

## Deliberately lit vegetation fires in Australia

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*Bushfire arson is an important issue in Australia, but studies analysing its prevalence and distribution are sparse and have focused on isolated areas or specific data collections. This paper summarises key findings of the Australian Institute of Criminology's extensive analysis of vegetation fires attended by Australian fire agencies, and represents the first attempt to quantify the extent of deliberately lit fires in Australia, focusing on when and where deliberate fires occur, and how their distribution varies as a function of natural and human factors. The study identifies the need for improved collection and integration of key data to inform both policy and practice. Despite the limitations of the empirical data, important implications for the management of fire and the prevention of ignitions are discussed. The paper notes the need to examine management practices along the urban interface including strategies to build community cohesion in rapidly growing population centres in these interfaces. It also highlights the need to develop ongoing resourced arson reduction strategies that effectively target broad sections of the community, while maintaining strategies that target specific offenders.*

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Director

With every Australian fire season, the media carries reports of bushfires that police and fire authorities believe were deliberately lit, but these represent just a fraction of all deliberate fires attended by fire services. While individual fire agencies are aware that deliberately lit fires are a problem in their jurisdiction, the complete picture has been lacking. Anecdotal information and, in some cases, data are shared between services. However, there has been limited collation of data or analysis at a state/territory or national level. Hence, there have been limited opportunities for individuals or organisations to compare the incidence and trends in deliberately lit fires within their area with that observed in other regions, agencies or jurisdictions. The lack of a complete picture is likely to impact on how relevant agencies and government departments assess risk, the priorities that they assign to arson reduction and probably the effectiveness of the strategies that are introduced to mitigate risk.

This paper provides a summary of the key findings and implications from an analysis of approximately 280,000 fire incidents attended by 18 Australian fire services, typically within a five-year period (Bryant 2008). It focuses on the extent of, and potential factors responsible for, the temporal and spatial distribution of deliberately lit fires across Australia, particularly as they compare with non-deliberate fires.

Differences in the way fire causes are attributed – including differences in the number and proportion of fires of unknown cause, the way fires lit by children are classified (accidental versus malicious), as well as genuine differences in the principal causes of fires – may hamper effective integration of information across jurisdictional and interagency boundaries. While detailed knowledge

  
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of fire causes is necessary to implement efficient and targeted arson reduction strategies, there is a strong correlation between the increased incidences of deliberate fires and greater densities of fires generally. Even in the absence of rigorous causal information, total incidence data can provide a valuable guide to deliberate fire hot spots.

**Number of fires**

Fire services attend between 45,000 and 60,000 vegetation fires in Australia every year. These fires typically account for 40 to 50 percent of all fires attended. Most occur in New South Wales (36%), Queensland (21%), Western Australia (15%) and Victoria (12%; 2002–03 to 2005–06; APC 2007).

**Causes of fires**

While Australia is particularly fire-prone, natural fires account for only six percent of known causes of vegetation fires attended by fire services. Over 90 percent are the result of people’s actions, and more often than not the result of deliberate ignitions; incendiary (maliciously lit fires) and suspicious fires account for one-half of known fire causes in Australia, and are the largest single cause of vegetation fires (Figure 1). However, if we consider in this analysis that accidental fires, which account for

35 percent of all known vegetation fire causes, include those accidentally lit by children and smoking-related fires, the proportion of preventable vegetation fires is much higher. Forty percent of all fires attended across Australia do not have a cause assigned by the responding fire agency.

Difficulties exist in determining how the numbers of deliberate (incendiary and suspicious) fires have changed over time, due to changes in database collection methods, difficulties in integrating databases, the considerable uncertainty in the causes of many fires and complexities in delineating the specific cause of particular temporal variations. For example, although the Western Australian Department of Environment and Conservation reports only minor variation in the number of fires from 1999–2000 to 2002–03, this belies the fact that severe weather conditions during 2002–03 trebled the number of natural fires. This alone would have been sufficient to reduce the proportion of deliberate fires, but 2002–03 was also marked by lower numbers of deliberate fires. The latter may reflect the impact of the recent introduction of targeted arson reduction strategies across Western Australia, increased closures of parks due to adverse fire conditions, or increased public awareness and vigilance.

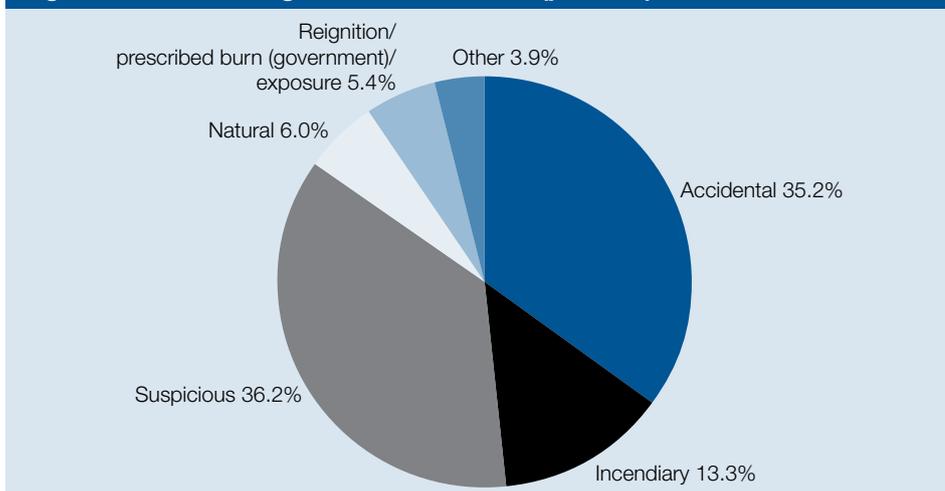
The division of responsibilities between individual agencies varies by jurisdiction. Both the number and principal causes of vegetation fires vary across agencies, depending on that agency’s jurisdiction and responsibilities. For example:

- Natural fires accounted for between 10 and 35 percent of all fires attended by land management agencies and rural fire services, but just one to five percent of fires attended by metropolitan and urban brigades.
- Rural fire services and land management agencies attend greater numbers and proportions of fire escapes from burn-offs and other land management activities – non-government burn-offs (not including government prescribed fires) typically comprise 5 to 25 percent, but up to 50 percent of all fires attended – although the incidence of this type of fire varies greatly even in rural areas due to differences in climatic conditions and land use patterns.
- Urban areas tend to be characterised by high proportions of deliberate and/or accidental fires, and experience less temporal fluctuations due to natural fires.

**Children**

It is difficult to accurately assess the number and proportion of fires started by children. This reflects both the problems associated with identifying the person responsible for a fire and limitations in the way that fires started by children are recorded in existing database structures. With the exception of some land management agencies, specific data were only available for instances where children had been implicated in accidentally causing the fire. Children were responsible for up to 24 percent of known fire causes by individual agencies, with the highest rates being reported by metropolitan/urban fire services. However, children under 16 years of age are likely to be significant contributors to the incidence of vegetation fires in

**Figure 1: ‘Known’ vegetation fire causes (percent)**



Source: Combined Australian fire agencies [computer data file]

all jurisdictions. The role of children in lighting fires is shown in the higher than predicted numbers of both deliberate and accidental fires between 3 pm and 6 pm, Monday to Friday. The inability to accurately identify the number and distribution of fires started by children is of concern, as it hinders the ability of fire services to evaluate the need for, and effectiveness of, interventions and education programs for children and adolescents who are likely to light fires.

### *Smoking*

Smoking-related activities are a common cause of non-deliberate, but preventable, fires attended by urban fire services (commonly 3 to 14%), but comprise a low proportion of all fires attended by rural fire services and land management agencies (1 to 4%). Markedly higher rates of smoking-related fires exist in metropolitan cities, particularly in inner city areas. For example, 41 percent of all fires attended by the Metropolitan Fire and Emergency Services Board, an agency whose jurisdiction is restricted to metropolitan Melbourne, were identified as smoking-related. Comparable rates are observed in inner city areas of Perth and Brisbane. Higher rates of smoking-related fires in urban areas coincide with greater population densities, resulting in a greater density of smokers and discarded cigarettes, and a greater prevalence of loose, highly combustible mulch in roadside and other urban landscaping.

### *Where fires occur*

As most vegetation fires are caused by people, their distribution is linked closely to human populations. Vegetation fires are not a phenomenon that is restricted to vegetated, sparsely populated areas of regional and rural Australia. While many Australians live in fear of the scenario where bushfires emerge out of the bush to threaten homes and lives, most vegetation fires in Australia result from the flow-on effects of human populations into neighbouring natural landscapes.

Between one-third and one-half of all vegetation fires attended by fire services in any state or territory occur in and around the capital city, with the greatest concentrations evident in the broad zone along the urban interface – the zone where people and vegetation coexist and interact. Similarly, high numbers of vegetation fires are associated with major regional centres, compared with neighbouring rural areas.

Conservation areas and forestry resources located next to urban areas, areas of population growth and expansion, or otherwise higher densities of people are vulnerable to increased fire-related problems. These include incendiary and/or careless and reckless behaviour, such as increased instances of vegetation fires arising from torching of abandoned or stolen vehicles. Increased unplanned fire activity up to 10 km from the urban interface has been documented in highly vegetated areas of the Sydney basin (Davidson 2006). These results potentially have significant ecological implications. It may be insufficient to simply allocate a certain portion of land for the protection of specific ecosystems or species. To ensure that environmental values are preserved, additional measures may be required to minimise human impacts; for example, through the establishment of environment buffers, intelligent and innovative environmental design, education, and crime and safety measures.

### *Hot spots*

Deliberate fire hot spots are characterised by high rates of fires per person, and commonly account for a high proportion of fires in a region, and potentially in a state or territory. High fire concentrations are evident across all agencies with responsibilities in the vicinity of the hot spot, so a genuine picture of the incendiary activity can only be achieved by combining data from each of the relevant agencies. These hot spots are

commonly located on the outer fringes of metropolitan areas, although regional examples also occur, and they generally lie within the broad zone along the urban interface. These communities are commonly characterised by a relatively low median age and/or a high proportion of young persons and, commonly, are socioeconomically disadvantaged (Nicolopoulos et al. 1997). In many instances, these are also areas characterised by a greater concentration of other problematic and antisocial behaviours.

### *Rapid urban expansion*

Large increases in fire numbers are evident in areas characterised by recent or current urban expansion and/or rapid population growth. Increased fire frequencies in these areas are not only facilitated by growth of the urban interface, but also may arise as a result of sociological factors that increase the likelihood of offending, particularly among the young. These include greater social distance (individuals are physically and psychologically separated from previous and/or available social networks), limited or non-existent recreational facilities, and at least initially, disjointed communities at a social level, where many people have arrived from other areas.

Areas of rapid urban expansion on the margins of metropolitan and regional centres commonly fall under the jurisdiction of rural services until a sufficient population density is reached and fire service provision boundaries are altered. Rapid increases in total fire numbers, commonly as a result of increased numbers of deliberate fires, place great strain on rural fire services, which rely principally on the efforts of volunteers. In many instances, these services may already face personnel shortages as a result of their aging population base, and face difficulties in recruiting and retaining new members at least in part due to the time required.

## When fires occur

The timing of vegetation fires ultimately reflects interactions between nature's cycles – which control vegetation fire risk – and the timetables of humans, who are the principal cause of vegetation fires. Fire risk is linked closely to rainfall distribution, the timing, intensity and predictability of which is governed by spatial and temporal interactions between geography and climate.

Although coastal interactions are evident, the timing of bushfire danger season in Australia varies, broadly, latitudinally across Australia – from summer and autumn in the south, to spring and summer across middle latitudes, and to winter and spring months coincident with the dry season in northern Australia.

Most vegetation fires in Australia, irrespective of cause, coincide with the bushfire danger period at that location. A notable exception is fires that result from the escapes of burn-offs. These fires, which are an important contributing factor for many rural fire services and land management agencies, peak just before and just after the bushfire danger season. This contributes to a longer season for accidental fires compared with other causes in rural and regional areas. The highest numbers of natural fires coincide with 'dry' thunderstorms during the peak of the bushfire danger season. During normal seasons, this period is short. However, lower than average winter and spring rainfall in those years associated with an El Niño event contributes to earlier episodes of natural fires, with numerous peaks in natural fires potentially occurring throughout the bushfire season.

The temporal distribution of deliberate fires is consistent with routine activities theory (Cohen & Felson 1979), which states that a crime – in this case arson – takes place within the context of everyday patterns of movement and activity. All that is required is a motivated offender (e.g. bored, idle, tempted,

provoked), suitable targets (e.g. targets characterised by ease of access, abundant flammable material, a perceived reward) and the absence of capable guardians (e.g. family, friends, neighbours, authorities, surveillance).

### *The day*

Generally, between 20 to 50 percent more deliberate, and 20 to 40 percent more accidental fires occur on Saturday and Sunday compared with weekdays, but locally higher values can be observed. Analysis of accidental fires indicates daily differences in fire attendances throughout the whole week are linked strongly to specific causes (e.g. use of recreational facilities). Similar relationships are likely to exist for deliberate fires, but there is limited capacity to investigate this possibility.

### *The time*

The timing of fires varies depending on the cause. Fires started by lightning potentially occur at any time of the day, but most natural fires coincide with the hot conditions conducive to thunderstorm activity, between midday and 6 pm. While impacted by natural forces, the timing of human-caused vegetation fires are related strongly to the timetables of people, whether they are day-to-day activities relating to work, school, shopping, or other personal or social activities. Surprisingly, almost one-quarter of all vegetation fires in Australia are attended between the hours of 10 pm and 6 am.

The timing of accidental and deliberate fires, and the extent of differences between the two, may vary between brigades, agencies and jurisdictions depending on variations in the principal causes of fires, and also on differences in the way specific causes (e.g. fires started by children) are classified.

A higher proportion of all deliberate fires (on average, 48%) occur between 6 pm and 6 am, compared with non-deliberate

fires (on average, 30%). During the day, deliberate fires peak between 3 pm and 6 pm, while accidental fires peak slightly earlier, between 1 pm and 4 pm. The window between 3 pm and 6 pm on weekdays reflects the time in which younger persons often travel unaccompanied by an adult through their local environment. On weekends, peak numbers of deliberate fires occur between 1 pm and 4 pm.

Deliberate fires at night – between 6 pm and 6 am – are most evident in urban and semi-urban environments, and primarily occur between Friday night and Saturday morning and Saturday night and Sunday morning in most jurisdictions (20 to 50%). The timing of night fires is highly variable at a local scale, probably due to local variations in social and cultural patterns of human activity, which govern when, where and how people interact with their local environment. The overall timing of fires started by children varies with age, such that by 13 to 16 years the patterns are virtually indistinguishable from general deliberate fire distributions.

## Size of fires

The size of a fire depends on both human and environmental factors, including the weather, dryness of vegetation, location, perceived environmental benefit/hazard of a fire, accessibility, availability of fire suppression resources and potential danger to human life and property, as well as the specific cause. Fortuitously, few fires are very large; most fires, irrespective of cause, are small, with total fire frequencies decreasing with increasing fire size. While this general trend is observed across all fire causes, deliberate fires typically comprise a decreasing proportion of all fire causes as fire size increases, whereas natural fires comprise higher proportions of larger fires. Deliberate fires resulting from illegal burn-offs are on average larger than deliberate fires resulting from vehicle arson or other incendiary activities. For

example, on average, illegal burn-offs attended by New South Wales National Parks and Wildlife Service from 1995–96 to 2003–04 burned 2,157 ha (median=170 ha), whereas the average size of arson/suspicious fires was 226 ha (median=2 ha). Overall, most fires attended by fire services tended to be small (under 1 ha), but rural fire services and land management agencies attend higher proportions of moderate and larger fires, due to the higher number of natural fires and escaped burn-offs, differences in the environment and accessibility, and environmental and fire management considerations.

There is some difficulty in determining the proportion or total area burned by a particular cause due to the partial replication of fires across databases, missing data and the inability to differentiate areas burned by specific causes during campaign fires. While it is important to know the total area burned – this will likely become more important with increased carbon accounting measures – some caution is required when interpreting statistics on total area burned, particularly in using such figures as a representation of severity, damage or potential to cause harm. The total area burned for any one category (for example, year, cause and region) is dominated by the largest fire events. Hence, the greatest total areas in Australia are burned in areas where fire is an intrinsic part of the environment or its management, namely the savannas of northern Australia. However, savanna fires less commonly pose a danger to human life and property, and in many cases no active suppression may be made. Therefore, it is not valid to compare a 100,000 ha fire in the Northern Territory with a 100,000 ha in the Victorian central highlands or Gippsland. A fire less than 5 ha can result in loss of life or property.

Natural causes are responsible for most of the total area burned in Australia.

These fires typically occur during comparatively short intervals within adverse bushfire seasons. Nationally, deliberate fires, while most frequent, are responsible for a small proportion of the total area burned. Moreover, a large proportion of the total area burned by deliberate fires results from illegal burn-offs. This statistic belies the dangers associated with deliberate fire ignitions, including:

- they are unplanned – posing hazards to the welfare of firefighters, the public and wildlife as adequate contingences to protect life and assets have not been put in place
- they commonly occur close to people and infrastructure, so even comparatively small fires can result in losses
- they needlessly waste the resources of fire agencies, increasing requirements for public funding, placing unnecessary burden on volunteer firefighters and their families, and potentially compromising service delivery to other incidents
- although many Australian ecosystems require fire to remain healthy, too frequent burning results in losses and/or changes in biodiversity, commonly facilitating invasion by weeds. Moreover, fires in fire-sensitive environments contribute to species loss and changes in ecosystem biodiversity.

### The importance of weather

The ease with which ignition takes place and how fast a vegetation fire spreads is linked to the weather. Factors like temperature, relative humidity, wind speed and the curing rate of vegetation form the basis of the fire danger index rating used by the Bureau of Meteorology and fire agencies to communicate about fire risk, both with each other and to the community by the ‘low to extreme’ fire danger rating scale. It is not surprising

that the weather can play an important role not only in when fires occur, but also the extent of vegetation burned and damage sustained. Most of the total area burned in Australia (excluding the tropical savannas of northern Australia) and greatest loss of property and life has occurred in a small number of devastating events. In south-eastern Australia (principally NSW, ACT and Victoria), these are often associated with El Niño events. These are natural climatic variations that occur when anomalous warming of the central and eastern Pacific Ocean contributes to offshore movement of rainfall, and dry or even drought conditions in eastern Australia.

El Niño events potentially influence both the frequency and total area burned in a given season, although any effects are most strongly observed for land management and rural fires services records, where natural causes and conditions play a more critical role. However, while the timing of vegetation fires in urban areas is a function of the weather – most fires occur during the bushfire season, and fewer fires occur during wetter seasons or weeks – there is a comparatively poorer relationship with either the frequency of fires or total burned and adverse bushfire seasons for urban fire services. This reflects the fact that total fire numbers in urban areas are influenced strongly by incendiarism and negligent or careless actions (e.g. fires lit accidentally by children, smoking-related fires), which tend to be high irrespective of the season.

The relative proportion of fires that occur in individual (low to extreme) fire weather conditions varies with location – some locations are inherently more bushfire prone than others – and from season to season, due to changes in weather conditions, which affect the number of adverse bushfire danger days in a given year. Most deliberate fires in Australia occur under comparatively mild conditions, because most Australians

live along the coastal fringe, where the climate is milder. Only a small number and proportion of all vegetation fires occur under extreme weather conditions, due to the limited number of days on which extreme bushfire weather are experienced. This is true for all fires, irrespective of cause.

Although inconclusive, the available evidence indicates that deliberate causes typically account for a decreasing proportion of all fires as the fire danger increases. That is, if the number of deliberate fires increases under more adverse conditions, the risk does not increase proportionally to the increases in risk of accidental and natural fires. Areas where the risk of deliberate fire ignitions during adverse bushfire weather is greatest are those that record a generally higher incidence of deliberate fires.

Analysis also identifies the need to target preventable fire causes. For example, in one urban area characterised by a high incidence of smoking-related fires, a decrease in the proportion of deliberate ignitions with increasing fire danger is accompanied by a marked increase in the proportion of smoking-related fires (Bryant 2008). This highlights the possibility that many vegetation fires occurring under adverse conditions may arise because people fail to take into account the weather conditions.

## Implications

This paper has summarised the key results from a systematic analysis of deliberate fires in Australia. While fire data supplied by individual agencies vary in

quality and continue to improve, analysis has highlighted limitations in database design that affect the capacity to accurately and unambiguously document factors surrounding the causes of a fire and effectively integrate and analyse data within and across agencies. Also, due to the complexities of the database, some training to assist fire officers in the accurate recording of incidents with the Australian Incident Reporting System database may be required, together with ongoing data quality assessment. Poor data quality hinders the capacity of an organisation to utilise this resource to implement fire reduction strategies.

Broad implications can be drawn from the existing, albeit imperfect, data. These include the need to:

- examine management practices along the urban interface. Effective fire prevention and arson reduction, particularly in some areas of rapid population growth or social disadvantage, will require strong coordination between fire and police services, but potentially also social welfare, community service, and environmental management and design agencies
- facilitate community cohesion in rapidly growing population centres
- implement measures to reduce the burden of deliberate and other fire causes on volunteer fire services, particularly along the urban interface
- develop ongoing resourced arson reduction strategies that effectively target broad sections of the community while maintaining strategies that target specific offenders

- increase the capacity of fire agencies to identify and develop strategies that target places, times and days based on local hot spot mapping
- develop and evaluate effective intervention and education programs and strategies for children and adolescents who are likely to light fires
- continue to improve engagement between landholders, land management agencies and fire services to minimise escape from legal and illegal burn-offs
- increase community awareness of, and involvement in, eliminating preventable fires.

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