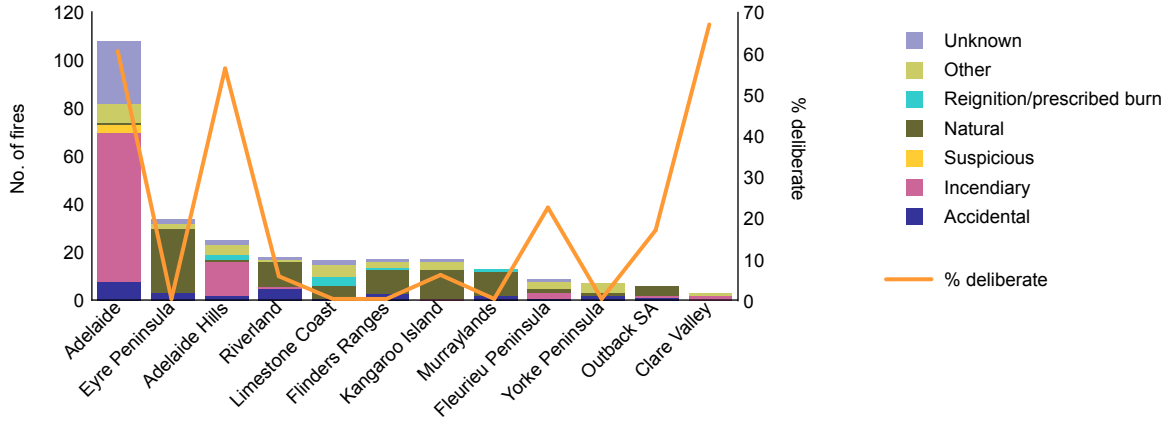
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 70: Fire cause by region, 1975–76 to 2003–04



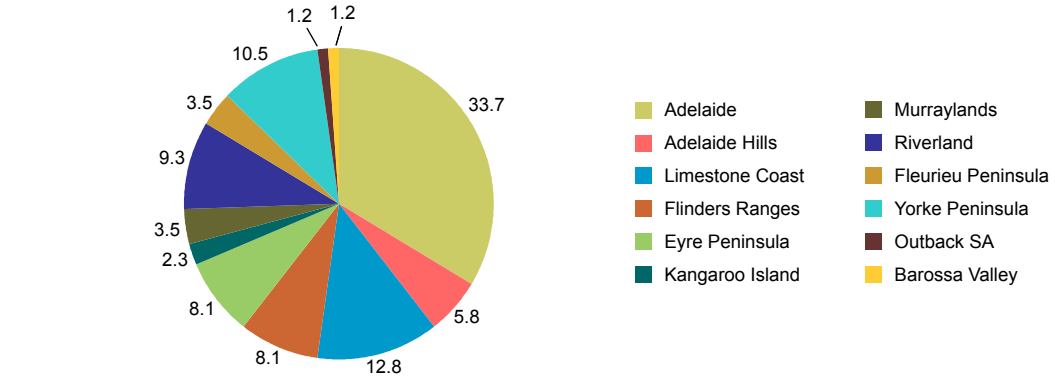
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 71: Fire cause by region, 1999–2000 to 2003–04



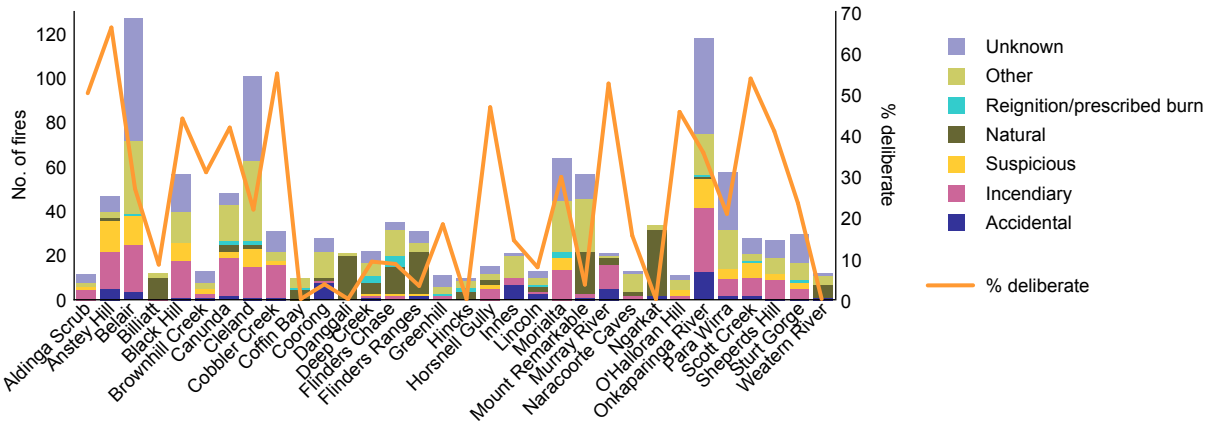
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 72: Campfires by region (percent)



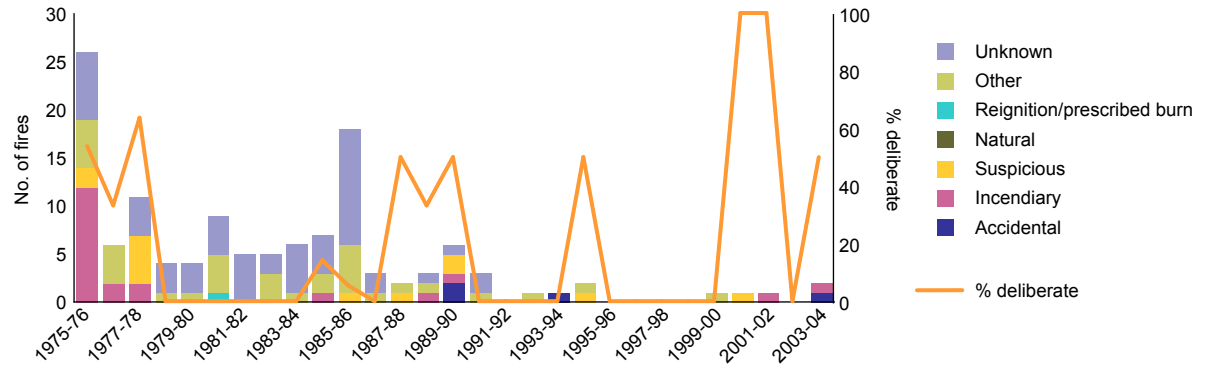
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 73: Reserve by fire cause



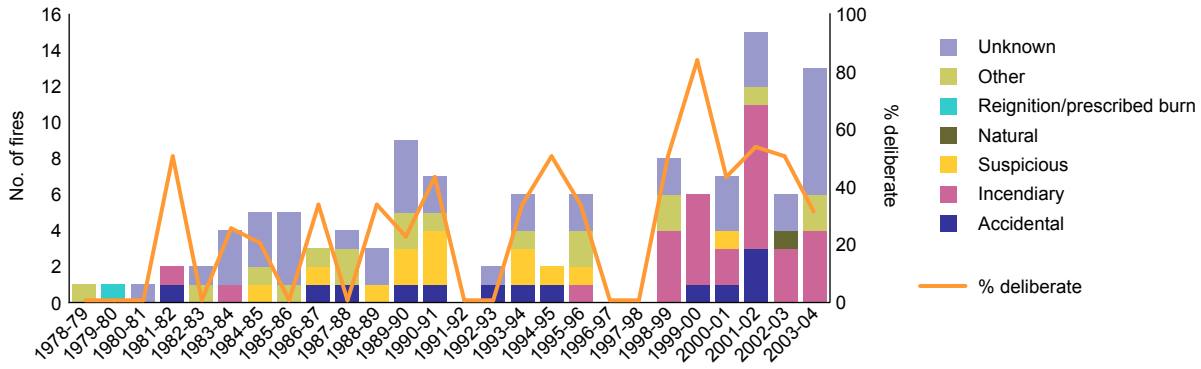
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 74: Belair Reserve – fire causes each year



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 75: Onkaparinga River Reserve – fire causes each year



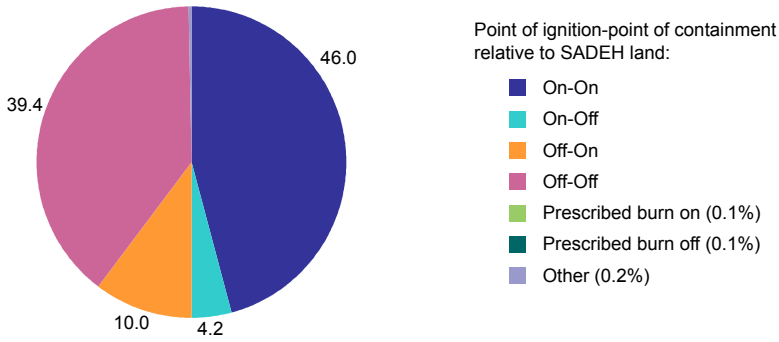
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

On-Off status

Forty-six percent of fires the SADEH attended started on SADEH-controlled reserves and were contained on those reserved (Figure 76). Only 4.2 percent of fires started on SADEH reserves but escaped into other lands. Ten percent of fires started outside SADEH lands but crossed onto those reserves. A further 39 percent started off, and where contained off, SADEH reserves.

Deliberate fires principally were lit on reserves and contained on those reserves, or, to a lesser extent lit off reserves and contained off the reserve (Figure 77). A higher proportion of all fires that were lit on reserves were deliberate, when compared with those lit off reserves. Nevertheless, approximately one-quarter of all fires that were lit off a reserve but subsequently travelled onto reserves were deliberately lit. A further 40 percent of fires passing onto SADEH reserves resulted from other causes. In contrast, 45 percent of fires that started on a SADEH reserve and subsequently passed onto neighbouring lands were natural in origin.

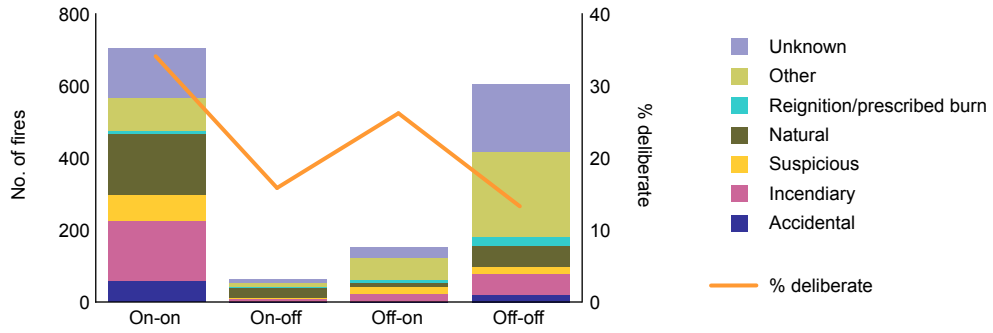
Figure 76: Point of origin and suppression relative to park boundaries (percent)



Note: On_on means Fire started on SADEH reserve and was contained on SADEH reserve; on_off means the fire started on SADEH reserve and burned into other land; off_on means fire started off SADEH reserve and burned into SADEH reserve; off_off means fire started off SADEH reserve and was contained off SADEH lands; PB refers to a prescribed burn, and on and off, to the location of that burn

Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 77: Cause of fires within specific on-off park categories



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Timing

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

Week of the year

Overall, the distribution of SADEH-attended fires strongly mirrors the trend observed for SACFS fires. Notably, the numbers of fires increase markedly from mid September onwards, concomitant with decreasing spring rainfall, reach a maximum early in the new year, before decreasing to negligible levels by the middle of the year. However, the timing of fires was strongly cause-specific, with the increase in the number of non-deliberate fires preceding the increase in deliberate fires (Figure 78). This principally reflects contributions from natural and other fire causes.

Large spikes in the number of natural fires are evident at week 44 (early November) and week 48 (early December), with smaller numbers of fires occurring throughout the remainder of summer (Figure 79). The spike at week 44 principally arises from fires during 2002–03 when 21 fires were caused by lightning strikes in a single week. In contrast, the spike at week 48 reflects a higher number of natural fires over a number of years. The observed distribution for natural fires is strongly dominated by exceptionally dry years, like 2002–03, and hence may not reflect the pattern expected in 'normal' years.

In contrast to natural fires, the number of deliberate fires started to increase in early November, and had peaked by the middle to late December. The number of deliberate fires remained elevated until mid to late March (Figure 78). An additional spike is evident at week 15, which may coincident with the Easter break/ school holidays.

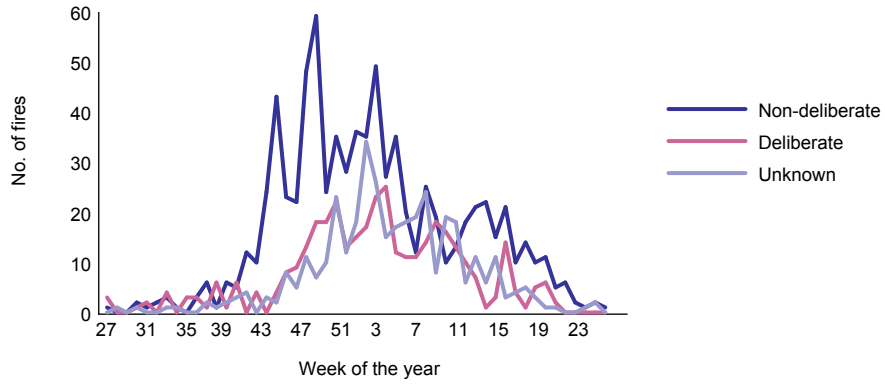
Day of the week

There no evidence to indicate that a fire of any particular cause was more likely to occur on one day of the week than another, including deliberate causes (Figure 80).

Time of the day

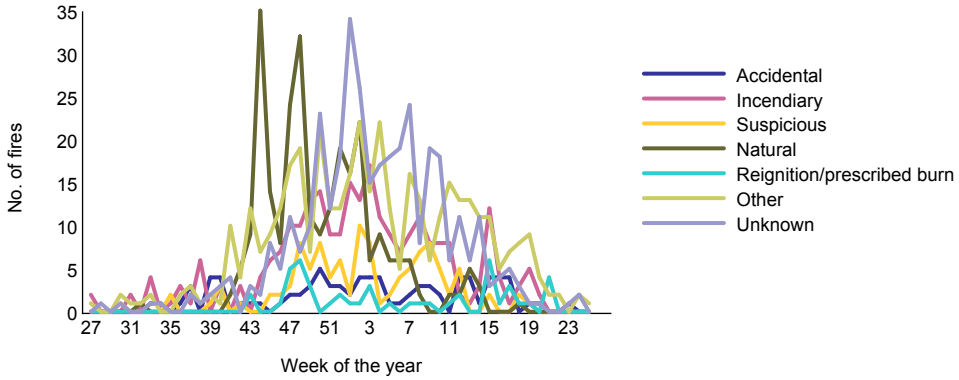
No information was available about the detection time of SADEH fires.

Figure 78: Cause by week



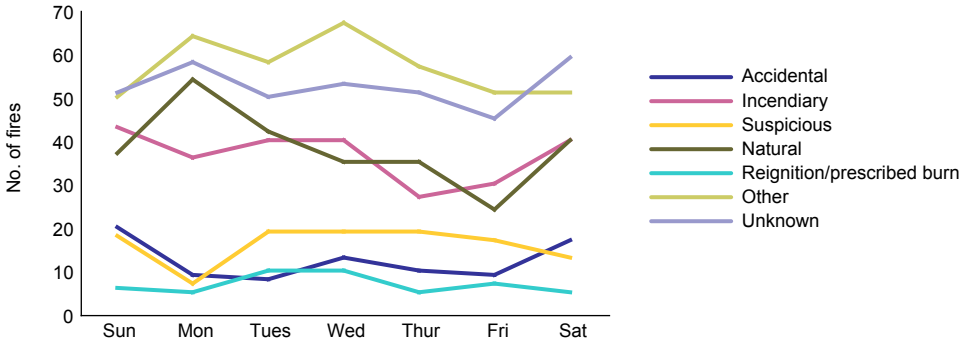
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 79: Cause by week (number)



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 80: Cause by day (number)



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Area burned

Data pertaining to the area burned was only available for the three years – 2001–02 to 2003–04. Over 700,000 ha burned during this period, but the statistics are dominated by fires in 2002–03, when abnormally large areas were burned. Notably, 95 percent of the total area burned during the observation period occurred in 2002–03 (Figure 81).

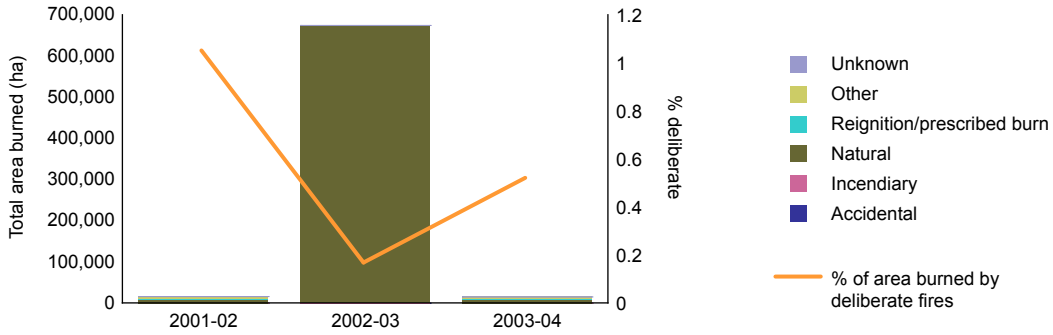
Overall, the majority of fires are small, and the number of fires decreased as the area size increased. Although this was observed for all causes, fires of different causes had very different size distributions. Largely shaped by events during 2002–03 there was a strong tendency for natural fires to be larger than fires of all other causes, with natural fires comprising an increasing proportion of successively larger area burned categories (Figure 82). Eight fires burned 1,000 ha or more during 2002–03. Of these, seven resulted from natural causes. One fire burned 600,000 ha. Another two fires (of 6,400 ha and 12,000 ha) occurred in Outback South Australia. Another 6,527 ha of land burned on Kangaroo Island, a 16,000-ha fire on the Eyre Peninsula, and two fires burned 28,000 ha and 1,500 ha in the Murraylands region.

Only five fires of non-natural causes exceeded 1,000 ha. One deliberate fire burned 1,000 ha. Another fire classified as deliberate resulted from reignition of a previous fire. Another three resulted from other causes. Overall, deliberate causes accounted for a decreasing proportion of fires as the size of the fires increased (Figure 82).

As large fires principally governed the total area burned, it is not surprising that 98 percent of the area burned in SADEH-attended fires were the result of natural causes (Figure 83). Incendiary fires accounted for only 0.2 percent of the total area burned. As noted however, the area burned statistics are dominated by the 2002–03 bushfire danger season, when unusually large fires resulted from natural causes. The value of 0.2 percent is unrealistic reflection of the area burned by deliberate fires, or their long-term relative impact on SADEH-managed lands.

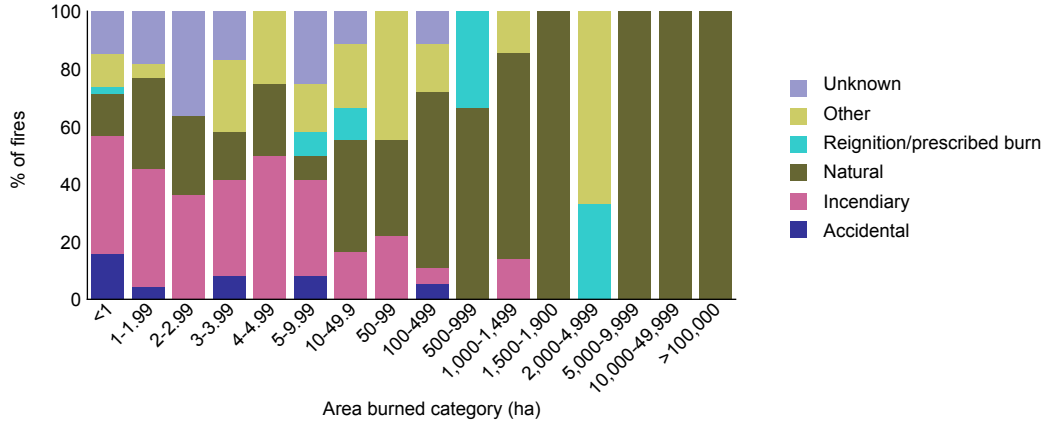
Overall, there was a tendency for the proportion of fires starting on, and being contained on, a SADEH reserve to account for a decreasing proportion of increasingly large fires (Figure 84). The notable exceptions were for the very large fires that presumably occurred on very large reserves in more remote South Australian locations. In contrast, fires started off reserves and contained off reserves accounted for higher proportions of moderately sized fires, as did fires that started on a SADEH reserve and subsequently spread to other lands. However, the overall number of such fires was very low.

Figure 81: Area burned by cause



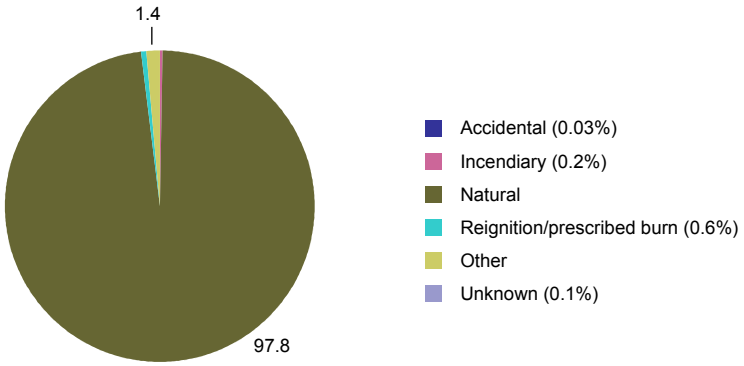
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 82: Percentage of fires within each area burned category that resulted from each cause



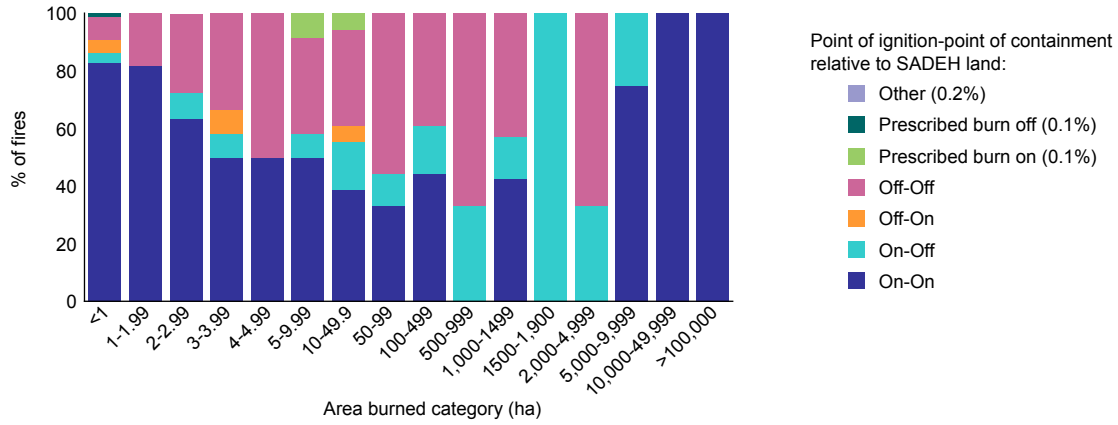
Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 83: Total area burned (percent)



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Figure 84: Area burned category by point or origin and containment/suppression



Source: AIC SADEH 1975–76 to 2003–04 [computer file]

Type of incident

As indicated in the overview, the SADEH is a land management agency. Hence, it is reasonable to assume that a high proportion of all fires attended could either genuinely be classified as a bushfires or had the potential, under adverse weather conditions, to develop into a bushfire. However, approximately three-quarters of all fires attended (where area was known) were less than 1 ha with almost 90 percent being less than 5 ha. Deliberate fires were on average smaller than accidental and natural fires.

Summary

There was an average of 3,200 landscape (vegetation) fires attended in South Australia every year from 2000–01 to 2005–06, with such fires typically comprising between 35 and 40 percent of all fires attended in the state (APC 2007). The overwhelming majority of vegetation fires are attended by the SAMFS and the SACFS, with the total number of incidents being evenly distributed between the two. Less than two percent of all vegetation fires were attended by SADEH, either within their reserves (50%) or on neighbouring property (50%).

Type of incident: Owing to differences in their jurisdictions and responsibilities, some differences are likely in the types of incidents attended by the three services, although this was difficult to illustrate based on the available data. For all agencies, there was a dominance of grassfires over other categories, with very a small proportion of all fires being forest fires

SAMFS: vegetation fires characterised by malicious activity in the area were primarily identified as grassfires (43%), small vegetation fires (36%) or other vegetation or outside fires (18%), for the interval from 1997–98 to 2005–06, although changes in the classification of fires indicate that many fires previously identified as grass fires are now classified as small vegetation fires or other vegetation or outside fire. Forest or wood fires (>1 ha) comprised 0.03% of fires attended

SACCFS: Approximately half (53%) of all the fires attended were grass or stubble fires, 38 percent were scrub and grass fires mixtures, with a further 7.1 percent being tree fires. Only 1.7 percent of vegetation fires were forest fires.

Cause: Incomplete data and a lack of internal and interagency consistency in causal categories hampered a rigorous evaluation of the causal data. Based on the available information, deliberate fires comprised:

- between 15 and 30 percent (estimate) of all vegetation fires attended by the SAMFS
- twenty percent (15.9% suspicious; 4.3% incendiary) of vegetation fires attended by the SACFS from 1997–98 to 2003–04
- thirty percent of fires attended by the SADEH.

Based on the available data, and reflecting the dominance of the SACFS and SAMFS in the fire statistics, it is estimated that approximately18 to 20 percent of all vegetation fires in South Australia were deliberate in origin.

Additional factors are summarised below:

- *Natural fires*: As observed elsewhere, the proportion of fires attended that were natural in origin varied markedly between agencies, being responsible for 30 percent of fires attended by SADEH (1999–00 to 2003–04 only), 12 percent of fires attended by SACFS and an unknown proportion of SAMFS fires. Based on the generally low rates of natural fires reported by metropolitan fire agencies, it is estimated that only about five percent of all vegetation fires in South Australia were natural in origin; that is 95 percent of all vegetation fires attended were human-caused.

- *Fires started by children*: Children were identified as being responsible for 4.7 percent of vegetation fires attended by the SAMFS as being associated with malicious activity, and 2.4 percent of all vegetation fires attended by the SACFS, with an average of 3.7 percent for the interval from 2000–01 to 2003–04. Children were identified in 3.1 percent of fires attended by SADEH. These statistics represent a minimum; actual incidences are likely to be somewhat higher, as the classification requires evidence of a child's involvement, for example being observed at the scene.
- *Smoking-related vegetation fires*: Two percent of malicious vegetation fires attended by the SAMFS were classified smoking-related. Actual incidences of smoking-related fires were probably markedly high given that the overwhelming majority of these fires are not identified as being associated with malicious activity. Smoking-related fires comprised between two and three percent of all vegetation fires attended by the SACFS each year, and 1.0 percent (category includes matches) of fires attended by the SADEH from 2000–01 to 2003–04.

Additional factors relevant to individual agencies are summarised below.

- *SAMFS*: 60 percent of malicious vegetation fires involved the use of an open flame or spark, of which half involved the use of matches. Twenty-six percent involved a hostile fire, 6.6 percent a fuel-powered object and 1.4 percent explosives or fireworks.
- *SACFS*: Of the 59 percent of cases where the specific ignition factor was identified (all fires causes), one-quarter related to burning off, with a further 10 percent involving harvesting or slashing, 12 percent being related to other machinery or vehicles, and 22 percent identified as resulting from other causes. Five percent of all deliberate fires related to burning off. This represented almost one fifth of all deliberate fires where the specific ignition factor was identified. Two-thirds of burnoffs that were classified as malicious were lit without a permit.
- *SADEH*: Neighbours burning off accounted for 4.2 percent of fires attended.

Location: Assuming that the distribution of malicious vegetation fires is representative of the distribution of vegetation fires attended by the SAMFS, and that the SAMFS, SACFS and SADEH attended 49.9, 48.3 and 1.8 percent of all vegetation fires respectively, it is estimated that 50 percent of all vegetation fires in South Australia occurred in the Adelaide region, seven percent each in the Flinders Ranges Adelaide Hills regions, six percent in the Limestone Coast region, five percent in the Eyre Peninsula regions, and three percent each in the Yorke Peninsula, Riverland and Murraylands regions. The Barossa and Clare Valleys, Kangaroo Island and Outback SA collectively only accounted for five percent of vegetation fires attended in SA. Not surprisingly, vastly different distributions were evident across agencies, as detailed below.

- *SAMFS*: 83 percent of all malicious vegetation fires attended by SAMFS occurred in the Adelaide region, with by far the greatest numbers being attended by the Elizabeth and Salisbury stations, followed somewhat distantly by Christie Downs, Angle Park and O'Halloran Hill. Ten percent of fires attended by SAMFS occurred in the Flinders Ranges region, with four percent in the Eyre Peninsula and two percent in the Riverland regions, being associated with major regional centres like Port Augusta, Port Pirie, Whyalla.
- *SACFS*: Fires attended by SACFS were more evenly distributed across the state, although high concentration were evident in the more highly populated regions, with the Adelaide, Adelaide Hills, Limestone Coast regions accounting for 17, 13 and 11 percent of all fires attended. A further 10 percent occurred on the Fleurieu Peninsula, seven percent on the Yorke Peninsula, six percent on the Eyre Peninsula.
- *SADEH*: 33 percent of all fires attended by SADEH occurred in the Adelaide region, with a further 20 percent occurring in the Adelaide Hills. Eleven percent of fires attended by SADEH occurred in the Limestone Coast region; with three to seven percent each being located in the Eyre Peninsula, Fleurieu Peninsula, Flinders Ranges, Kangaroo Island, Murrayland and Riverland regions.

Timing: The timing of vegetation fires is summarised by the week of the year, day of the week and the time of the day on which they occurred.

Week of the year: the overwhelming majority of all fires occurred between early November and mid April, coincident with the bushfire danger season. Some subtle differences were evident between years and between causes. Within the SACFS data there is clear evidence for a peak in burnoffs between mid-September and early December, and between mid April and mid May, just prior to and at the close of the bushfire danger period. Peaks in natural fires occurred in SACFS and SADEH data between early November and early February. However, high numbers of natural fires in November and to a lesser extent December was unusual, principally being a feature of 2002–03, a year associated with widespread drought. Incendiary and suspicious fires were high through the bushfire danger season, principally between November and mid April.

Day of the week: Overall, greater numbers of vegetation fires in South Australia occur on weekends than on weekdays, although the extent of this trend varied between agencies, between regions and depending on the cause, as illustrated below.

- **SAMFB**: 1.4 to 1.5 times more malicious vegetation fires occurred on Sunday and Saturday respectively than on the average weekday, being as high as 1.7 to 2.2 higher and 2.7 to 2.5 times higher on Sunday and Saturday as the weekday average in the Flinders Ranges and Eyre Peninsula regions. Vegetation fires in the Adelaide region were 40 percent more likely on both Sunday and Saturday.
- **SACFS**: 33 percent more fires (all causes) occurred on Saturday, but higher numbers of fires were not observed on Sunday compared with any other day of the week. Overall, deliberate causes were 36 percent higher on Sundays and 57 percent higher on Saturdays than on the weekday average, whereas more accidental fires occurred on Tuesday and Saturday than on other days of the week. Regional differences are noted; in Adelaide and Adelaide Hills regions, higher proportions of deliberate fires occurred on Saturday than on Sunday, whereas on the Fleurieu Peninsula the reverse prevailed.
- **SADEH**: no differences were evident based on by day of the week.

Time of the day: vegetation fires occurred varied marked based on cause, day of the week and region. The trends observed for the SAMFS and SACFS are summarised below.

SAMFS: malicious vegetation fires define two peaks, with maximums occurring at 5 pm to 6 pm and 10 pm to 11 pm. Rates were variable at local scale; commonly between 50 and 70 percent of all malicious vegetation fires occurred between 6 pm and 6 am for most metropolitan stations, with commonly between 20 and 35 percent occurring between midnight and 6 am. Lower proportions of fires occurred at night in those locations recording the highest numbers of fires overall. Higher numbers and proportions of nighttime fires were evident on Friday night–Saturday morning and Saturday night-Sunday morning. A high number and proportion of fires in major regional urban centres also occurred at night; 48 to 54 percent of all malicious vegetation fires in the Flinders Ranges, Eyre Peninsula and Riverland regions occurred between 6 pm and 6 am.

SACFS: most fires occurred between 10 am and 8 pm, irrespective of cause. However, non-deliberate fire frequencies peaked between 2 and 3 pm whereas peak numbers of deliberate fires occurred between 3 and 5 pm, overlapping with the peak in child fire s that occurred from 4 to 6 pm. Higher proportions of deliberate than non-deliberate fires, occurred at night; 43 percent of all deliberate fires occurred between 6 pm and 6 am, with 26 percent of deliberate fires occurring between midnight and 6 am. Increases in night fires were most evident for Friday night–Saturday morning and Saturday night–Sunday morning. However, the tendency for deliberate fires at night, particularly between midnight and 6 am, varied markedly by location, being higher in the Adelaide region but comparatively lower in many less populated regional areas. Children lit most fires between 4 and 6 pm.

Educational facilities: SAMFS data for vegetation fires at educational facilities indicate that the majority occur outside of schools hours (including the period in which one might expect children to be making their way home); 1.6 times more occurred on Sunday and 2.2 times more likely to occur on Saturday than on the average weekday; high numbers were lit between 3 pm and 6 pm but in many cases this was on weekends rather than weekdays; approximately 60 percent (where time was recorded) occurred between 6 pm and 8 am.

Area burned: Overall, fire frequency decreased with increasing size, although it is evident that fires attended by the SACFS were on average smaller than those reported by the SADEH, reflecting differences in cause, accessibility etc. There is clear evidence that natural fires accounted for an increasing proportion of fires attended by the SADEH as fire size increased. This is evident to a lesser extent in the SAACFS data, although in that case, accidental and more rarely deliberate fires were also a contributor. Large fire events are the overwhelming contributor to any figures regarding the total area burned as outlined below.

SADEH records indicate seven million hectares was burned from 2001–02 to 2003–04, of which 98 percent was burned by large natural fires during 2002–03. During the same interval incendiary fires burned 1,339 ha, being responsible for just 0.2 percent of the total area burned.

SACFS: 144,686 ha were burned from 1997–98 to 2003–04. Of this 31 percent resulted from accidental causes, 28 percent from natural origins, and 32 percent from fires of unknown causes. Less than six percent of the total area burned was the result of fires of incendiary or suspicious origin. For the SACFS, large areas were burned by natural fires in both 1997–98 and in 2002–03. The greatest areas were burned by deliberate fires in 2000–01 and 2002–03.

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