



**Australian Government**

**Australian Institute of Criminology**

# **Understanding bushfire: trends in deliberate vegetation fires in Australia**

**Colleen Bryant**

**Technical and Background Paper**

**No. 27**



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## Contents

Acknowledgements.....	iv
<b>Introduction.....</b>	<b>1</b>
Background and purpose of this report.....	2
Definitions and key concepts.....	3
Key themes.....	6
Sources of data.....	7
Limitations to accuracy of fire information.....	9
Sources of background information.....	12
<b>Methodology.....</b>	<b>13</b>
Sample set used.....	14
Database structure and period of data analysed.....	14
Vegetation fires.....	15
Cause.....	23
Agent responsible for fires.....	37
Location.....	39
Timing.....	51
Area.....	51
Vegetation.....	52
Fire restrictions/fire bans.....	55
Fire danger index.....	55
Sources of background information.....	56

## State and territory chapters

**New South Wales**

**Victoria**

**Queensland**

**Western Australia**

**South Australia**

**Tasmania**

**Australian Capital Territory**

**Northern Territory**

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## Introduction

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## Background and purpose of this report

Australia is the most fire-prone continent and country on Earth. In any one year numerous fires burn hundreds of thousands to millions of hectares of savannas, other grasslands, bushland and forests. While fire is an essential component of many ecosystems, a natural instrument for maintaining biodiversity and hence a tool that enables many species to survive, not all fires are natural or beneficial. Humans play a significant role in modifying the timing, frequency and size of bushfires, in some cases to the detriment of the environment and to the endangerment of property and human life. While some human-caused fires are for the purposes of managing the environment, protecting human life and property, or the result of accidental actions, many fires occur through negligence, carelessness, mischievousness, or outright maliciousness, with little regard for either the environment or people who might be adversely affected. It is this latter group of fires – herein referred to as deliberate ignitions – that forms the central theme of this report.

Although a number of studies have documented the incidence of deliberate fires for isolated areas of Australia (see Willis 2004), there is a distinct lack of consolidated national data. As Willis (2004: 27) illustrated in his literature search on bushfire arson:

In response to a question on notice in the Australian House of Representatives, which asked whether it was a fact that 70 per cent of bushfires are the result of arson, Dr Brendan Nelson, Minister for Education, Science and Training stated that the Department of Education, Science and Training did not have any statistical information on bushfires arising from arson (Hansard 2003). In response to the same question, Wilson Tuckey, Minister for Regional Services, Territories and Local Government was also unable to advise whether the suggested rate was correct, stating that while a significant proportion of bushfires are suspected to be due to arson, there is no consistent national approach to the collection and analysis of bushfire data (Hansard 2003).

This report represents the first concerted effort to establish **plausible** rates of illegal firesetting in vegetation across Australia. The term plausible is emphasised, as this is inherently an imprecise science. There are intrinsic difficulties in determining the causes of bushfires. In some cases there may be little evidence to confirm or deny whether a fire was deliberate, accidental or natural in origin. The relative isolation and concealment offered by bushland means there are few witnesses to the act. In many cases, firefighters or investigators will develop a suspicion that a fire was deliberately lit based on the location, timing or other circumstances, or in the absence of another feasible explanation. In light of the uncertain nature of these determinations, any assessment of the rates of deliberate firesetting must be regarded as partially speculative, and therefore an estimate only.

The report is based on vegetation fire data supplied by a large number of fire agencies across Australia. Although this report is intended to provide an overview of incidence, cause, timing and location of bushfires in Australia, in many cases the data agencies provided includes all fires that burned vegetation, irrespective of size. These are equivalent to the landscape fires documented in the Australian Government's Productivity Commission report on Emergency Management (APC 2007). The implication is that that analysis includes bushfires but also any other vegetation fire attended by fire agencies. These may be fires in suburban parkland, along roadsides, hedgefires, or fires on a football oval. There is no clear means, within many databases, for distinguishing when a vegetation fire constituted a bushfire. Hence, this report examines the propensity for deliberate firesetting in vegetation in general as opposed to bushfires specifically.

The nature of this report is technical, providing a basis for guiding research and policies adopted by fire agencies, other researchers and interested individuals. The technical nature of the report reflects the fact that in many instances the nature of the information provided by fire services is itself complex. Also there are inherent difficulties associated with attempting to source, collate and analyse multiple databases from different time periods, database structures, variable lists, etc. In order to maintain the highest level of data



integrity, the data from individual agencies have been analysed separately. Although strict comparisons across agencies are typically not possible, the adoption of a common set of themes in analysis allows similarities and differences in the overall incident, timing, distribution, etc. of fires to be highlighted. However, it is not possible to entirely replicate this across agencies, as subtle differences exist in the structure of databases and the structure of fire agencies within each jurisdiction. These differences subsequently affect interpretations that can be placed on the data. This report forms the basis for a number of smaller publications that will summarise the key findings of the document.

## Definitions and key concepts

This report attempts to document the number, size and distribution of potentially illegal fires lit in vegetation in Australia. It is essential, before proceeding, to understand how the two most critical terms central to this theme are defined, namely **deliberate fires** and **vegetation fires**.

### Deliberate fires

Arson is the term most commonly used within our everyday vocabulary to describe fires that have been illegally lit. There are a number of underlying tenets to the common usage of this word (Willis 2004) namely:

- **the setting or starting of fire** – fire is the fundamental element of arson and without the setting of fire, arson does not exist
- **intention or wilfulness** – all definitions of arson exclude fires that are started by natural causes or accidents
- **malice** – most definitions of arson incorporate an element of malice, thereby excluding fires that are started intentionally but with positive or legitimate intent
- **property** – most definitions require that there be some kind of property or object which is burned.

Inclusion of the element of malice is problematic in many respects. Although people may light a fire illegally they do not necessarily do it with the intent to cause harm (Willis 2004).

In its strictest sense the concept of arson rests with its legal definition and there are a number of differences between the legal definition of arson and its common usage. One of the most fundamental differences pertains to the issue of intent. A number of states have adopted the model code for arson-related offences, which no longer requires that the person intended to cause harm, they only had to be reckless to causing a fire and reckless as to the spread of the fire to vegetation or property belonging to another (Model Criminal Code Officers Committee 2001:46). The most critical complication is that of using the legal definition of arson that arises only when a person is found guilty of the charge.

Using this strict legal definition poses a number of problems for establishing the number of fires that possibly were illegally lit in Australia. In many instances, there are fundamental difficulties in establishing the cause of a fire, let alone finding the perpetrator and achieving a successful prosecution in court. Analysis of data based on court convictions may provide an accurate assessment of the actual numbers of proven bushfire arson cases – according to the legal definition – but is unlikely to provide an accurate estimate of the number of unplanned, deliberate fires and potentially illegal fires across Australia each year.

In order to circumvent this issue, this report draws upon the data for all vegetation fires documented by most fire agencies from across Australia. The causes of fires recorded within these databases are documented in a number of ways, but fire agencies rarely use the term arson. The majority of urban and

rural fire brigades classify fires based on the codes outlined by the Australasian Fire Authorities Council (AFAC) in the Australian Incident Reports System (AIRS). Within this system AFAC defines two separate categories of potentially unplanned deliberate or illegal fires (that is, incendiary and suspicious), with the distinction between these categories only differing in the level of proof of evidence required. Within the AIRS codes, a fire is:

- **incendiary** if there is a legal decision or physical evidence that indicates that the fire was deliberately set
- **suspicious** where the circumstances indicate the possibility that the fire has been deliberately set; for example, separate unrelated fires were found, or there were suspicious circumstances and no accidental or natural ignition source could be found.

### What is a deliberate fire?

In the broad context, a deliberate fire is one where the intent of the person is to start a fire, for a person placing burning material to cause ignition (Esplin, Gill & Enright 2003). According to this definition, deliberate fires would include arson, but they would also include prescribed burns; for example, fires that were deliberately lit to achieve a set goal (such as to remove hazardous fuel, encourage germination, or to clear old growth pastures to encourage green pick) and comfort fires that are lit to keep warm and cook food. If conducted properly neither prescribed fires nor comfort fires are illegal.

In this report the term deliberate will be used to denote that a person intentionally caused an ignition where the intention was to cause, or was reckless to the possibility of causing, harm or destruction to life or property. Accordingly, this definition effectively incorporates all 'unplanned' fires (see glossary) that were intentionally started by human beings, but will include prescribed burning practices that are conducted illegally. In this report a deliberately lit fire therefore refers to illegal fire setting.

It is important to recognise that assigning a cause to a fire may be somewhat subjective. Indeed, the AIRS Instruction Manual for implementing these definitions says:

It should be understood that this item [incendiary and suspicious fires] in particular requires the officer to make a reasonable judgment using his or her expertise and experience in the area of fire behaviour and cause. Whilst it is accepted that there will be instances where the ignition factor will not be apparent, the reporting officer should not require irrefutable evidence of the cause to be present before making a determination (AFAC, 1997; E5 Ignition Factor).

It is evident, after examining data from many different agencies, that the rates at which agencies apply the term incendiary as opposed to suspicious varies markedly both within and across agencies. For some, the number of fires classified suspicious markedly outweighs those classified incendiary, for others the reverse is the case. However, there is greater uniformity across and within agencies when the total number of fires classified incendiary and suspicious is combined into a single variable. This implies that it is likely to be the inferred certainty that varies both within and across agencies, rather than the actual instances of potentially deliberate fires. To circumvent intra- and inter-jurisdictional differences, this report adopts the term deliberate to describe all fires that were either classified incendiary or suspicious (all references to the term deliberate hereafter in this report use this definition).

This effectively says: we believe that the best guess of the attending fire officer most reasonably reflects the actual cause of the fire, and there is a reasonable probability that most suspicious fires were incendiary in origin, but that is just that physical evidence was lacking. It is implicit within this definition that there is some uncertainty in the estimated proportions of fires that potentially arose from deliberate causes, but this is the best guess it is possible to make. It is strenuously highlighted that the term deliberate used in this report is not a term typically used by fire agencies, for which this term may have different connotations.

It is also noted that not all fire agencies, particularly land management agencies, use the AIRS codes or definitions. Other agencies may use the terms deliberate, arson, malicious incendiary, illegal burning-off, mischievousness, and motor vehicle arson. Hence in this report the definition of a deliberate fire refers to illegal fires as follows:

- **Deliberate fire:** All fires classified by fire agencies as incendiary, suspicious, deliberate, arson, malicious incendiary, illegal burning-off, mischievous.

## Vegetation fires

Many different terms are used to describe fires that occur in vegetation, often with subtly different emphasis and meaning. The term bushfire is a uniquely Australian term that is used to describe an unplanned fire that occurs in the 'bushland', incorporating fires that occur in grass, (grassfires), forest (forest fires), scrub (vegetation composed of shrubs; scrub fire) and other vegetation categories; that is, any fire that occurs outside the urban environment (Ellis, Kanowski & Whelan 2004). This is similar to the term wildfire or sometimes wildland fires used in the United States.

The Australian Forestry and Forest Products Division of the CSIRO (2000) defines as wildfires all vegetation fires that were accidentally lit, lit by arson or the result of a lightning strike, and that burn unchecked. They distinguish wildfires from fires that were deliberately lit to achieve a set goal, such as to remove hazardous fuel, encourage germination, or to clear old growth pastures to encourage green pick, which are collectively called 'prescribed' or 'controlled' fires.

The common usage of the term bushfire, by people outside of fire and nature-based agencies, tends to be shaped by those events that most commonly appear in the media; that is, large, dangerous and devastating fires that sweep through bushland, typically destroying everything in their path.

Use of the term wildfire in most fire agencies' databases, the definition that ultimately governs the types of fire incidents available for analysis, is somewhat different from those outlined above. The majority of urban and regional/rural-based agencies (that is non-land management agencies) classify fires based on the AIRS codes. Within this definition a wildfire specifically encompass all fires where the type of incident code is from 160 to 179 (Table 3 in the Methodology section). Effectively this encompasses all fire incidents the fire agency attends that occur in vegetation irrespective of size, incorporating both small (less than 1 ha) and large (greater than 1 ha) fires. Hence, in an urban area a 'wildfire' may include a fire that genuinely occurs in an area of native vegetation, as an isolated pocket within a suburb, or along the urban interface, but equally may include fires that occur in grass along the roadside (such as where a single tree or shrub is set on fire), on the local oval, or in shrubs outside the local hospital, residence, restaurant or police station. The latter fires are not what one typically calls a bushfire or a wildfire.

Ascertaining which of the fires attended by fire agencies genuinely constituted a bushfire according to the CSIRO definition is not a simple task. The dominant types of fires each agency attended will be shaped by their responsibilities and jurisdiction. For example, it is probably reasonable to assume that a higher proportion of fires land management agencies attended were genuinely bushfires, in the classical sense. Similarly, rural-based agencies might attend a higher proportion of fires that pertain to rural practices; for example, fires started on farmland as a result of harvesting or slashing, or fires that result from the escape of burn offs (prescribed burning). It cannot be assumed, however, that all fires these agencies attend fall within these broad categories. A number of factors that vary between the states and territories will determine which agency will attend, for example:

- The jurisdictions of individual agencies commonly encompass a broad range of environments. For example, although the jurisdiction of urban brigades may largely encompass urban areas, they also typically include expanses of open space, pockets of remnant vegetation, an urban–rural/forest interface. Similarly, the jurisdiction of many rural/regional brigades includes both rural and urban areas. In some instances, urban areas occur adjacent to or, as is the case for the Royal National Park in New South Wales, within areas that come under the jurisdiction of land management agencies.

- In order to meet their responsibilities to protect people and the environment, individual agencies commonly attend fires on lands that directly lie outside their tenure or jurisdiction.
- There is typically a high level of cooperation between fire fighting agencies, with individual agencies volunteering services for fires that lie outside their jurisdiction. These fires may be local, in another region or even in another state or territory.
- The dominant type of fires agencies attend is dependent on the structure of the agencies, and the distribution of responsibilities for fire services within a given state or territory, as well as the distribution of people and the dominant land uses that occur within each area. All can vary marked within and between each state and territory.

Unfortunately, the 'Type of Incident' variable was not available for many databases, so small versus large vegetation codes cannot be used as a determinant. Moreover, although many small vegetation fires that occur in urban areas may not constitute a bushfire in the classical sense, size is not by itself necessarily a determinant. Without precise grid coordinates it is not possible to determine the exact environment in which each fire occurred. Even if this information were available, it is beyond the resources of this project to undertake such an analysis.

This report uses the term vegetation fire to describe all fires attended by fire agencies that occur in vegetation. These are distinguished from those that occur in buildings (structural fires) and fires that occur in vehicles (vehicle fires). The term bushfire is retained for specific instances where it has been confidently identified as a vegetation fire that has burned unchecked. This includes historically large bushfires.

The majority of vegetation fires that fire agencies attended are unplanned. However, databases from land management agencies may incorporate a small number of fires recorded as prescribed burns. In most instances fires arising from fire management practices are not documented in the same database as unplanned fires, unless the fire escaped control lines, in which case it no longer represents a controlled fire.

## Key themes

This report incorporates five key themes that wherever possible are replicated across analyses for individual agencies and jurisdictions; the themes address underlying questions about the nature of bushfires in general, and bushfire arson in particular in Australia. These questions include:

- What are the most common causes of bushfires in Australia? This theme examines the overall incidence of bushfire, the potential role of arson relative to other fires causes, and specific causal information – ignition factors, form of heat of ignitions, people identified as being responsible, for example, fires started by children, and specific types of fires, for example, smoking related fires.
- How do the frequency and causes of fires vary spatially, at both regional and local scales, by the type of complex/land use, and in relation to population distributions within that jurisdiction?
- How do the frequency and causes of fires vary temporally – by season, week of year, day of week, time of day, and in relation to adverse climatic conditions?
- What is the size of the area burnt by fires? That is, the size distribution by fires of different causes, variables impacting on the total area burnt, total area burnt by deliberate and non-deliberate fires, particularly as it pertains to adverse bushfire seasons.
- What is the relationship between bushfire arson and periods of adverse bushfire weather? This portion of the analysis draws on information about status of fire restrictions and total fire bans, bushfire danger ratings, available weather information (rare) and firesetting activities during particularly adverse bushfire danger periods.

In addition, the analysis locally examined the type of vegetation burned and the incident type to enable the reader to more accurately assess the type of fires that individual agencies attended. In one specific instance, for the Western Australian Department of Environment and Conservation, the analysis examines specific environmental factors, to highlight the impact that arson potentially has on ecologically vulnerable and endangered ecosystems.

## Sources of data

Individual state and territory governments are responsible for delivering emergency services, including the arrangements for protecting life, property and the environment. Most jurisdictions divide responsibilities for delivery of fire services between several agencies based on the discrete function of the organisation and the geographical area, although the structure and responsibilities of individual agencies varies across jurisdictions. The major agencies responsible for suppressing wildfires in Australia are summarised in Table 1.

The vegetation fire data of individual agencies were examined over several consecutive years (typically a five-year period), to take account of the natural fluctuations in the incidence of bushfire that arise from climatic variability. For the list of agencies from which data was acquired, the interval over which the data pertained, and additional comments about the data see Table 2 in the Methodology section.

**Table 1: Agencies responsible for suppressing wildfires in Australia<sup>a</sup>**

<b>Jurisdiction</b>	<b>Urban</b> <b>Principally attend fire incidents within major urban centres</b>	<b>Rural</b> <b>Principally attend fire incidents in rural areas</b>	<b>Land management agency</b> <b>Attend fire incidents in National Parks and state forests</b>
<b>New South Wales</b>	NSW Fire Brigades provides urban fire services to major metropolitan and regional urban centres; principally permanent and retained firefighters working from fire stations but also includes community fire units and their members	NSW Rural Fire Service provides fire services to most of regional New South Wales outside major urban centres, but does provide firefighting services in more than 1,200 towns and villages; fire-fighting duties principally lie with volunteers	Forests NSW is responsible for managing public native forests as well as hardwood and softwood planted forests
			National Parks and Wildlife Service is responsible for managing National Parks and other conservation reserves
<b>Victoria</b>	Metropolitan Fire and Emergency Services Board provides urban fire services coverage from the Melbourne CBD to the middle and outer suburbs; principally permanent and retained firefighters working from fire stations		Department of Sustainability and Environment is responsible for public lands
	Country Fire Authority provides urban and rural fire services coverage for all parts of Victoria other than the Melbourne Metropolitan Fire District and public lands; this includes outer metropolitan Melbourne and regional centres; incorporates some career firefighters who work from urban stations but is heavily reliant on volunteers in regional Victoria		

**Table 1: Agencies responsible for suppressing wildfires in Australia<sup>a</sup> (continued)**

Jurisdiction	Urban	Rural	Land management agency
	Primarily attend fire incidents within major urban centres	Primarily attend fire incidents in rural areas	Attend fire incidents in National Parks and state forests
Queensland	Queensland Fire and Rescue Service incorporates both urban and rural fire services (Queensland Rural Fire Service); is staffed by largely permanent and volunteer staff		Queensland Parks and Wildlife Service is responsible for managing parks and forests reserves
			Forestry Plantations Queensland is responsible for managing softwood and hardwood forest plantations from the former Department of Primary Industry – Forestry
			Department of Natural Resources and Water (Forest Products) subsequent to the South East Queensland Regional Forests Agreement (December 1999); is responsible for native forests set aside for logging
South Australia	Metropolitan Fire Service provides fire services to major urban centres in South Australia; permanent and retained firefighters working from fire stations		Department of Environment and Heritage is responsible for fires that are on, or threaten, national parks and other conservation areas in South Australia
	Country Fire Service – provides fire services in rural areas as well as in smaller urban centres in South Australia; draws on volunteer firefighters		Forests SA manages state-owned forest resources
Western Australia	Fire and Emergency Services Authority (FESA) provides and coordinates fire services across WA. The Operations Services division within FESA incorporates two components – the Fire and Rescue Service of Western Australia (career and volunteer) and bushfire brigades (volunteer). Career firefighters within the Fire and Rescue Service operate from stations in metropolitan Perth and some major regional centres. The remainder of the state outside national parks and forests is covered by the Volunteer Fire and Rescue Service and volunteer Emergency Service Units (ESU), which are an amalgamation of the FRS, Bush Fire Service (BFS) and State Emergency Service (SES)		Department of Environment and Conservation is responsible for fires that are on, or threaten, national parks and forests in WA
Tasmania	Tasmania Fire Service provides coverage for both urban and rural areas, excluding national parks and state forests; comprises both career and volunteer firefighters		Tasmania Parks and Wildlife Service is responsible for managing national parks and other conservation reserves
			Forestry Tasmania is responsible for managing the state forests
Northern Territory	NT Fire and Rescue Service comprises both urban stations and volunteer/community fire units; includes permanent staff, part-time auxiliaries and volunteers; principally operates in urban/community settlements	Bushfires Council responds only to grass fires and bushfires on land outside the Fire and Rescue Service response areas	
Australian Capital Territory	ACT Fire Brigade principally provides fire services in urban areas; comprises career firefighters	ACT Rural Fire Service is principally responsible for suppressing bush and grass fires within rural and remote areas of the ACT; incorporates one brigade staffed by ACT land management agencies	

a: excludes brigades employed by large-scale public and private land managers; port, mining and other infrastructure brigades; and land management departments and brigades operating under Australian Government jurisdiction (for example, airport and defence installations)

## Limitations to accuracy of fire information

There are fundamental limitations to the accuracy of fire information presented in this report. These derive from inherent limitations associated with the detection and investigation of fires, as well as inaccuracies that arise from the documentation of those events.

### Inherent limitations

Two factors where there are inherent limitations to the accuracy of the data relate to the cause of a fire and the time a fire occurred.

**Causal determination:** There are inherent uncertainties in the labelled cause of a fire. Determining the cause of a fire requires a high level of skill and knowledge. Specialist fire investigators take into account the available physical and circumstantial evidence, such as burn patterns, signs of the fire's path, weather conditions and the presence of human activity as well as potential factors that influence fire behaviour in outdoor environments. However, such investigations are resource intensive, requiring many hours of investigation by highly skilled investigators, and hence only a small proportion of all vegetation fires attended by fire agencies are subject to such investigations. The resources available for, or access to, such resources are likely variable across the different agencies. Moreover, the presence of a trained fire investigator does not necessarily guarantee that the cause of a fire will be established with absolute certainty, due to a lack of physical evidence.

Individual fire agencies typically maintain two distinct databases, one – the incidents database – documents all fire incidents the agency attended; the other – the investigations database – records detailed information about cause investigations. There are advantages and disadvantages to analysing data from these distinct data sources. Detailed investigations are likely to provide a greater accuracy regarding the cause and origin of a bushfire. However, although the cause of those fires may be known with a greater degree of accuracy, the subset of bushfires investigated is not necessarily representative of all bushfires; fires are only referred to investigation teams in specific instances and generally comprise a small proportion of all bushfires attended by fire agencies. Conversely, the incident data may provide a more accurate guide to total incidence of bushfire, but there is likely to be greater uncertainty as to the cause of the fire. There is likely to be a greater level of subjectivity in the assessment, with the accuracy of the assessment being subject to the experience of the officer.

This report is based entirely on the incidents data, which means that causes of these fires have been subjectively determined.

**Time fires occurred:** There are inherent difficulties in specifically pinpointing the time a fire occurred. The time documented may variably be recorded as the detection time or the alarm time. Technically, these do not necessarily equate to the same time, although in most instances the delays between the time a fire is detected, the time it is reported, and the time the fire station is notified are likely small, and of little consequence. However, such delays make identification of unique fire instances in large databases problematic.

The greatest uncertainty about the time of ignition relates to the time that transpired before the fire was detected, and the alarm was raised. In urban environments this is likely comparatively small, although may be affected by the time of day the fire occurred. However, in remote and rural areas fires may not be detected for hours or days depending on the remoteness, degree of through traffic and observable evidence of fire.



## Limitations of databases

The accuracy of the analysis was ultimately affected by the quality and structure of information available for analysis. Inherent limitations in the data and database structure, as well as the methods adopted in the analysis affected the accuracy of information provided in this report. These limitations manifest in several different ways, namely data quality, lack of uniformity in database structure, complexity in fire incidence data, presentation of spatial information, and unique instances.

**Data quality:** The accuracy of data recorded in the database appears highly variable both between and within individual agencies. This is most evident for spatial and temporal information. As an example this may be reflected in postcodes that do not exist, grid references that plot in the middle of the ocean, not valid times. An additional problem relates to inclusion of information that can only to be understood by local people. Given that such errors exist within the spatial and temporal information, it follows that there are probably errors within the causal data and other data fields. With one or two exceptions (see Methodology), the data, particularly as it pertains to the causal field, has been taken at face value and not altered.

**Lack of uniformity in database structure:** One of the greatest hurdles in undertaking a multiple agency analysis pertains to lack of uniformity within the database structure available for analysis. Fire agencies nationally are increasingly trying to introduce a consistent method and structure for recording fires. Most non-land management fire agencies use the classification scheme outlined in the Australasian Incidence Reporting System (AIRS). Although fire agencies are working towards generating a core set of data that are uniform across agencies, these were not necessarily reflected in the datasets available for analysis because:

- The AIRS was only introduced in 1997 and adoption of this system did not occur simultaneously or uniformly.
- Reporting within the AIRS system occurred, in some instances, over several years; and in some cases older data were retrospectively incorporated into the AIRS database structure.
- The types of variables available for analysis were not consistent across agencies even though agencies used a similar database structure.
- Agencies may record a number of variables, but not all variables were supplied with the dataset made available for analysis.
- Most land management agencies do not use either AIRS, as these database systems are not necessarily compatible with the types of information such agencies are interested in storing. This requires agencies to either maintain two distinct databases or undertake substantial development of the database. Given the comparatively small number of fires, it may be beyond the capacity of many land management agencies to do either.
- The time periods of fires available for analysis differed between agencies and across jurisdictions and therefore prevented a direct comparison between agencies.

Database structures are continually evolving, and the information used in this report does not necessarily accurately reflect the current situation practiced in individual agencies.

**Complexity in fire incidence data:** Fire reports typically encapsulate a complex array of information, about the fire scene and if possible, when, where, how and why the fire occurred. It is inherently difficult to capture all details of a fire in a database structure without it becoming excessively unwieldy. Many fires result from multiple factors, and database structure are generally ill equipped to deal with multiple parallel options. Additional complications arise, because there are varying levels of uncertainty associated with any one field. The AIRS codes that fire agencies use attempt to capture as much information as possible. Although this provides a powerful way of documenting detailed fire information, there is inherent flexibility within the database that potentially enables the same type of event to be coded in multiple ways.



The complexity of the database and the potential for different means of coding necessarily affects the level to which the information extracted from the database accurately reflects the fire event. Further inaccuracies may be introduced when one attempts to reduce this information into a simple causal classification scheme, as adopted in this study, as this will rarely encapsulate this complexity, without introducing ambiguous classifications.

**Presentation of spatial information:** It is useful when analysing large databases to group information so it can be more easily understood. This is true of spatial information.

In this report, the spatial distribution of fires is examined on several levels, at both regional level, and more localised levels. The principle structure for regions adopted in this analysis was loosely based on Australian Bureau of Statistics tourism regions (2005). The principal reason for adopting this structure relates to the fact that this type of statistical area is one with which most people are conceptually familiar. At a more localised level, the data may be analysed at using smaller ABS statistical areas or even a postcode or suburb level. The type of unit used and the way locations were assigned to specific regions varied between datasets, depending on the type of information available, the purpose of the analysis, and the type of information that individual agencies regarded as appropriate.

There are several important things to note about the spatial analysis of fires, namely:

- There are fundamental differences between the statistical regions, divisions, subdivisions, local areas used in this report and those defined by the Australian Bureau of Statistics. In this report, fires were assigned to a statistical location based on the suburb name or postcode. However, there is not a direct correspondence between a suburb and postcode and statistical areas. The latter often crosscut suburb and postcode boundaries.
- It is inherently difficult to classify fires attended by land management agencies into any systematic regional structure, as owing to their large size, they tend to crosscut, statistical areas and regions. Hence, in the analysis of data from land management agencies this analysis has tended to assign reserves to a particular region based on the region name or to adopt the regional structure provided by individual agencies. This necessarily means there is not a direct correlation between the regional structures for agencies within the same jurisdiction, despite the fact that they possess similar names.
- Although information may be presented at a regional or local level, caution is required before using this information to shape policy or procedures for arson reduction strategies. Patterns that manifest at a broader level are ultimately an amalgamation of many patterns that manifest at smaller levels, and it is necessary to investigate the specific causes of high numbers of fires within a local area before implementing arson reduction strategies, if those strategies are to prove successful. Vegetation fires have many different causes. Moreover, there are commonly many different reasons underlying higher incidents of deliberate fires, including different demographic structures or social issues. Hence, the trends presented in this report cannot be assumed to be representative at a local level, but rather provide a broad guide to the trends observed nationally and within individual jurisdictions and regions.

**Unique instances:** Individual bushfires analysed in this report do not necessarily represent a unique fire instance. More than one fire agency may attend the same incident if the fire is located next to a jurisdictional boundary. For example, land management agencies are responsible for managing all lands under their control (be they economical or ecological in nature). Hence, they may attend fires outside their jurisdiction, alongside urban or rural brigades in order to prevent that fire spreading into their tenure. The reverse is also the case. During large bushfire campaigns, resources are, to some extent, pooled in order to protect life and property. Hence, agencies are called upon or volunteer services to areas that lie outside their jurisdiction, be that within or external to a particular state or territory.

As individual agencies record deployment of resources to individual fires, those instances are duplicated across agencies. Such instances are unlikely to markedly affect the total fire frequencies calculated from

the accumulated data, but may grossly affect calculations based on total area burned, as attendance by multiple agencies is most likely for large fires, and large fires constitute the bulk of the total area burned. It is impossible to identify or remove all such instances, and no attempt has been made to do so, as not all agencies will document the same detection time or data, point of origin or even area burned in these fire instances. During large bushfire campaigns, when conflagrations result from the merging of many different fires with multiple points of origin and potential causes, there are potentially many different ways of documenting these fires.

It is also possible that some fires may be duplicated internally within some agencies. This may occur in instances where more than one brigade attended a particular fire. However, different agencies have different ways of documenting attendance of multiple brigades at a fire event. Whether this practice occurred and the proportion of instances where this may occur has not been evaluated. This means that a single fire may be represented more than once in the databases and therefore in the analyses in this report.

### **Implications for the data presented in this report**

Information about causal attributions is a 'best guess' and therefore the trends presented in this report are an approximation. It would be misleading and counterproductive to integrate the analyses for all agencies for each state or territory jurisdiction because each had different database structures and covered different timeframes; as well, duplication of large fires across agencies would affect analyses of the total area burned. Data from each agency are therefore presented independently, making use of similar underlying variables. In specific instances, a joint or side-by-side analysis has been undertaken to draw attention to the commonalities or to highlight differences.

Although attempts have been made to standardise the way in which fires are classified, this was not entirely possible. The onus is on the reader to familiarise themselves with the methodology used in individual instances (see Methodology); instances where this affects data interpretation are typically highlighted in the text.

It is important to take these points into consideration when interpreting the data.

### **Sources of background information**

AFAC 1997. *Australasian Incident Reporting System instruction manual*. Australian Fire Authorities Council. Mount Waverley, Victoria.

APC 2007. *Report on government services 2007, Part D: emergency management*. <http://www.pc.gov.au/gsp/reports/rogs/2007/emergencymanagement/index.html>

Esplin B, Gill AM & Enright N 2003. *Report of the Inquiry into the 2002–2003 Victorian Bushfires*. Melbourne: State Government of Victoria

Willis M 2004. *Bushfire arson: a review of the literature*. Research and public policy series no. 61. Canberra: Australian Institute of Criminology. <http://www.aic.gov.au/publications/rpp/61>

## Methodology

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## Sample set used

The number of agencies who have responsibility for attendance at, and suppression of fires, and the relationships between those agencies varies between state and territory jurisdictions, as outlined in Table 1. Data for vegetation fire incidents were sourced from 18 fire agencies, with representatives from each state and territory. The databases provided refer only to those fires recorded within the incidence database: they do not include information recorded in the separate fire investigations databases that may be maintained by individual agencies. Although the incidence data cover the overwhelming majority of vegetation fires in Australia, there were some omissions (Table 2).

## Database structure and period of data analysed

The majority of urban and rural services use the Australasian Fire Authorities Council's (AFAC) Australian Incident Reporting System (AIRS) to classify information about individual incidents including the location, timing, origin, form of heat of ignition, ignition factors etc of individual fire incidents. This database contains information about all incident types attended by individual agencies, from structural, vehicle, and vegetation fires through to hazardous chemical spillages, rescue and emergency medical service incidents, among other incident types. While most agencies currently use AIRS, at the time the analysis was undertaken, there were a number of inconsistencies across those databases that prevented integration of the fire data into a single database. These inconsistencies arise from several factors, as summarised below.

- The AIRS (I) database structure was only implemented in 1997. The time at which individual agencies implemented the system varied. For some, the system was fully operational from 1997 onwards, while for others, the implementation occurred at some later point or the system was implemented progressively over a number of years.
- In some instances the implementation of the AIRS database structure occurred midway during the period analysed and the data supplied were an amalgamation of data from two different database structures; either a physical combination of the two datasets – maintaining the classification systems used in each – or by retrospectively incorporating existing data into the AIRS database. The discordance between database structures affected the period available for analysis and/or the interpretation that could be made from the data.
- Data for agencies utilising the AIRS database structure were sourced via different pathways. Some AIRS databases were sourced from AFAC, while others were sourced from individual agencies (see Table 2). At the time of making data requests, not all agencies had submitted data into the centrally-held AFAC AIRS database or the data held within that database at the time were of inferior quality and so data were independently sourced from individual agencies.
- Many land management agencies do not report fire data within the AIRS database structure. To some extent the current structure of the AIRS database is incompatible with types of fire data recorded by land management agencies. Contribution to AIRS would require the maintenance of two independent databases.

The result is that the variables available for analysis, the timeframe for which data were available, and the way in which the data were structured or categorised varied across databases. These differences prevented agencies and jurisdiction using a single internally consistent database structure. Hence data from individual agencies within each jurisdiction were analysed and presented separately.

While this approach created a large report, it has the advantage that trends pertinent to individual agencies are not dominated by data from agencies or jurisdictions that record markedly higher numbers of fires. This approach has also highlighted fundamental deficiencies in the data, thereby providing a basis for future improvements.

Comparisons across agencies and jurisdictions are facilitated by the adoption of a simplified causal field, by analysing similar types of information in different databases and by drawing on specific common variables. Nevertheless, it was not possible to completely remove all inconsistencies, and it is essential that the reader be aware of the methodology that underlies the analysis and the implications that this has for the interpretation of the data. Many of these inconsistencies are highlighted in the text where they are relevant. Some relevant similarities and differences between datasets and the classification of data are summarised in Table 4 and are discussed in further detail below.

## Vegetation fires

As outlined in the introductory section, this analysis examined the incidence of vegetation fires generally as opposed to bushfires specifically. This reflects the fact that there are fundamental limitations within the databases themselves that often prevent such a distinction being made, the inherent difficulty of actually defining what constitutes a bushfire using quantitative and reproducible techniques, and philosophical arguments about the potentiality of an action; the actual reality (for example 1 ha burned on the road verge) does not necessarily reflect potential consequences of an action (that the fire could have easily spread in to the neighbouring national parks and burned 10,000 ha). The latter relates to the philosophical question that underpins attitudes toward bushfire arson. Even if we could distinguish between what may or may not have constituted a bushfire in the database, is it valid to distinguish between acts of arson just because one fire burned 1 ha but another burned 10,000 ha? The balance between small and large fires will vary substantially between agencies, depending on jurisdiction and responsibilities. For example, urban brigades are likely to attend a higher proportion of small fires than a land management agency whose jurisdiction covers national parks or state forests. The methods used to identify and classify vegetation fires used in this analysis are outlined below. The method used varied depending on whether the agency recorded information using AIRS codes, and the structure of information provided. Whether or not individual agencies used AIRS cases and specific information regarding the structure of that data are outlined in Table 4.

### AIRS databases: wildfires

All urban and most rural fire agencies record fire incidents using AIRS (Table 4). Although individual agencies may have attended a variety of incident types (particularly urban-based agencies), in most cases the data supplied by the agency included only vegetation fire data. Where data were supplied by AFAC (see Table 4), it was necessary to distinguish wildfires from other fire incident types.

For agencies utilising the AIRS database structure, the analysis was conducted on all fires defined as a wildfires – that is, all fires where the type of incident variable code (A23) was recorded as 160 to 179 (Table 3). Nevertheless, some modifications occurred in both the FESA and SAMFS analyses as illustrated below.

### FESA

FESA data between 1997–98 and 2001–02 derive from two distinct encoding formats. The 2000–01 and 2001–02 data were coded using AIRS, whereas the 1997–98 and 1998–99 data appeared to have been coded using an alternative scheme that was subsequently incorporated into the AIRS database. The transfer between these two systems occurred during the 1999–2000 season. Divergence in the format prevented a consistent interpretation of causal data over the five-year period.

The FESA analysis used 1997–98 and 2001–02 (denoted AFAC–FESA in the text) relied on using two subsets of data. In all cases including causal information (for example, non-deliberate or deliberate, causal category, heat of ignition etc), which was most cases, the analysis only examined fires from 2000–01 and 2001–02. However, some analyses of temporal trends used the five years of data as this yielded greater accuracy.

Where only the 2000–01 and 2001–02 data were used, vegetation fires were defined using the AIRS wildfire definition; that is, all instances where Type of Incident (A23) = 160 to 179. All analyses based on the 2000–01 to 2001–02 data are consistent with other AIRS databases (with the exception of the SAMFS). Owing to changes in database codes this definition could not be used for the 1997–98 and 2001–02 data, failing to identify vegetation fires from 1997–98, 1998–99 and part of 1999–2000. The analysis of the five-year data is based on an alternative definition of vegetation fires. In this instance a vegetation fire is all instances where the vegetation variable was recorded as 0 to 99.

There is not an exact correspondence between the AIRS wildfire category used for the 2000–01 and 2001–02 subset and the alternative wildfire classification devised for the 1997–98 to 2001–02 interval. However, there is a broad overlap. Of the 21,990 fires recorded for the 2000–01 and 2001–02 seasons, 13,769 cases overlapped. There were 177 cases where fires were classified as wildfires based on the ‘type of incident’, but were not recognised using the alternative wildfire definition and 10 cases where fires were classified as bushfire using the alternative wildfire definition but not considered wildfires based on the ‘type of incident’.

The FESA analysis also draws on summary fire data sourced independently from FESA for the 2000–01 to 2006–07 interval. All fires within this dataset qualify as wildfires according to the AIRS definition.

### South Australia Metropolitan Fire Service (SAMFS)

Although in an AIRS format, the analysis of SAMFS data differed from that used elsewhere in several fundamental ways:

- The data, particularly prior to 2001–02, were compromised by ongoing industrial action. Intervals affected by industrial action included:
  - 1997–98: 15–26 September 1997 and 24 February – 20 March 1998
  - 1998–99: 15 December 1998 – 28 April 1999 and 12–28 May 1999
  - 1999–2000: 25 January – 30 June 2000
  - 2000–01: 1–2 July 2000 and 21–22 February 2001

Variations in both the length and timing of the industrial disputes varied, and total fire numbers cannot be used to evaluate genuine temporal variations in bushfire numbers, except for the interval from 1997–98 to 2000–01.

The SAMFS analysis is only based on vegetation fires where the ‘activity in the area’ was designated ‘malicious activity’ (AIRS code 81), as this was the only data supplied. Consequently, it is impossible to accurately ascertain the significance of deliberate fires relative to other causes. Some broad estimates are made within the text using the combined ‘grass’ and wildfire data provided by the SAMFS in their annual report (available online at <http://www.samfs.sa.gov.au/>) using the data supplied for rubbish and grass fires associated with malicious activity. Using this combined information it is estimated that 17 to 31 percent of all vegetation and rubbish fires attended by the SAMFS were recorded as having ‘malicious activity in the area’ in the interval from 1997–98 to 2005–06. For the seasons not impacted by industrial action (2002–03 to 2005–06) the value was 17 to 20 percent. It is emphasized that this information is only an estimate and therefore potentially subject to error.

## Non-AIRS databases

In most instances the data supplied by individual agencies that, at the time of making the data requests were not using AIRS, only included vegetation fires. All land management agencies fell within this category. However, in some cases, individual land management agencies included a small number of fires that were variously categorized as rubbish tip, rubbish fires, waste disposal etc. These may have genuinely been burning rubbish or alternatively a vegetation fire that resulted from the escape of a rubbish fire at a rubbish tip, an incinerator in the backyard etc. – the available information is unclear. Given the lack of any corroborating evidence these ‘rubbish fires’ were included within the vegetation fire analysis conducted in this report, with the number of cases involving rubbish fires being documented in Table 4. In fact, all cases were used for agencies not using the AIRS database structure with the following exceptions:

**Forestry Plantations Queensland:** Analysis was based on fire instances with a unique ‘fire id.’ and ‘fire no.’, thereby removing duplicates that existed within the database.

**Queensland Parks and Wildlife Service:** The variable ‘report id’ identified unique bushfire instances in the QDPWS database. These were 86 cases of duplicated records that were removed prior to analysis.

**South Australia Country Fire Service:** SACFS fires were classified into three types of fires using the ‘fire type’ variable provided:

- *vegetation fire*: forest fires, grass or stubble fire, scrub and grass fire, tree fire
- *rural fire*: grain/crop fire, haystack
- *rubbish fire*: dump, rubbish bin, rubbish fire.

The SACFS analysis was restricted to those fires that fell within the vegetation fire category above.

**South Australia Department of Environment and Heritage:** In the dataset supplied, the variable ‘fire number’ did not discreetly identify fires. In numerous cases, the fire number was repeated and in some cases identified fires with the same cause and on the same date. This mainly occurred when the cause was lightning, suggesting that these duplications may indicate multiple lightning strikes. In some cases, fire number also identified multiple other fires that may have occurred on different dates and with different causes. For analysis purposes, it was considered that each entry in this dataset was a separate fire, although it is acknowledged that the recording of multiple lightning strikes as separate fires may tend to increase the proportion of fires assigned to natural causes, as compared to other datasets where this did not occur.

**Table 2: Agencies providing data to this study**

Agency	Date range	Comment
NSW Fire Brigades	1997–98 to 2001–02	
NSW Rural Fire Service	1999–2000 to 2003–04	
NSW National Parks and Wildlife Service	1995–96 to 2003–04	
Forests NSW	1997–98 to 1/12/2003	
Metropolitan Fire and Emergency Services Board	1997–98 to 2001–02	
Victorian Country Fire Authority	1999–2000 to 2003–04	
Victoria Department of Sustainability and Environment	1993–94 to 2003–04 (some older data used)	
Qld Fire and Rescue Service	1997–98 to 2001–02	Data does not provide coverage of fires attended by the Rural Fire Services in regional Queensland, as reporting of fires by volunteers in that jurisdiction is voluntary. The Rural Fire Service provides fire services for 93 percent of the total area of the state, outside of major urban centres
Qld Parks and Wildlife Service	1999–2000 to 2003–04	Data is incomplete but strongly impacted by numerous and substantial tenure changes since the South East Forest Agreement (changes commencing 1999–2000)
Forestry Plantations Queensland	1975–76 to October 2004	Data subsequent to 1999–2000 subject to changes in land tenure (as above)
Qld Department of Natural Resources and Water (Forest Products)	No data	
SA Metropolitan Fire Service	1997–98 to 2005–06 (1998–99 to 2000–01 variably incomplete due to industrial action)	Data only includes a subset of wildfires (fires where the activity in the area was reported as malicious); analysis draws on both rubbish and vegetation fires
SA Country Fire Service	1997–98 to 2003–04	
SA Department of Environment and Heritage	1975–76 to 2003–04 (two databases combined)	
Forests SA	No data	
WA – Fire and Emergency Services Authority	1997–98 to 2001–02 (but principally 2000–01 and 2001–02)	This dataset is incomplete: most complete coverage appears to be provided for metropolitan Perth and major regional centres
WA – Department of Environment and Conservation	1999–2000 to 2002–03	
Tasmanian Fire Service	July 1999 – November 2004	
Forestry Tasmania	No data	
Tas. Parks and Wildlife Service conservation reserves	No data	
NT Fire and Rescue Service	1999–2000 to 2003–04	
NT Bushfires Council	No data	
ACT Fire Brigade	No data	
ACT Rural Fire Service	1975–76 to 2002–03 Part data (see comments)	Analysis conducted on a small subset of the wildfires acquired from ACT Parks Conservation and Lands (Environment ACT); included data initially derived from the Bushfire Council (ACT Rural Fires Service), as well as from Canberra Urban Parks and ACT Parks and Conservation (both now within Environment ACT); dataset represents only a subset of fires attended by ACT Rural Fire Service



**Table 3: Type of incident codes for vegetation fires in the Australasian Incident Reporting System**

<b>AIRS code</b>	<b>Type of incident (A23): Wildfire</b>
161	Forest or wood fire (more than 1 ha)
162	Scrub or bush and grass mixture fire
163	Grass fire
164	Cultivated grain or crop fire
165	Cultivated orchard or vineyard fire
166	Cultivated trees or nursery stock fire
169	Vegetation or other outside fire not classified above
160	Vegetation or other outside fire; insufficient information to classify further
171	Small vegetation fire less than one hectare
179	Small vegetation fire not classified above
170	Small vegetation fire; insufficient information to classify further

Table 4: Summary of databases and variables used in analysis – part one

		Period	AIRS codes	Data provided by	Vegetation fire definition	AIRS-Form of heat of ignition	Cause based on variable	Child; child's age
<b>NSW</b>	NSWFB	1997–98 to 2001–02	Yes	AFAC	AIRS wildfire	Yes	Ignition factor	Yes, Yes
	NSWRFS	1999–00 to 2003–04	Yes	NSW RFS	AIRS wildfire	No	Ignition factor	Yes, Yes
	NSW NPWS	1995–96 to 2003–04	No	NSW NPWS	Vegetation fires (includes 5 fires at rubbish tips)		Cause	No
	SFNSW	1997–98 to 1–12–2003	No	SFNSW	Vegetation fires (includes 12 fires relating to rubbish disposal)		Cause	No
<b>Vic</b>	MFB	1997–98 to 2001–02	Yes	AFAC	AIRS wildfire	Yes	Ignition factor	Yes, Yes
	CFA	1999–00 to 2003–04	Yes	CFA	AIRS wildfire	No	Ignition factor	Yes, Yes
	DSE	1993–94 to 2003–04 <sup>a</sup>	No	DSE	Vegetation fires (includes 85 domestic rubbish fires; 31 industrial rubbish fires)		Cause	Yes, No
<b>Qld</b>	QFRS	1997–98 to 2001–02	Yes	AFAC	AIRS wildfire	Yes	Ignition factor	Yes, Yes
	FPQ	1975–76 to October 2004	No	FPQ	Vegetation fires (unique records only)		Cause	No
	QPWS	1999–2000 to 2003–04	No	Qld PWS	Only wildfires (unique records only)	No	Cause	No
<b>SA</b>	SAMFS	1997–98 to 2005–06 <sup>b</sup>	Yes	SAMFS	AIRS wildfire (only fires where activity in the area was categorised as malicious)	Yes	Activity in the area='Malicious'	Yes, Yes (incomplete)
	SACFS	1997–98 to 2003–04	Yes & No <sup>e</sup>	SACFS	Vegetation fires	No	Additional factor & Fire cause	No
	SADEH	1975–76 to 2003–04 <sup>c</sup>	No	SADEH	Vegetation fires	No	Cause; comment	No
<b>WA</b>	FESA	1997–98 to 2001–02 <sup>d</sup>	Yes	AFAC	AIRS wildfire	Yes	Ignition factor	Yes, Yes
	WADEC	1999–2000 to 2002–03	No	DEC	Vegetation fires		Fire cause description	No
<b>Tas</b>	TFS	July 1999 to November 2004	Yes	TFS	AIRS wildfire	No	Ignition factor	Yes, Yes
<b>NT</b>	NTFRS	1999–00 to 2003–04	Yes	NTFRS	AIRS wildfire	Yes	Ignition factor	Yes, Yes
<b>ACT</b>	ACT PCL	1975–76 to 2002–03	No	ACT PCL	Vegetation fires; does not include urban data	No	Ignition factor (not AIRS)	No

**Table 4: Summary of databases and variables used in analysis – part two**

	<b>Smoking related fires defined using variable</b>	<b>Smoking related fires; cause</b>	<b>Classification of natural fires</b>	<b>Date variable</b>	<b>Time: (Y/N); variable</b>	
<b>NSW</b>	NSWFB	Form of heat of ignition division = 'Heat from smokers' materials'	82% accidental; 6% incendiary; 7% suspicious; 4% unknown	30.1% lightning; 27.3% high wind; 41.5% natural condition event NC/IO; 0.9% high water	Alarm datetime	Yes; alarm datetime
	NSWRFS	Ignition Factor = 'Abandoned, discarded material' (Code 310)	100% accidental	73.8% lightning; 18.2% high wind; 8.0% natural condition event NC/IO; 0.1% high water	Incident datetime	Yes; incident datetime
	NSW NPWS	cause = 'Smoking'	100% other	100% lightning	Ignition date	No
	SFNSW	cause = 'Pipe, cigarette, match'	100% other	100% lightning	Start date	Yes; weather, time
<b>Vic</b>	MFB	Form of heat of ignition division = 'Heat from smokers' materials'	90% accidental; 0.3% incendiary; 7% suspicious; 2% unknown	11.8% lightning; 17.6% high wind; 67.2% natural condition event NC/IO; 3.3% high water	Alarm datetime	Yes; alarm datetime
	CFA	Ignition Factor = 'Abandoned, discarded material' (Code310)	100% accidental	46.2% lightning; 41.6% high wind; 12.0% natural condition event NC/IO; 0.2% high water	Incident datetime	Yes; incident datetime
	DSE	Cause = 'Pipe, cigarette, match'	100% accidental	100% Lightning	Fire started	No
<b>Qld</b>	QFRS	Form of heat of ignition division = 'Heat from smokers' materials'	75% accidental; 3% incendiary; 9% suspicious; 9% unknown	21.3% lightning; 52.6% high wind; 25.6% natural condition event NC/IO; 0.4% high water	Alarm datetime	Yes; alarm datetime
	FPQ	No data		100% lightning	Detected date	Yes; detected time
	QPWS	No data		100% lightning	Fire date	No
<b>SA</b>	SAMFS	Form of heat of ignition division = 'Heat from smokers' materials'	Not applicable	Not applicable	Incident date	Yes; alarm time
	SACFS	Cause = 'Matches, smoking devices, candles, lanterns' or 'Heat from smokers materials'	16.8% accidental; 30.5% incendiary; 5.3% suspicious; 46% other	56.9% lightning; 29.3% heat from natural source	Alarm date	Yes; alarm time
	SADEH			100% lightning	Fire started date	No
<b>WA</b>	FESA	Form of heat of ignition division = 'Heat from smokers' materials'	40% accidental; 3% incendiary; 26% suspicious; 29% unknown	9.7% lightning; 20.0% high wind; 69.3% natural condition event NC/IO; 0.9% high water	Alarm datetime	Yes; alarm datetime
	WADEC	No data		100% lightning	Detection date	Yes; detection time
<b>Tas</b>	TFS	Ignition Factor = 'Abandoned, discarded material' (Code 310)	100% accidental	23.4% lightning; 56.8% high wind; 19.4% natural condition event NC/IO; 0.5% high water	Incident datetime	Yes; incident datetime
<b>NT</b>	NTFRS	Form of heat of ignition division = 'Heat from smokers' materials'	56% accidental; 1.7% incendiary; 29% suspicious; 12% unknown	40.5% lightning; 33.3% high wind; 26.2% natural condition event NC/IO	Alarm date	Yes; alarm time
<b>ACT</b>	ACT PCL	No data		100% lightning	Fire date	No

**Table 4: Summary of databases and variables used in analysis – part three**

		Location information	Post code	Tourism Region	Region based on variable	Region classification based on variable	Fire restrictions	Fire danger index	Area burned	Vegetation	Tenure
<b>NSW</b>	NSWFB	Statistical local area; postcode	Yes	Yes	Postcode	Postcode	No	No	No	No	No
	NSWRFS	Incident location; RFS-FCC	No	Yes	Incident location (suburb); RFS FCC	Incident location (suburb); RFS FCC	No	No	Yes	Yes	No
	NSW NPWS	Region; location name; LGA; electorate; long/lat; reserve	No	No	Reserve name	Reserve name (derived from 'Reserve')	No	No	Yes	No	Yes
	SFNSW	Site id; fire name; location	No	No	Site location (modified)	Site location (modified)	No	Insufficient information	Yes	No	Yes
<b>Vic</b>	MFB	Statistical local area; postcode	Yes	Yes	Postcode	Postcode	Yes	Yes	Yes	Yes (but not used)	No
	CFA	Suburb; AMG coordinates	No	Yes	Suburb	Suburb	Yes	No	Yes	Yes	No
	DSE	Fire region; fire district; latitude-longitude	No	No	Fire region	Fire region	No	No	Yes	Yes (but not used)	Yes
<b>Qld</b>	QFRS	Statistical local area; postcode	Yes	Yes	Postcode	Postcode	Yes	Yes	Yes	Yes (but not used)	No
	FPQ	District; logging area	No	No	District	District	No	Yes	Yes	Yes	Yes
	QPWS	Georefs; reserve name	No	Yes	Reserve name	Reserve name	No	No	Yes	No	Yes
<b>SA</b>	SAMFS	Station; incident suburb	No	Yes	Incident suburb	Incident suburb	No	No	No	No	No
	SACFS	Location	No	No	Region	Location	No	No	Yes	Yes	No
	SA DEH	District; region; reserve	No	Yes	Reserve (suburb)	Region	No	No	Yes	No	No
<b>WA</b>	FESA	Postcode	Yes	Yes	Postcode	Postcode	Yes	Yes	Yes	Yes (but not used)	No
	WADEC	Region; division; fire name; AMG coordinates	No	No	Region	Region	No	Yes (numerical)	Yes	Yes	Yes
<b>Tas</b>	TFS	Suburb; postcode	Yes	Yes	Suburb	Suburb	No	No	Yes	Yes	No
<b>NT</b>	NTFRS	Suburb	No	Yes	Suburb	Suburb	No	No	Yes	Yes	No
<b>ACT</b>	ACT PCL	Reserve; district; ACT PCL district	No	No	District	District	No	No	Yes	No	No

a: but includes comparisons with older data from Davies 1997 b: 1998–99 to 2000–01 variably incomplete due to industrial action c: two databases combined d: but principally 2000–01 and 2001–02 e: change in database structure mid way through the reporting interval f: but incomplete g: only available for 1975 to 2001 h: also included information about the drought index; humidity; temperate; wind strength; wind direction; average fuel weigh i: NC not classified; I/O, = insufficient information to classify further

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## Cause

There was at least one variable relating to the cause of each vegetation fire provided for each database analysed. The level of detail varied markedly between AIRS and non-AIRS databases.

The complexity of the AIRS database, and discrepancies between the causal information provided by agencies – both between AIRS and non-AIRS databases and across different AIRS database – meant that it was necessary to develop a causal classification scheme that summarised the most pertinent aspects of the principal causes of vegetation fires across Australia. Two levels of cause were generated – the cause category (see below), and deliberate versus non-deliberate.

More specific aspects of the cause of fires have also been analysed, including summaries of categories within the ignition factor and/or form of heat of ignition variables in the case of AIRS databases, or specific causal categories provided in non-AIRS databases. The methodology behind these simplifications and the specific impact that this has on some variables are outlined in detail below.

### Cause category

The cause category incorporates seven classes of cause, including accidental, incendiary, suspicious, natural, reignition/exposure/prescribed burn, other and unknown. Although this cause classification was generated for all databases, there are some differences between AIRS and non-AIRS databases, and also between non-AIRS databases for which there were fundamental differences in the structure of the data provided. The method used to define the cause category for individual databases are outlined below, together some of the implications of using this classification system.

#### AIRS databases

The cause category for AIRS databases was defined using the ‘ignition factor’ variable, as follows:

**Accidental:** includes AIRS codes 300 to 390 (relating to ‘misuse of heat of ignition’), 400 to 490 (‘misuse of material ignited’), 500 to 590 (‘mechanical failure, malfunction’), 600 to 690 (‘design, construction and installation deficiencies’), 700 to 790 (‘operational deficiencies’), and 960.

**Incendiary:** AIRS codes 100 to 190; incendiary fires that occurred during and outside civil disturbances.

**Suspicious:** AIRS codes 200 to 290; suspicious fires that occurred during and outside civil disturbances.

**Natural:** AIRS codes 800 to 890; includes any natural condition or event – high wind, earthquake, high water including floods, lightning, or any other natural condition not classified, or where there was insufficient information to classify further.

**Reignition/exposure:** AIRS codes 920 to 935; includes rekindling from a previous fire, cases where a separate removed/detached/adjoining/protected exposure catches alight. Note that in contrast to that used for some other databases land management databases, for agencies using the AIRS classification, this category does not include data from prescribed burns.

**Other:** AIRS codes 900 to 910, and 990; this includes fires started by animals, as well as any cases the cause of the fire is not classified above, or there was insufficient information to classify further.

**Unknown:** includes instance where ignition factor was listed as not applicable, undetermined, not reported, and there were missing values.

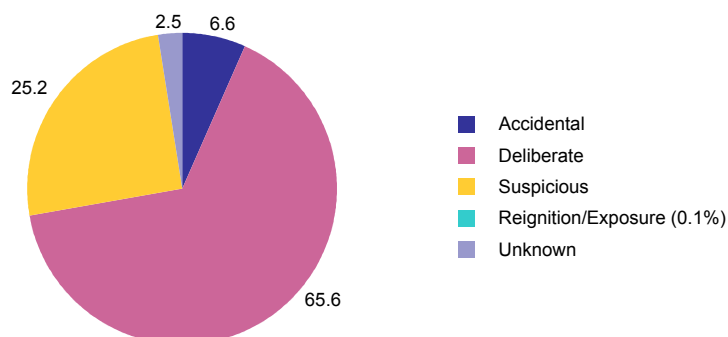
The correlation between specific ignition factor codes and the causal category is outlined in Table 5. The only exception to the classification scheme adopted above was for the South Australia Metropolitan Fire Service.

As noted previously, the only information available for the SAMFS analysis was vegetation fires for which the ‘activity in the area’ was designated ‘malicious’. Although a large overlap obviously exists, not all fires classified as associated with malicious activity were classified as incendiary or suspicious within the ignition factor variable. Notably, only 65.6 percent of wildfires (AIRS definition) where there was malicious activity in the area were classified as incendiary based on the ignition factor code (Figure 1). A further 25.2 percent were suspicious. Collectively, 90.8 percent of SAMFS wildfires associated with malicious activity would have been classified as deliberate according to the causal classification scheme used in this report.

A similar analysis conducted on fires attended by the CFA revealed that only 90 percent of those vegetation fires associated with malicious activity were labelled incendiary or suspicious within the ignition factor variable. It is also evident from the CFA data that there are instances of fires labelled incendiary or suspicious within the ignition factor code, but the activity in the area was not labelled malicious. The SAMFS and CFA data highlight that some mismatch is likely to exist between the information provided by the ignition factor and activity in the area variables. The implication is that neither in isolation is likely to detect all deliberate or malicious fires.

In an attempt to maximise the number of fires available for analysis, and given the considerable discrepancies that already existed between the analyses of the SAMFS and other databases, the SAMFS analysis incorporated all vegetation fires associated with malicious activity, even though not all such fires would have strictly been classified as deliberate according to guidelines used for other AIRS databases.

**Figure 1: Causal classification of SAMFS wildfires associated with malicious activity**



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

**Table 5: Ignition factor codes defined in the AIRS database**

AIRS ignition factor codes		Cause category
<b>Incendiary, legal decision or physical evidence indicates that the fire was deliberate lit</b>		
110	Incendiary, not during civil disturbance	Incendiary
120	Incendiary, during civil disturbance	Incendiary
<b>Suspicious circumstances indicate the possibility that the fire may have been deliberately lit, separate, unrelated fires were found, or there were suspicious circumstances and no accidental or natural ignition factor could be found</b>		
210	Suspicious, not during civil disturbance	Suspicious
220	Suspicious, during civil disturbance	Suspicious
<b>Misuse of heat of ignition</b>		
310	Abandoned, discarded material. Included are discarded cigarettes and cigars	Accidental
320	Thawing	Accidental
330	Falling asleep	Accidental
340	Inadequate control of open fires. Included is smoking out animals and insects	Accidental
361	Children: child playing 0–5 years old	Accidental
362	Children: child playing 6–12 years old	Accidental
363	Children: child playing 13–16 years old	Accidental
371	Unconscious	Accidental
372	Mental impairment	Accidental
373	Physical impairment	Accidental
374	Affected by drugs	Accidental
375	Intoxication by alcohol	Accidental
370	Unconscious, mental or physical impairment, drug, alcohol stupor, insufficient information available to classify further	Accidental
390	Misuse of heat of ignition not classified above	Accidental
300	Misuse of heat of ignition; insufficient information to classify further	Accidental
<b>Misuse of material ignited</b>		
410	Fuel spilled, released accidentally	Accidental
420	Improper fuelling technique	Accidental
430	Flammable liquid used to kindle fire	Accidental
440	Washing part, cleaning, refinishing, painting	Accidental
450	Improper container	Accidental
460	Combustible too close to heat	Accidental
481	Children: child playing 0–5 years old	Accidental
482	Children: child playing 6–12 years old	Accidental
483	Children: child playing 13–16 years old	Accidental
490	Misuse of material ignited not classified above	Accidental
400	Misuse of material ignited; insufficient information to classify further	Accidental
<b>Mechanical failure, malfunction</b>		
510	Part failure, leak, break	Accidental
520	Automatic control failure. Included are delayed ignitions of oil burners	Accidental
530	Manual control failure	Accidental
540	Short-circuit, ground fault	Accidental
550	Other electrical failure	Accidental
560	Lack of maintenance, worn out	Accidental
570	Backfire. Included are ignitions outside of the combustion chamber. Excluded are fires originating as a result of hot catalytic converters (610)	Accidental
590	Mechanical failure, malfunction not classified above	Accidental
500	Mechanical failure, malfunction; insufficient information available to classify further.	Accidental

**Table 5: Ignition factor codes defined in the AIRS database (continued)**

AIRS ignition factor codes		Cause category
<b>Design, construction, installation deficiency</b>		
610	Design deficiency	Accidental
620	Construction deficiency	Accidental
630	Installed too close to combustibles	Accidental
640	Other installation deficiency	Accidental
650	Property too close to other heat source	Accidental
690	Design, construction, installation deficiency not classified above	Accidental
600	Design, construction, installation deficiency; insufficient information available to classify further	Accidental
<b>Operational deficiency</b>		
710	Collision, overturn, knock over	Accidental
720	Accidentally turned on, not turned off	Accidental
730	Unattended	Accidental
740	Overloaded	Accidental
750	Spontaneous heating	Accidental
760	Improper start-up, shut-down procedures	Accidental
770	Failure to clean. Included is a fouled flue	Accidental
790	Operational deficiency not classified above	Accidental
700	Operational deficiency; insufficient information to classify further	Accidental
<b>Natural condition/event</b>		
810	High wind	Natural
820	Earthquake	Natural
830	High water, including floods	Natural
840	Lightning	Natural
890	Natural condition/event not classified above	Natural
800	Natural condition/event; insufficient information available to classify further	Natural
<b>Other ignition factor</b>		
910	Animal	Other
920	Re-kindled from a previous fire	Reignition/Exposure
931	Separate, removed exposure	Reignition/Exposure
932	Separate, detached exposure	Reignition/Exposure
93 <sup>3</sup>	Separate, adjoining exposure	Reignition/Exposure
934	Attached, protected exposure	Reignition/Exposure
935	Attached, unprotected exposure	Reignition/Exposure
960	Vehicle	Other
990	Other ignition factor not classified above	Other
900	Other ignition factor; insufficient information available to classify further	Other
<b>Undetermined or not reported</b>		
008	Ignition factor not applicable	Unknown
000	Ignition factor undetermined	Unknown
Blank	Ignition factor not reported	Unknown

## Non-AIRS databases

Causal classification of fires for agencies that did not using AIRS proceeded along very different lines, and varied between agencies depending on the exact structure of the incidence data provided. The name of the cause variable provided that was used to define the cause category variable is outlined for each agency in Table 4. The relationship between the categories within the cause variable provided and the cause category generated there from are outlined for individual agencies in Tables 6 to 16

**New South Wales State Forests:** The correlations between the causal information provided and the cause category are summarised in Table 6.



**Table 6: Cause provided and cause category used for New South Wales State Forests data**

Code	Cause (provided)	Cause category (generated)
0	. (Missing)	Unknown
1	Lightning	Natural
2	Machinery	Accidental
3	Pipe, cigarette, match	Other
4	Cooking/heating/camp fire	Accidental
5	Train	Accidental
6	SF Prescribed burning	Prescribed burn
7	NPWS Prescribed burning	Prescribed burn
8	DBFS Prescribed burning	Prescribed burn
10	State Rail Authority burning	Prescribed burn
11	Incendiarism	Incendiary
12	Other rural burning	Other
13	Electricity transmission	Accidental
14	Waste disposal industrial/domestic	Accidental
15	Burning by other public authority	Prescribed burn
99	Other, please specify	Other

**NSW National Parks and Wildlife Service:** The correlations between the causal information provided and the cause category are summarised in Table 7.

**Table 7: Cause provided and cause category used for New South Wales National Parks and Wildlife Service data**

Code (provided)	NSW NPWS cause (provided)	Summarised cause (generated)	Cause category (generated)
BOL	Burning off – legal	Burning off – legal	Accidental
CC	Camp/cooking	Domestic/recreational	Accidental
PL	Power line	Facilities	Accidental
FE	Farm equipment	Industry/farming	Accidental
BOL/RIG	Burning off – legal (reignition)	Reignition	Accidental
A	Arson	Arson/suspicious	Incendiary
A/BOL	Arson/burning off – legal	Arson/suspicious	Incendiary
A-MV	Arson – motor vehicle	Arson – motor vehicle	Incendiary
BOI	Burning off – illegal	Burning off – illegal	Incendiary
BOI (A)	Burning off – illegal (arson)	Burning off – illegal	Incendiary
AS	Arson suspected	Arson/suspicious	Suspicious
AS-MV	Arson suspected – motor vehicle	Arson – motor vehicle	Suspicious
L	Lightning	Lightning	Natural
L?	Suspected lightning	Lightning	Natural
RIG	Re-ignition	Re-ignition	Re-ignition
D	Domestic	Domestic/recreational	Other
RT	Rubbish tip	Facilities	Other
T	Trains	Facilities	Other
I	Industrial	Industry/farming	Other
SAW	Sawmill	Industry/farming	Other
MV	Motor vehicle	Motor vehicle	Other
MIS	Miscellaneous (known)	Other	Other
MIS (spot over)	Miscellaneous (spot fire)	Other	Other
MIS (spot fire)	Miscellaneous (spot fire)	Other	Other
MIS (Smouldering logs/trees)	Re-ignition	Re-ignition	Re-ignition
SMO	Smoking	Smoking	Other
HR	Unknown	Unknown	Other
MIS (FLA)	Miscellaneous (unknown)	Unknown	Other
??????	Unknown	Unknown	Unknown
U	Unknown	Unknown	Unknown

**Victorian Department of Sustainability and the Environment (DSE):** The DSE analysis was undertaken in a manner that attempted to be consistent with the analysis used elsewhere in this report, but to maintain the same causal categories adopted by Davies (1997) in his report on DSE data for the period from 1976–77 to 1995–96 (denoted as FMB Cause in Table 8), to enable consistent evaluation of long-term changes in fire cause for that agency. The analysis of the DSE data presented in this study concentrated on the 1993–94 to 2003–04 period, but where possible, data or trends from Davies (1997) are included to provide a greater overview of long-term variations of bushfire activity on or near Victorian public lands. The relationship between the cause provided, FMB cause and cause category is outlined in Table 8.

**Table 8: Cause provided and cause category used for Victorian Department of Sustainability and the Environment data**

Cause (provided)	FMB cause (generated)	Cause category (generated)
Burning vehicle, machine	Deliberate	Incendiary
Deliberate lighting (malicious)	Deliberate	Incendiary
Burning off (railway)	Escapes – burning	Accidental
Burning off (stubble, grass, scrub)	Escapes – burning	Accidental
Burning off (windrow, heap)	Escapes – burning	Accidental
Relight-burning off	Escapes – burning	Accidental
Waste disposal, domestic	Escapes – burning	Accidental
Waste disposal, industrial, sawmill, tip	Escapes – burning	Accidental
Campfire, barbeque	Escapes – campfire, BBQ	Accidental
Exhaust, chainsaw	Machines	Accidental
Exhaust, other	Machines	Accidental
Snigging, hauling	Machines	Accidental
Pipe, cigarette, match	Pipe, cigarette, match	Accidental
Power transmission	Public utilities	Accidental
Train	Public utilities	Accidental
Lightning	Lightning	Natural
Burning building	Miscellaneous	Other
Burning house, stove, flue	Miscellaneous	Other
Fireworks	Miscellaneous	Other
Other	Miscellaneous	Other
Relight – wildfire	Miscellaneous	Other
Burning off (departmental prescribed)	Departmental burns	Re-ignition/prescribed burn
Relight-prescribed fire	Departmental burns	Re-ignition/prescribed burn
Null	Unspecified	Unknown
Unknown	Unspecified	Unknown

**Forestry Plantations Queensland:** The correlations between the causal information provided and the cause category are summarised in Table 9.

**Table 9: Cause provided and cause category used for Forestry Plantations Queensland data**

FPQ cause	Causal category
Accidental: all reasonable care taken, unlucky accident	Accidental
Accidental: carelessness	Accidental
Accidental: gross negligence	Accidental
Accidental: reasonably foreseeable; event due to stupidity or incompetence	Accidental
Intentional: illegal attempts at hazard reduction burning	Incendiary
Intentional: malicious incendiarism	Incendiary
Intentional: mischief making	Incendiary
Intentional: torching abandoned/stolen vehicle	Incendiary
Intentional: unknown but suspected	Suspicious
Accidental: act of God (e.g. lightning)	Natural
Accidental: unknown, not suspected	Unknown

**Queensland Parks and Wildlife Service:** The classification of QPWS fires was based on the QPWS cause variable provided, although for fires classified as resulting from arson, both the cause and cause certainty variable were used. The methodology used for the QPWS analysis is summarised in Table 10.

**Table 10: Causal category generated and the QPWS ‘Cause’ and ‘Cause certainty’ variables**

Causal category	QPWS cause	Cause certainty
Accidental	Escaped other burn	Known and suspected
Accidental	Escaped other burn	Known and suspected
Accidental	Machinery/equipment	Known and suspected
Incendiary	Arson	Known
Suspicious	Arson	Suspected
Natural	Lightning	Known and suspected
Re-ignition/PB	Escaped QPWS burn	Known and suspected
Re-ignition/PB	Re-ignition	Known and suspected
Other	Other	Known and suspected

**South Australia Country Fire Service:** The SACFS dataset incorporated two variables regarding the cause of fires, namely, the ‘cause’ and ‘additional factors’ variables. Fires were classified into the seven-tiered causal category used elsewhere based on the ‘additional factor category’ as outlined in Table 11. However, in many instances, discrepancies existed between the ‘cause’ and ‘additional factors’ variables. Attempts were made to correct these anomalies. For example, based on the additional factor variable the majority of fires started by lightning strikes were classified as accidental. These were subsequently recoded as a ‘Natural condition or event’. There were 1,287 cases of where the cause was listed as ‘unknown – suspected human’ but in the additional factors, they were classified as ‘malicious’. These fires were categorised suspicious.

There are potentially a number of other anomalous cases where no attempt was made to correct or alter the data. For example, fires started by a bird scarer were labelled ‘malicious’ and ‘misadventure’ for two and one cases respectively. There were several cases where no cause was provided but the additional factor was listed as accidental, children, malicious and other factor. For some categories, such as burn offs the situation was complex. Within the burning off category there are three subdivisions, ‘Burning and burn offs – with permit’, ‘Burning and burn offs – without permit or out of fire danger season’ and ‘Burning off – permit unknown’. Clearly, some burn offs are the result of accidents, some burns are conducted without a permit during the bushfire danger period and may be illegal. There were 24 instances where ‘Burning and burn offs – with permit’ was considered malicious and 12 cases were it was attributed to misadventure. That burning off with a permit was considered malicious is not unrealistic if burning was undertaken without due regard for the possibility of escape even though a permit had been obtained. There was one case where a harvesting related fire was viewed as misadventure, another where static electricity build-up was determined to be malicious. Again, these attributions may correct in light of the particular circumstances associated with each fire. Other cases where some confusion arises in the interpretation of fires are those pertaining to the re-kindling of a fire. There were two, six, and 12 cases where rekindling was attributed to fires started by children, malicious causes and misadventure respectively. It is unclear in this instance if such attributions refer to the cause of the original fire or these are genuine classification errors. Instances where there are potentially misclassifications are outlined in Table 12.

**Table 11: 'Additional factor' variable provided and cause category used for South Australia Country Fire Service data**

Additional factors (provided)	Cause category (generated)
Incendiary, deliberate	Incendiary
Malicious	Incendiary
Suspicious circumstances	Suspicious
Accidental	Accidental
Design, installation deficiency	Accidental
Mechanical failure, malfunction	Accidental
Misadventure	Accidental
Operational deficiency	Accidental
Natural condition/event	Natural
Children	Other
Misuse of heat ignition	Other
Misuse of material ignited	Other
Other factor	Other
None	Unknown
Undetermined	Unknown

**Table 12: Cause (column) and additional factors (row) for SACFS data with potentially anomalous classifications**

Cause	Missing	Accidental	Children	Malicious	Misadventure	Natural condition/ event	Operational deficiency
Bird scarer/rabbit fumigator/other vermin control device				2			
Burning and burn offs – with permit				24			
Cooking/food preparation				1			
Electrical – powerlines					2		
Fireworks				13			
Harvesting – static electricity				1			
Heat from electrical equipment arcing, overloaded						5	
Heat from natural source							2
Mechanical cutting tool/welders				2			
Missing	143	3	1	1	1		
Rekindle			2	6			
Rekindle					12		
Vehicle – other				5			
Vehicle – other					2		
Vehicle exhaust (not harvest)					3		
Vehicle exhaust (not used in harvesting)				2			

**South Australia Department of Environment and Heritage:** The SADEH dataset was generated by merging two individual datasets that covered the intervals from 1975 to 2001 and 2001 to 2004. Although both datasets incorporated a cause variable that was consistent across the two datasets, this variable incorporated comparatively few types of cause.

More specific information about causes of fires was listed within the 'comments' field for the 1975 to 2001 data, but not the 2001 to 2004 data. In order to preserve a consistent method of classification across the combined dataset, the causal classification for the SADEH is largely based on the 'cause' variable (Table 13). All fires where the cause was listed as arson were classified as incendiary. However, 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 sevenfold causal classification scheme, and as deliberate within the deliberate versus non-deliberate classification scheme. No attempt was made to integrate other specific causal information into the sevenfold causal classification structure using the comment variable for the 1975 to 2001 data. One of the implications of this methodology is that many fires that would normally be classified as accidental were classified as 'other' within the SADEH analysis.

The causal information presented in the Comment variable for 1975 to 2001 is used in some aspects of the analysis. The information within the comments variable has been summarised to yield the 'detailed cause' variable. The relationship between the detailed cause variable, the cause category variable and the comment variable for the SADEH 1975 to 2001 data is summarised in Table 14.

**Table 13: Cause provided and cause category used for South Australia Department of Environment and Heritage data**

Cause (provided)	Cause category (generated)
Arson	Incendiary
Campfire	Accidental
Escape from prescribed burn	Re-ignition/Prescribed burn
Lightning	Natural
Other	Other
Unknown	Unknown

**Table 14: Cause classification of 1975 to 2001 SADEH fires based on 'Comment' variable**

Comment (provided): original cause description	Detailed cause (generated)	Causal category (generated)
Agricultural machine	Agric. machinery/power tool	Other
Barbeque	Barbeque	Other
Children with matches	Children	Other
Cigarette or match	Cigarette or match	Other
Escape from burning window (Other organisation)	Escape from burning window (Other organisation)	Other
Exhaust system	Exhaust system	Other
Incinerator	Rubbish/Incinerator	Other
Neighbour burning off scrub	Neighbour burning	Other
Neighbour burning off stubble	Neighbour burning	Other
Possible rekindle	Rekindle	Other
Possibly children	Children	Other
Rubbish tip	Rubbish/Incinerator	Other
Spark from powerline	Power line	Other
Spark from power tool	Agric. machinery/power tool	Other
Spark from welder	Agric. machinery/power tool	Other
Train – brake shoe	Train – brake shoe	Other
(July 2003): Not recorded		Unknown
(July 2003): Other	Other	Other
(July 2003): Rekindle	Rekindle	Other
(July 2003): Spark from machinery	Agric. machinery/power tool	Other
(July 2003): Suspected arson		Suspicious

**Department of the Environment and Conservation (WA):** The correlations between the causal information provided and the cause category are summarised in Table 15. In addition to the above, where the cause provided was ‘unknown’ or ‘cause not listed’ but for which an offence was suspected in the ‘Offence suspected’ variable, fires were classified as suspicious.

**Table 15: Cause provided and cause category used for Western Australian Department of the Environment and Conservation data**

DEC fire cause description	Cause category
Accidental by other industry	Accidental
Accidental by recreational forest users	Accidental
Accidental by timber industry	Accidental
Escape from other burning off (not CALM <sup>a</sup> )	Accidental
Deliberate	Incendiary
Lightning	Natural
Escape from CALM prescribed burn	Reignition/Prescribed burn
Cause not listed	Unknown
Unknown	Unknown

a: CALM refers to Department of Conservation and Land Management, which has subsequently been incorporated into the Department of the Environment and Conservation.

**Australian Capital Territory Forests:** The correlations between the causal information provided and the cause category are summarised in Table 16.

**Table 16: Cause provided and cause category used for ACT Parks Lands and Conservation database**

Ignition factor	Cause category
Accident	Accident
BBQ	Accident
Arson	Incendiary
Lightning	Natural
Prescribed burn	Re-ignition/PB
Prescribed burn (Re-ignition)	Re-ignition/PB
Re-ignition	Re-ignition/PB
Other	Other
Unknown	Unknown

## Deliberate versus non-deliberate

The cause categories above have been recombined to yield three categories:

- **non-deliberate:** includes accidental, natural, re-ignition/exposure, spot-over and ‘other’ causes
- **deliberate:** includes both incendiary and suspicious fires
- **unknown:** includes all those fires listed in the above category as unknown.

## Ignition factor summary

In instances where the ‘form of heat of ignition’ variable was not available for AIRS databases (see Table 4), the ignition factor data were summarised to yield a classification that provided more specific information about the causes of fires, without becoming bogged down in the myriad of causes that potentially may lead to a vegetation fire. The summarised variable is referred in this report to as the ‘ignition factor summary’.

The ignition factor summary variable was used in the analysis of the NSW Rural Fire Service, Tasmanian Fire Service and the Victorian Country Fire Service data, and is based on the divisional headings outlined in the AIRS handbook (AFAC 1997), namely 'incendiary', 'suspicious', 'misuse of heat ignition', 'misuse of material ignited', 'mechanical failure, malfunction', 'design, construction, installation deficiency', 'operation deficiency', 'natural condition', 'other' and 'unknown'. However, the suspicious and incendiary fires have been combined into a single category titled 'deliberate'. In the case of both the TFS and NSWRF data no indication was made whether fires attributed to children resulted from the misuse of heat of ignition or from the misuse of the material ignited, as is the case in the AIRS database. In summarising the ignition factor codes all fires within these databases implicating children for were incorporated into the misuse of heat of ignition category.

## Form of heat of ignition

The form of heat of ignition variable was supplied for six agencies employing the AIRS database structure. This includes the four agencies for which data were acquired through AFAC (NSWFB, MFB, QFRS, FESA), the SAMFS and NTFRS.

With the exception of the NTFRS a similar method was used to summarise the form of heat of ignition categories. This was based strictly on the divisional headings outlined in the AIRS database and included the following sub categories:

### **Heat from fuel-fired, fuel powered object (Fuel-powered object), includes:**

- Spark, ember, flame escaping from gas-fuelled equipment
- Heat from gas-fuelled equipment, including pilot lights and normal flames
- Spark, ember, flame escaping from liquid-fuelled equipment
- Heat from liquid-fuelled equipment, including pilot lights and normal flames
- Spark, ember, flame escaping from solid-fuelled equipment
- Heat from solid-fuelled equipment
- Spark, ember, flame escaping from equipment; fuel unknown
- Heat from equipment; fuel unknown
- Heat from fuel-fired, fuel-powered object not classified above
- Heat from fuel-fired, fuel-powered object; insufficient information available to classify further.

### **Heat from electrical equipment arcing, overload (Electrical), includes:**

- Water cause short-circuit arc
- Short-circuit arc from mechanical damage
- Short-circuit arc from defective, worn insulation
- Unspecified short-circuit arc
- Arc from faulty contact, loose connection, broken conductor
- Arc, spark from operating equipment or switch
- Arc from overloaded equipment – included are wires and motors
- Fluorescent light ballast
- Heat from electrical equipment arcing, overload, not classified above
- Heat from electrical equipment arcing, overload; insufficient information available to classify further.

**Heat from smokers' materials, including heat from materials in use or after use. Excluded are matches and lighters (450 & 460; smoking-related), includes:**

- Cigarette
- Cigar
- Pipe
- Heat from smokers' materials, not classified above
- Heat from smokers' materials; insufficient information available to classify further.

**Heat from open flame, spark (Open flame), includes:**

- Cutting torch operation (separating metals)
- Welding torch operation (joining metals)
- Torch operation, other cutting and welding, including plumbers' furnaces, blowtorches, plumbers' torches, Bunsen burners, soldering and heating operations, paint stripping torches, drip torches and other torch operations
- Candle, taper
- Match
- Lighter (flame type)
- Camp-fires, including fires for cooking or personal comfort on the ground, in appliances designed for the purpose or in properly constructed fireplaces
- Rubbish fires, including small fires on ground for the disposal of domestic and garden refuse
- Incinerators, including appliances for the burning of domestic and garden refuse
- Bonfires
- Burn-off fires, including burn-off of grass, crops and scrub for agricultural purposes. Usually associated with the clearing of land. Also includes the use of fires for fuel reduction/wildfire prevention purposes
- Windrows, slash/fire, including large scale burning of heaps of materials. Generally associated with the forest industry and land clearing
- Open fires, not classified above
- Open fires, not classified above
- Open fires, insufficient information available to classify further
- Backfire from internal combustion engine, excluding flames and sparks from exhaust system (130)
- Heat from open flame, spark not classified above
- Heat from open flame, spark; insufficient information available to classify further.

**Heat from hot object or friction (Hot object/friction), includes:**

- Heat, spark from friction, including overhead tyres, slipping drive belts
- Molten, hot material, including molten metal, hot forging, and hot glass
- Hot ember, ash
- Electric lamp, including light bulbs
- Re-kindle, re-ignition
- Heat from properly operating electrical equipment
- Heat from improperly operating electrical equipment



- Heat from hot objects or friction not classified above
- Heat from hot objects or friction; insufficient information available to classify further.

**Heat from explosives/fireworks (Explosives/fireworks), includes:**

- Munitions, including bombs, ammunition and military rockets
- Blasting agent, primer cord, black powder fuse, including ammonium nitrate, when used as an explosive
- Fireworks, including sparklers
- Paper cap, party popper
- Model rocket and amateur rocketry
- Incendiary device, including Molotov cocktails
- Heat from explosive, fireworks not classified above
- Heat from explosive, fireworks; insufficient information available to classify further.

**Heat from natural source (Natural), includes:**

- Sun's heat, usually concentrated
- Spontaneous ignition, chemical reaction
- Lightning discharge
- Static discharge
- Heat from natural source not classified above
- Heat from natural source; insufficient information available to classify further.

**Heat spreading from another hostile fire (Exposure)[Hostile fire], includes:**

- Heat from direct flame, convection currents
- Radiated heat
- Heat from flying brand, ember, spark
- Conducted heat
- Heat spreading from another hostile fire not classified above
- Heat spreading from another hostile fire; insufficient information available to classify further.

**Other form of heat of ignition (Other), includes:**

- Microwaves
- Multiple forms of heat of ignition
- Not applicable
- Other forms of heat of ignition not classified in any division above
- Other forms of heat of ignition: ; insufficient information available to classify further.

**Undetermined or not reported (Unknown), includes:**

- Form of heat of ignition undetermined
- Form of heat of ignition not reported

The form of heat of ignition for the NTFRS differed slightly from that used above. For the most part, the form of heat of ignition was summarised using the divisional headings, as outlined above except that

- ‘Heat from smokers materials’ division was combined with fires attributed to matches and lighters (originally within the ‘Heat from open flame, spark’ category) into a single category titled ‘Cigarettes, matches, lighters’.
- ‘Incendiary device’ was removed from the ‘Heat from fireworks/explosive’ category forming a category by itself titled ‘Incendiary’.
- ‘Heat from fuel-fired, fuel-powered object’ and ‘Heat from electrical equipment arcing, overloaded’ were combined into a single category titled ‘Mechanical, electrical’.
- Fires resulting from ‘Torch operation, welding torch and other torch operation’ (originally in ‘Open flame, spark’ division) were incorporated into mechanical, electrical category.
- Categories titled ‘Heat from flying brand, ember, spark’ and ‘Heat from properly operating electrical equipment’ were incorporated into the ‘Mechanical, electrical category’.
- Fires attributed to ‘Burn-off fires’ and ‘Camp-fires’ were extracted from the ‘Heat from open flame, spark’ categories and formed single categories by themselves.
- ‘Other’ category includes fires attributed to ‘Candle, taper’, ‘Heat spark from friction’, ‘Molten, hot material’, ‘Not applicable’, ‘Other form of heat of ignition not classed in any division’, ‘Other forms of heat ignition; I/I to classify further’, ‘Rubbish fires’ ‘Windrows/slash/fire’.
- Open flames, re-ignition category incorporated fields: ‘Heat from direct flame, convection currents’, ‘Heat from open flame, spark not classified above’, ‘Heat from open flame, spark; I/I to classify further’, ‘Heat spreading from another hostile fire not classified above’, ‘Open fires not classified above’, ‘Open fires; insufficient information to classify further’ and ‘Re-kindle, Re-ignition’.

## Implications for the causal classification scheme

There are a number of implications that arise from differences in the structure of the databases provided and the methods employed to summarise the causal data contained within them. Some implications specific to individual databases are discussed above. Three areas where discrepancies arise across databases are for natural fires, smoking-related fires, and in the re-ignition/exposure/prescribed burn category.

### Natural fires

There are some subtle differences in the way that natural fires were classified across AIRS and non-AIRS databases. Typically, all fires in non-AIRS databases classified as natural were the result of lightning. However, for AIRS databases, natural fires refer not only to fires started by lightning, but also high wind, earthquake, high water (including floods), or other unspecified natural condition or events (not classified or insufficient information to classify further). However, it is evident from the analysis of some agencies’ databases, that incorporated within this category are human-caused fires, where natural conditions have been responsible for the escape but not for the ignition of the fire. Hence, for AIRS databases the ‘natural’ category may actually overestimate the numbers of fires that resulted from natural ignitions, and actual percentages of natural fires may be somewhat lower. The breakdown of the specific causes of causes of natural fires is outlined in Table 4.

## Smoking-related fires

A uniform method for identifying smoking related fires could not be adopted across all agencies. Many of the non-AIRS database structures included an individual category within the cause variable that specifically related to fires starting from cigarettes and other smoking-related materials. The situation for AIRS database was somewhat more complex.

For those agencies for which the 'Form of heat of ignition' variable was available, smoking related fires were based on cases where the 'Form of heat of ignition' = 'Heat from smokers' materials' division. For the agencies where only the AIRS ignition factor was available, smoking related fires refer to all cases where the ignition factor was classified 'abandoned, discarded materials'. Using the databases for which both the form of heat of ignition and the ignition factor were available it is evident that although many of the fires that resulted from 'Heat from smokers' material' (Form of heat of ignition) were subsequently categorised as resulting from the 'Abandoned, discarded material' code within the ignition factor variable, there was no one to one correspondence, as the ignition factor may be listed as incendiary, suspicious, or unknown, among other variables. The extent of the overlap varied markedly between agencies, from 58 to 83 percent (Table 17). Similarly, fires classified as 'Abandoned, discarded material' that were subsequently categorised within the 'Heat from smokers' materials' ('Form of heat of ignition' variable) was not 100 percent, and again varied between agencies. For example, 80 percent of all NSWFB fires where the ignition factor was identified as 'abandoned, discarded materials' were also classified as 'heat from smokers materials' in the form of heat of ignition variable (Table 17). The implications of the above observations are three-fold:

- analyses of cigarette-fires based on abandoned and discarded materials are likely to underestimate the number of smoking related fires by as much as 30 to 50 percent
- smoking-related fires defined on the basis of the form of heat of ignition variable may subsequently be classified as accidental, incendiary, suspicious, other, or unknown within the cause category classification scheme, whereas all smoking related fires defined on the ignition factor alone will be classified as accidental
- smoking-related fires are a problem over and above that posed by deliberate firesetting. The extent of this problem varied markedly between agencies and appeared to be intimately related to population density.

The variables used to categorise smoking-related fires for each database, and their classification with the cause category structure is outlined in Table 4.

**Table 17: Fires in the Heat from smokers' material division and those classified as Resulting from abandoned or discarded materials in the ignition factor variable (percent)**

	NSWFB	MFB	QFRS	FESA
'Heat from smoker materials' subsequently classified with the 'Abandoned, discarded materials' (ignition factor) category	72.4	83.1	57.8	45.6
'Abandoned, discarded materials' (ignition factor) category that were classified as 'Heat from smoker materials'	80.0	95.3	75.6	88.5

## Agent responsible for fires

### AIRS database: implications for child fires

The AIRS database does not specifically identify the agent responsible for the fire, with the exception of children. Fires pertaining to children are broken into six categories. This includes three categories each within the 'misuse of heat of ignition' (codes 361–363) and 'misuse of material ignited' (codes 481–483)

divisions, pertaining to children with ages from 0 to 5 years, 6 to 12 years, and 13 to 16 years. Hence, in this study 'child' fires refers to all fires started by persons aged 16 years and younger. Many AIRS databases included ignition factor codes of 360 and 480, which were taken to refer to non-deliberate child fires lit by child playing, of unknown age. Moreover, the TFS and NSWRFs did not differentiate between the misuse of heat of ignition and misuse of materials ignited in the database supplied for analysis.

Although the number of fires identified as resulting from children playing is in and of itself a useful statistic, fundamental design flaws within the database prohibit agencies from accurately knowing the number of fires for which children have been identified as being responsible: malicious fires started by children 16 years or younger are classified as incendiary or suspicious. Moreover, there are likely to be numerous fires for which the role of children has not been identified, as they were not observed at the scene.

There are two significant outcomes from the structure of the AFAC (2007):

- It is impossible for individual agencies to access the known incidences of fires started by children 16 years and under, if those agencies record fires in strict accordance with the guidelines outlined in AFAC (1997). This means that, although juvenile intervention programs are implemented in all states and territories in Australia, it is impossible to determine their effectiveness at a gross scale, or to enable targeting of areas of high risk or known problem areas (other than by relying on the anecdotal evidence, retained by fire fighting staff, who may or may not have contact with the educational component implemented by fire services).
- Given that fires started by children are potentially a significant component within the incendiary and suspicious categories, the classification of fires started by children has an important bearing on the actual rates of deliberate versus non-deliberate fires recorded by individual agencies. Differences in the way child fires are attributed across agencies, can lead to marked differences in the recorded levels of deliberate firesetting and pose significant issues for the integration of data between fire agencies (see combined MFB and CFA analysis). In this analysis, differences in the attributions of child fires are reflected in differences in the proportion of accidental versus incendiary or suspicious fires.

## Non-AIRS databases

Only two non-AIRS agencies include any information about the agent responsible for ignition.

**Victorian Department of Sustainability and the Environment (DSE):** The agents responsible for DSE fires have been summarised into the following categories:

- *Children:* Children
- *Government employee:* Employee DSE or PV; Employee NRE; Employee, forestry industry, Employee, other department.
- *Farmer/grazier:* Farmer/farm employee; full-time; Farmer/farm employee part-time; Grazing leaseholder, Farmer/grazier
- *Lightning:* Natural
- *Recreationist:* recreationist, bushwalker; recreationist, camper; recreationist, day visitor; recreationist: day fisherman.
- *Resident:* Resident, part-time; Resident, full-time
- *Traveller:* Traveller
- *Other:* Employee, other industry; military; other
- *Unknown:* Unknown, Null

As the agent responsible for fire is independent from the cause variable, fires attributed to children, like other agents, may be classified as either accidental or deliberate.

**South Australian Country Fire Service (SACFS):** The SACFS delineate fires started by children within the 'additional factors' variable. Again, because this variable is independent from the cause variable, fires started by children are categorised as accidental, incendiary, suspicious etc within the SACFS analysis.

## Location

The amount and type of information about the location of a fire varies markedly across databases. Most variables that specially record information about the location of a fire have been noted in Table 4. In this study, broad geographical distribution of fires was examined by region, as well as smaller geographical units, including statistical regions, statistical local areas, postcodes or suburbs, depending on the structure of the information provided and ease with which information could be most clearly presented. Other variables examined that provide information about the location of a fire, include the type of complex or property use, tenure, point of origin.

## Region

Where possible a common regional structure was employed across agencies. The unifying concept adopted was based on the ABS's tourism region. However, it was not possible to adopt this structure for many land management agencies, owing to the structure of the information provided.

### Tourism region

Although tourism regions are primarily used to monitor tourism activities, there are several advantages to using this approach in examining the distribution of fires. Using the modified approach adopted here, it was easy to assign large numbers of fires to different regions using either the postcode or suburb name provided. Moreover, tourism regions have been intentionally developed to parallel the regional structure adopted by the tourism industry, and therefore have greater familiarity with a broader audience than units like statistical subdivisions, which are most familiar to those who deal with statistical data. Tourism region maps are included within the discussion for each state and territory, with the exception of the Australian Capital Territory.

In this study, tourism regions were generated using ABS (2005) concordance files. However, fundamental differences exist between the regions outlined in that document and structure adopted herein. Notably, the ABS tourism regions are built from statistical local areas (SLA) which often crosscut individual postcodes or suburbs. In contrast, tourism regions used in this study were assigned to a particular region based on the suburb name and/or postcode variable. Table 4 outlines whether the data were analysed using tourism region, and other variables used to assign individual fires – for example postcode versus suburb. The exact methodology is also discussed at the commencement of each agency's analysis.

In some cases where only the suburb name was provided, it was necessary to generate the postcode variable first. Assignment based on suburb name was complicated in cases where there was more than one suburb of the same name in the same state or territory and use of local names which bear no resemblance to official place names to record information in the database. In these instances, additional information was examined, but if no further clues were available, then these fires were assigned as location unknown.

The correlation between postcodes or suburb and region were assisted by the use of the postcode selector tool incorporated in Decipher Technologies website (<http://www.decipher.biz/>), which is based on ABS (2005).

For two land management agencies, fires were assigned to a tourism region based on the name of the reserve: the Queensland Parks and Wildlife Service and the South Australian Department of Environment and Heritage.

**Queensland Parks and Wildlife Service:** Each reserve was allocated to one of the 12 tourism regions, as follows:

- *Brisbane*: includes Bellthorpe Aggregation, Bribie Island Aggregation, Bunyaville Forest Reserve, Carbrook Wetlands Aggregation, D'Aguilar North Aggregation, D'Aguilar South Aggregation, Daisy Hill-Venman Aggregation, Glen Rock Area, Helidon Hills Aggregation, Moogerah Peaks National Park, Moreton Island Aggregation, North Stradbroke Island Aggregation.
- *Bundaberg*: includes Bania Aggregation, Bulburin Aggregation, Calrossie Aggregation, Deepwater National Park, Eurimbula Aggregation, Gurgeena-Nour Nour Aggregation, Pile Gully Aggregation.
- *Darling Downs*: includes Barakula Aggregation, Booroodoo Aggregation, Braemar Aggregation, Bunya Mountains Aggregation, Conloi Aggregation, Dunmore State Forest, Expedition Aggregation, Expedition Range Aggregation, Girraween Aggregation, Kinkora Aggregation, Kumbarilla Aggregation, Main Range Aggregation, Morgan Park Resources Reserve, Nudley State Forest, Sundown Aggregation, Whetstone Aggregation, Western Creek State Forest, Wondul Aggregation, Yelarbon State Forest.
- *Fitzroy*: includes Blackdown Aggregation, Byfield Aggregation, Carnarvon Nogoia Aggregation, Castle Tower Aggregation, Cudmore Aggregation, Kroombit Aggregation, Rundle Range Aggregation.
- *Gold Coast*: includes Lamington National Park – Green Mountains & Southern sections, Mount Barney Aggregation, Nerang Aggregation, South Stradbroke Island Aggregation, Springbrook Aggregation, Tamborine Aggregation.
- *Hervey Bay/Maryborough*: includes Allies Creek State Forest, Cooloola Rainbow Beach Aggregation, Fraser Island Eurong Aggregation, Great Sandy National Park, Great Sandy District, Imbil Aggregation, Mount Walsh Aggregation, Poona Aggregation, Vernon Aggregation, Wigton Aggregation, Wondai Aggregation, Wrattens Aggregation, Yabba Aggregation.
- *Mackay*: Credition State Forest, Dipperu National Park.
- *Northern*: Blackwood National Park, Bowling Green Bay Aggregation, Cape Pallarenda-Townsville Town Common Aggregation, Dalrymple National Park, Lumholtz Southern Aggregation, Paluma Aggregation, Palmer Goldfields Resources Reserve, White Mountains Aggregation.
- *Outback*: Lawn Hill Aggregation, Lochern National Park, Moorrinya National Park, Oakview Aggregation, Porcupine Gorge National Park.
- *Sunshine Coast*: Amamoor Aggregation, Beerburrum Aggregation, Conondale Aggregation, Mapleton Aggregation, Mooloolah River Aggregation, Noosa Aggregation, Parklands Aggregation, Squirrel Aggregation.
- *Tropical North Queensland*: Bulleringa National Park, Cairns (Whitfield-Kamerunga) Aggregation, Cairns Coast Northern Marine Aggregation, Cape Melville National Park, Eubenangee Swamp Aggregation, Forty Mile Scrub National Park, Herberton Range Forest Reserve, Herberton Range Aggregation, Hull River Catchment Aggregation, Iron Range Aggregation, Jardine Aggregation, Koombooloomba Aggregation, Kurrimine Aggregation, Lakefield Aggregation, Lumholtz National Park Western Section, Mitchell and Alice Rivers National Park, Mungkan Kandju Aggregation, Russell River Aggregation, Staaten River National Park, Tully Gorge Aggregation, Tumoulin Aggregation, Undara Volcanic Aggregation, White Rock Aggregation, Wooroonooran National Park – North Section.

- *Whitsundays*: Cape Upstart Aggregation, Conway Aggregation, Mount Aberdeen National Park.

**South Australia Department of Environment and Heritage:** the specific allocation of individual reserves is outlined below:

- *Adelaide*: Onkaparinga River, Cobbler Creek, Para Wirra, Hackam, Sheperds Hill, Belair, Sturt Gorge, Hallett Cove, Anstey Hill, Mount Osmond, Angove, O'Halloran Hill, Brownhill Creek, Fort Glanville, Windy Point, Moana Sands, Aldinga Scrub, Ferguson.
- *Adelaide Hills*: Cleland, Morialta, Montacute, Greenhill, Horsnell Gully, Scott Creek, Kenneth Stirling, Charleston, Cudlee Creek, Mark Oliphant, Warren, Totness, Black Hill.
- *Barossa Valley*: Kaiserstuhl.
- *Clare Valley*: Redbank, Spring Gully.
- *Eyre Peninsular*: Franklin Harbor, Lincoln, Pureba, Yumberra, Whittlebee, Lake Newland, Kellidie Bay, Pinkawillinie, Seaford Rise, Heggaton, Coffin Bay, Barwell, Bascombe Well, Carappee Hill, Caratoola, Cocata, Gawler Ranges, Greenly Island, Hambidge, Hincks, Kathai, Kulliparu, Lake Gilles, Laura Bay, Middlecamp Hills, Munyaroo, Sleaford Mere, Verran Tanks, Vanilla, Whyalla, Yalata, Yellabina.
- *Fleurieu Peninsular*: Finnis, Newland Head, Deep Creek, Talisker Conservation, Mount Billy, Cox Scrub, Kyeema, Mount Magnificent, Myponga, Nixon-Skinner, Spring Mount, The Elbow.
- *Flinders Ranges*: Winninowie, Gammon Ranges, Mount Remarkable, The Dutchmans Stern, Flinders Ranges, Mambray Creek, Mount Brown, Telowie Gorge.
- *Kangaroo Island*: Cape Torrens, Western River, Beyeria, Flinders Chase, Beatrice Islet, Cape Gantheaume, Cape Hart, Dudley, Kelly Hill, Latham, Mount Taylor, Nepean Bay, Parndana, Pelican Lagoon, Vivonne Bay.
- *Limestone Coast*: Carcuma, Fairview, Mud Islands, Gum Lagoon, Messent, Coorong, Bucks Lake, Canunda, Stoneleigh Park Heritage, Desert Camp, Beachport, Belt Hill, Big Heath, Bool Lagoon, Calectasia, Ewens Ponds, Furner, Hacks Lagoon, Kelvin Powrie, Little Dip, Lower Glenelg River, Martin Washpool, Mount Boothby, Mount Monster, Mount Scott, Naracoorte Caves, Padthaway, Penola, Poocher Swamp, Reedy Creek, Tantanoola Caves.
- *Murraylands*: Billiat, Ngarkat, Swan Reach, Mount Rescue, Brookfield, Karte, Ridley, Roonka, Scorpion Springs, White Dam.
- *Outback*: Innamincka, Witjira.
- *Riverland*: Murray River, Calperum, Danggali, Chowilla, Kapunda Island, Peebinga, Cooltong, Loch Luna, Maize Island Lagoon, Moorook, Pike River, Pooginook.
- *Yorke Peninsular*: Innes, Warrenbein, Carribe, Clinton, Leven Beach, Point Davenport, Port Gawler.
- *Unknown*: Missing, off park, Other DEH managed land, Redbanks, Weatherspoon's, Unnamed.

**South Australia Country Fire Service:** Although tourism regions (ABS 2005) were used in the analysis of the SACFS data, there were some limitations to the regional classification of individual fires, as:

- there were 823 cases for which grid reference data was available in the absence of a location name – it was beyond the resources of this project to convert these to a regional classification used elsewhere, and the location of these fires was listed as unknown.
- there were also 171 instances where location information was completely absent.
- location details provided were vague – for example, '100 km north of such-and-such' – the number of cases was comparatively minor.
- more than two locations with the same name existed in South Australia.
- the location name provided did not correspond to the official name of the suburb.

In total there were 1,171 instances (13.6 percent) where the region was not allocated.



### Agencies for which tourism regions were not used

It was not possible to use the tourism region model for all databases, as there was insufficient information, the effort required in converting the data was too high, or the large area covered by reserves (in the case of land management agencies) negated the value of that system. The classification schemes adopted for agencies where tourism region were not used are outlined below.

**State Forests NSW:** The regional location of SFNSW fires was principally recorded under two variables, the site name, which provides the name of the regional office or operations centre, and the variable titled 'label name' which represent a single place name, and presumably corresponded to the name of the local forestry office that provided fire suppression services. Based on the 'label name' provided, fires were assigned to one of 12 regions, as outlined in Table 18, although additional modifications were made with regard to specific reserves (Table 19).

**Table 18: Site name, region name provided and region assigned for NSW State Forests data**

Site code	Site name (provided)	Label name (provided)	Region (generated)
0	Non State Forest RC	Non SF	Unknown
400	Softwoods Divisional Office	Albury	Murray
401	Macquarie Regional Office (Bathurst)	Bathurst	Explorer Country
403	Oberon Operations Centre	Oberon	Explorer Country
404	Tumbarumba Operations Centre	Tumbarumba	Snowy Mts
405	Hume Regional Office (Tumut)	Tumut	Snowy Mts
419	Walcha Operations Centre	Walcha	North West
421	South Coast Regional Office (Batemans Bay)	Batemans Bay	South Coast
423	Monaro Regional Office (Bombala)	Bombala	Snowy Mts
424	South East Regional Office (Eden)	Eden	South Coast
425	Moss Vale Operations Centre	Moss Vale	Southern Highlands
426	Narooma Operations Centre	Narooma	South Coast
427	Queanbeyan Operations Centre	Queanbeyan	Capital Country
441	Bulahdelah Operations Centre	Bulahdelah	North Coast
442	Hunter Regional Office (Newcastle)	Newcastle	Hunter
444	Gloucester Operations Centre	Gloucester	Hunter
445	Kempsey Operations Centre	Kempsey	North Coast
447	Manning Regional Office (Taree)	Taree	North Coast
448	Macleay/Hastings Regional Office (Wauchope)	Wauchope	North Coast
461	Northern Rivers Regional Office (Casino)	Casino	Northern Rivers
464	Dorrigo Operations Centre	Dorrigo	North Coast
465	Grafton Operations Centre	Grafton	Northern Rivers
466	Glen Innes Operations Centre	Glen Innes	North West
470	Urbenville Operations Centre	Urbenville	Northern Rivers
471	Urunga Operations Centre	Urunga	North Coast
472	Northern Regional Office (Walcha)	Walcha	North West
481	Baradine Operations Centre	Baradine	North West
482	Riverina Regional Office (Deniliquin)	Deniliquin	Riverina
483	Western Regional Office (Dubbo)	Dubbo	Explorer Country
484	Forbes Operations Centre	Forbes	Explorer Country
485	Inverell Operations Centre	Inverell	North West
486	Narrandera Operations Centre – Hardwood	Narrandera–Hardwood	Riverina
487	Narrandera Operations Centre – Cypress	Narrandera–Cypress	Riverina
800	Hardwoods Divisional Office	Grafton	Northern Rivers
801	Mid North Coast Regional Office (Coffs)	Coffs Harbour	North Coast
999	Head Office	Head Office	Sydney



**Table 19: Additional changes made to the assignment of region for the SFNSW data**

Reserve name (provided)	Region (generated)
Aberdare State Forest	Hunter
Nullica State Forest	Hunter
Mount Mitchell State Forest	Northern Rivers
Moogem State Forest	Northern Rivers
Kanangra Boyd National Park	Sydney
Mummel Gulf	North West

**NSW National Parks and Wildlife Service:** A region variable, titled 'region', was provided with the dataset. Although this variable was used in a limited number of instances, there were inconsistencies in the way the locations were coded for individual reserves. For example, a single reserve could have been classified within several different NPWS regions (as defined in the data). In some cases this may reflect reality where, due to their large extent some parks can extend across region boundaries. In other cases, the classification system was not consistent with zone boundaries. The classification scheme adopted in the study drew on the regional domains defined by the NSW NPWS on their website <http://www.nationalparks.nsw.gov.au/>. The allocation of fires to a particular region was based on the name of the reserve. In instances where fires occurred off park but the name of the park was included, the fire was attributed to that reserve in the 'Reserve' variable, and the regional attribution made accordingly. In the absence of information about the reserve name, fires were allocated to a region based on other location information (see Table 4), including the local government area, electorate etc. Wherever the original 'region' variable was used in the NSW NPWS analysis, data were cleaned to remove inconsistencies.

The allocation of reserves into individual regions is outlined below:

- *Central NSW:* Abercrombie River NP, Arakoola NR, Avisford NR, Binnaway NR, Cataract NP, Cocoparra NP, Conimbla NP, Coolah Tops NP, Coolbaggie NR, Coppermania NR, Goobang NP, Goulburn River NP, Gurrangang Crown Rese, Hill End Historic site, Kirramingly NR, Macquarie Marshes NR, Mt Canobolas SCA, Mt Kaputar NP, Mullion Range SRA, Munghorn NR, Nangar NP, NAP Rocky Glen, Narran Lake NR, Pilliga NP, The Rock NR, Timmallie SF, Turon NP, Warrumbungles NP, Weddin Mtns NP, Winburndale NR, Wombat Creek CR, Yuranighs Ab Grave.
- *Hunter & MNC:* Arakoon NR-Hat Head NP, Awabakal NR, Baalijin NR, Bago Bluff NP, Barakee NP, Barrington Tops NP, Bellinger River NP, Ben Halls Gap NP, Bindarri NP, Biriwal Bulga NP, Bollanolla NR, Bongil Bongil NP, Boonanghi NR, Booti Booti NP, Bowraville NR, Brett NP, Bugar NR, Cascade NP, Cedar Brush NR, Clenrder SRA, Clybucca HS, Coolongolook NR, Cooperabung Range NP, Coorabakh NP, Copeland Tops SRA, Crowdy Bay NP, Darawank NR, Dorrangan NP, Dorrigo NP, Dunggir NP, Fishermans Bend NR, Ganay NR, Garby NR, GFRNP, Ghin-doo-ee NP, Glenrock SRA, Hexham Swamp NR, Jagun NR, Jasper NR, Junuy Juluum NP, Juugawaarri NR, Karuah NR, Khappinghat NP, Killabakh NR, Kooragang Island NR, Kumbatine NP, Lake Innes NR, Lake Macquarie SRA, Limeburners Creek NP, Lower Hunter NP, Macquarie NR, Maria NP, Monkerai NP, Monkeycot NP, Moonee Beach NP, Mt Royal NP, Myall Lakes NP, Ngambaa NR, North Brother, Nymboi-Binderay NP, Pambalong NR, Pickett Hill Aboriginal, Pulbah Island NR, Queens Lake NR, Rawdon Creek NP, Running Creek NP, Seaview NP, Singleton, Skillion NP, Snapper Island NP, Talawahl NP, Tapin Tops NP, The Glen NP, Tingira Heights NP, Tomalla Nature Reser, Tomaree NP, Tomaru NP, Towarri NP, Ulidarra NP, Valla Beach NP, Wallabadah NR, Wallamba, Wallarah NP, Wallaroo NR, Wallingat NP, Watagans NP, Willi Willi NP, Woko NP, Worimi NR, Yarravel NP.

- *New England Tablelands*: Bagul Waajaarr NR, Bald Rock NP, Barool NP, Bluff River NR, Bolivia Hill NR, Boonoo Boonoo NP, Boorolong NR, Butterleaf NP, Capoompeta NP, Carrai NP, Cathedral Rocks NP, Chaelundi NP, Cottan-Bimbang NP, Coutts Crown NR, Cunnawarra NP, Dalmorton SF, Ellis SF, Georges Ck NR, Gibraltar Range NP, Guy Fawkes River NP, Hewitts Peak NR, Indawarra NP, Ironbark NR, Jobs Mountain NR, Kings Plains NP, Kwiambal NP, Mann River NR, Moonpar SF, Mt Hyland NR, Mt McKenzie NR, Mt Yarrowyck NR, Mummel Gulf NP, New England NP, Nowendoc NP, Nymboida NP, Oxley Wild River NP, Single NP, The Basin NR, Timbarra NP, Torrington SCA, Warabah NP, Warra NP, Washpool NP, Watsons Ck NR, Werrikimbe NP.
- *Northern Rivers*: Arakwal NP, Banyabba NR, Billinudgel NR, Border Rangers NP, Broadwater NP, Bundjalung NP, Bungabee NP, Bungawalbin NP, Byrne's Scrub NR, Candle SF, Candole SF, Captains Creek NR, Chambigne NR, Cudgen NR, Fortis Ck NP, Hortons Creek NR, Inner Pocket NR, Koreelah NP, Koukandowie NR, Lawrence Road SCA, Mallanganee NP, Mooball NP, Mt Jerusalem NP, Mt Neville NR, Mt Pikapene NP, Mt Warning NP, Nightcap NP, Pikapene NP, Ramornie NP, Richmond Range NP, Richmond River NR, Sherwood NR, Tallawudjah NR, Tooloom NP, Toonumbar NP, Tuckean NR, Tucki Tucki NR, Tweed Heads Historic Reserve, Tyagarah NR, Ukerebagh NR, Uralba NR, Woodford Island NR, Woodford NR, Wooyung NR, Yabbra NP, Yuraygir NP.
- *Outback NSW*: Ingleba NR, Kinchega NP, Lake Urana NR, Mallee Cliffs NP, Nombinnie NR, Tarawi NR, Tilpilly Station, Weisners Swamp NR, Yathong NR.
- *South Coast and Southern Highlands*: Alpine NP, Bago SF, Bamarang NR, Barnunj SRA, Bellbird NR, Ben Boyd NP, Bermagui NR, Biamanga NP, Bomaderry Creek RP, Bondi Gulf NR, Borang NR, Bournda NP, Brindabella NP, Broulee Is NR, Budawang N P, Budderoo NP, Bundundah NR, Bungonia SRA, Clyde River NP, Comerong Is NR, Conjola NP, Coolangurra SF, Coolumbooka NR, Coolungubra, Coopralammero NP VIC, Corramy SRA, Croajunolong VIC, Cudmirrah NP, Cullendulla Creek NR, Dananbilla NR, Dandelong NR, Deua NP, Egan Peaks NR, Ellerslie NR, Eurobadalla NP, Fitzoy Falls, Jerawangala NP, Jervis Bay NP, Kooraban NP, Kosciuszko NP, Livingstone NR, Macquarie Pass NP, Meroo NP, Mimoso Rocks NP, Monga NP, Montague Is. NR, Morton NP, Mt Imlay NP, Murramarang NP, Nadgee NR, Narrawallee NR, Nungatta NP, Parma Creek NR, Razorback NR, Red Rocks NP, Rodway NR, Scabby Range NR, SE Forest NP, Seven Mile Beach NP, South East Forest NP, State Forest, Tallaganda NP, Tinderry NR, Triplarina NP, Tumbalong Reserve, Wadbilinga NP, Wallaga Lake NP, Wee Jasper NR, Weraboldera NP, Wingello, Woolamia NR, Woomargama NP, Worrigee NR, Yanununbeyan NR, Yowaka.
- *Sydney and surrounds*: Agnes Banks NR, Bargo SRA, Berowra Valley RP, Blackheath Glen Res., Blue Mountains NP, Botany Bay NP, Bouddi NP, Brisbane Water NP, Burragorang SRA, Castlereagh NR, Cattai NP, Clifton Gardens, Cockle Bay NR, Comelroy SF, Cordeax Dam, Dharawal SRA, Dharug NP, Evans Crown NR, Garawarra SRA, Gardens of Stone NP, Garigal NP, Garrawarra SRA, Georges River NP, Gosford NP, Gulger NR, Head Office, Heathcote NP, Hornsby Council, Illawarra SRA, Jiliby SCA, Kanangra Boyd NP, Ku-ring-gai Chase NP, Lake Cataract Catchment, Lane Cove NP, Leacock RP, Lion Island NR, Llandilo, Long Island NR, Manobalai NR, Marramarra NP, Mile Ridge, MSRA, Mulgoa NR, Munmorah NP, Muogamarra NR, Nattai NP, Newnes State Forest, Parr SCA, Popran NP, Putty SF, Rileys Island, Royal NP, Scheyville NP, Sydney Harbour NP, Thirlmere Lakes NP, Warragamba Special a, Warringah LGA, Werakata NP, Western Sydney Region, Windsor Downs NR, Wirrabalong NP, WNP, Wollemi NP, Wollondilly NR, WSRP, Wyrrabalong NP, Yengo NP, Yerranderie SRA, YRP.

**Forestry Plantations Queensland:** Analysis was conducted using the logging district information provided by the FPQ. These regions are not congruent with the tourism regions.

**Western Australian Department of Environment and Conservation:** Analysis was based on regions supplied by DEC. These regions are not congruent with the tourism regions.

**Victorian Department of Sustainability and the Environment:** Region information was as supplied by DSE. These regions are not congruent with the tourism regions.

**Australian Capital Territory Parks Lands and Conservation:** The ACT PCL data were analysed using the information provided within the 'district' variable, except that:

- the districts of Gungahlin and Hall were combined
- all districts named NSW and ACT were labelled 'other'
- districts labelled Woden/Canberra or Woden/Weston have been assigned to the Woden region
- districts labelled Woden/Tuggeranong/Stromlo have been assigned to the Weston Creek region.

## Statistical areas

In some instances, individual analyses draw on small statistical units for analysis, including statistical region sectors (SRS), statistical subdivision (SSD), and statistical local areas (SLA). Fires were allocated to a statistical local area based on the postcode – either provided or generated from the suburb name – using the ABS (2001a and 2001b). These SLAs then formed the building blocks for the SRS and SSD used in this analysis.

Fundamental differences exist between the statistical units used in this analysis and formulated by the ABS, as follows:

- postal areas used by the ABS and not identical to postcodes used by Australia Post, although the differences are small
- ABS SLAs commonly crosscut postcode boundaries; this impacts not only on SLAs but also the SRS and SSD which are generated from them.

Although there is a variable called statistical local area within some AIRS databases, there were gross inaccuracies in this field, and consequently no attempt was made to use this information in individual analyses. Notably, SLA boundaries and names are subject to change yearly and between each census. Multiple SLA numbers were commonly recorded for the same postcode, obviously covering multiple years, but no information was provided about the SLA definition used in assigning each SLA. Moreover, this variable was not always completed or was subject to other errors. Hence, this variable is less than useful, and could well be removed from the AIRS database structure.

It is noted, that because the tourism regions are defined using ABS (2005) and SLA and SSD were defined using statistical units defined in 2001 (ABS 2001a, & 2001b), there is some discordance between these two classification system. The differences are small, and do not impact markedly on either the total number of fires discussed, or the implications that arise therefrom.

## Fire frequency per person

The analysis of fires on a per person basis was conducted using the population of individual postcodes at the 2001 census. It is again highlighted that there is not an exact correspondence between postal areas (ABS) and postcodes (Australia Post) although the differences are small.

## Land tenure

Most agencies responsible for fire services in regional and rural areas attend fires on multiple tenures because fire services are coordinated to prevent the escalation of fire events, and because suppressing fires on adjoining tenures reduces the possibility for fires to cross tenure boundaries and affect the tenure

for which an agency has responsibility. For example, a national parks and wildlife service will monitor and commonly attend fires near the boundary of a national park, in an attempt to prevent that fire from entering the park, where there may be greater risk of escape and greater difficulties posed for suppression. In many instances, individual agencies record specific information about the tenures on which fires occurred, in some cases distinguishing whether the fire started on or outside of that organisation's tenure, and also where the fire was subsequently controlled and extinguished relative to that tenure. In some cases, the tenure information presented in this report has been summarised from that provided in the database. Details of these modifications are outlined for individual agencies below.

**State Forests NSW:** Modifications to the tenure categories used in the SFNSW analysis are outlined in Table 20.

**Table 20: Tenure category provided, explanation, and tenure category generated for State Forests NSW data**

Entry	Tenure	Tenure (generated)
CL	Crown land (leased)	Private property/leasehold (PP)
LG	Local government	Local government (LG)
MR	Military reserve	Other government authority/Interstate (OGA)
NP	National park	National parks (NP)
ON	Other – National Parks control	Other government authority/Interstate (OGA)
OS	Other – State Forests control	Other government authority/Interstate (OGA)
OT	Other public	Other government authority/Interstate (OGA)
PP	Private property	Private property/leasehold (PP)
PV	Pastures protection board (TSR)	Other government authority/Interstate (OGA)
SF	State forests	State forests (SF)
TE	Transmission line easements	Other government authority/Interstate (OGA)
VC	Vacant crown land	Vacant crown land (VL)
WS	Water supply catchment	Other government authority/Interstate (OGA)
.	Missing	Missing (XX)/Unknown

**NSW National Parks and Wildlife Service:** The relationship between the tenure categories provided and the tenure categories using in this analysis are outlined in Table 21.

**Table 21: Tenure category provided and used for NSW National Parks and Wildlife Service data**

Code	Tenure	Category	Code
1	?????	U	Unknown
2	ACT	OGA	Other government authority/Interstate
3	BMCC	LG	Local government
4	C	U	Unknown
5	CL	CL	Vacant crown land
6	Council	LG	Local government
7	EA	OGA	Other government authority/Interstate
8	Federal	OGA	Other government authority/Interstate
9	FH	U	Unknown
10	I	U	Unknown
11	LG	LG	Local government
12	LGA	LG	Local government
13	LH	PP	Private property/Leasehold
14	NP/LGA	M	Multiple
15	NP/PP/SF	M	Multiple
16	NPWS	NPWS	National Parks & Wildlife Service
17	NPWS (Commonwealth)	NPWS	National Parks & Wildlife Service
18	NPWS (Ungazetted)	NPWS	National Parks & Wildlife Service

**Table 21: Tenure category provided and used for NSW National Parks and Wildlife Service data (continued)**

Code	Tenure	Category	Code
19	NPWS/PP	M	Multiple
20	NPWS/SCA	M	Multiple
21	NPWS/SCA/PP	M	Multiple
22	NPWS/SF	M	Multiple
23	NPWS/SF/PP	M	Multiple
24	NPWs	NPWS	National Parks & Wildlife Service
25	NRE	U	Unknown
26	OO	U	Unknown
27	PL	PP	Private property/Leasehold
28	PP	PP	Private property/Leasehold
29	PP/CL	M	Multiple
30	PP/NPWS	M	Multiple
31	PP/NPWS/SF	M	Multiple
32	PP/NPWS/u/k	M	Multiple
33	PP/Other	M	Multiple
34	PP/SF	M	Multiple
35	PP/SF/NPWS	M	Multiple
36	PP/VCL	M	Multiple
37	PP/VCL/NPWS	M	Multiple
38	PTE	U	Unknown
39	QLD	OGA	Other government authority/Interstate
40	QLD npws	OGA	Other government authority/Interstate
41	R	OGA	Other government authority/Interstate
42	RR	OGA	Other government authority/Interstate
43	RTA	OGA	Other government authority/Interstate
44	Rail	OGA	Other government authority/Interstate
45	SCA	OGA	Other government authority/Interstate
46	SF	SF	State forests
47	SF/NPWS	M	Multiple
48	SF/PP	M	Multiple
49	SFL	SF	State forests
50	SRA	OGA	Other government authority/Interstate
51	SW	OGA	Other government authority/Interstate
52	TSR	OGA	Other government authority/Interstate
53	U	U	Unknown
54	U (VicNP)	OGA	Other government authority/Interstate
55	VCL	VL	Vacant crown land
56	VCL & PP	M	Multiple
57	VCL PP	M	Multiple
58	VCL/NPWS/Priv	M	Multiple
59	VCL/PP	M	Multiple
60	VIC	OGA	Other government authority/Interstate
61	VICTORIA	OGA	Other government authority/Interstate
62	VL	VL	Vacant crown land
63	Various	M	Multiple
64	WA	OGA	Other government authority/Interstate
65	WA/NPWS	M	Multiple
66	WLL	U	Unknown
67	npws	NPWS	National Parks & Wildlife Service
68	pp	PP	Private property/Leasehold
69	sf	SF	State forests
70	xxx (missing)	XX	Unknown

**Victorian Department of Sustainability and the Environment:** The tenure categories used in the DSE analysis were as those provided, except that:

- the two categories, ‘Occupied crown land within FPA’ and ‘Occupied crown land outside FPA’ were collapsed to a single category titled ‘Occupied crown land’
- the two categories, ‘Private property within FPA’ and ‘Private property land outside FPA’ were collapsed to a single category titled ‘Private land’.

**Forestry Plantations Queensland:** Some modification were made to the tenure categories used in the FPQ analysis relative to that provided, as indicated in Table 22.

<b>Entry</b>	<b>Tenure (provided)</b>	<b>Tenure (generated)</b>
SF	State forest	State forest
Sf	State forest (error)	State forest
NP	National park	National park
LGR	Local govt reserve	Local govt reserve
USL	Unallocated state land	Vacant crown land
VCL	Vacant crown land	Vacant crown land
CFHD	Crown freehold	Other government authority
CWR	Camp & water reserve	Other government authority
FR	Forest reserve	Other government authority
MRD	Main roads	Other government authority
RLWR	Railway Dept reserve	Other government authority
ROAD	Shire roads & stock routes	Other government authority
FREE	Freehold land	Private property/leasehold
GHFL	Grazing homestead perpetual lease (error)	Private property/leasehold
GHPL	Grazing homestead perpetual lease	Private property/leasehold
MISC	Miscellaneous	Other
SL	Special lease	Other
TR	Timber reserve	Other
UNK	Unknown	Unknown

**Department of Environment and Conservation (WA):** Tenure categories as provided.

### Specific location information

Many databases, particularly those database following the AIRS format, document specific information about where a fire started, including the area of origin, the use of the property and the type of complex where the fire occurred. Unfortunately the information available for analysis varied markedly between agencies.

## Area of origin

This variable is only relevant to databases using AIRS classification codes. Area of origin refers to the area within a property where the fire originated, being defined by the use at the time of fire ignited. This variable was only in the Victorian CFA analysis.

**Victorian Country Fire Authority:** The area of origin information supplied by the CFA was summarised using the division outlined in the AIRS database, including ‘means of egress’, ‘assembly, sales areas (groups of people)’, ‘functional areas’, ‘storage areas’, ‘service facilities’, ‘service, equipment areas’, ‘structural areas’, ‘transportation, vehicle areas’, and ‘other’ locations. However, the ‘fields’, ‘lawn, field, open area’, ‘scrub or bush area, woods, forest’, ‘on or near railroad right of way, embankment’, ‘on or near highway, roadway, street, public way, parking lot’ and ‘vacant structural area with no current use’ which are included under the ‘other’ divisional category in the AIRS database, were delineated as separate categories. A separate category for ‘crops, grain, grain handling equipment’ was also delineated.

## Complex type

This variable is only relevant to databases using AIRS classification codes. According to the AIRS definition a complex is a property complying with all three of the following:

- under one management and ownership
- located within a continuous boundary and
- with multiple uses, that is:
  - a single building with two or more property uses
  - more than one building with the same or different fixed property uses
  - other property uses.

Complex type was used across a number of urban and rural fire services. Where complex types are used, they directly reflect the categories defined within the AIRS database, although in some cases the labels have been abbreviated.

## Property use

This variable is only relevant to databases using AIRS classification codes. The type of property use refers to the use of the property at the time the fire occurred. The property use variable used in the analysis is as defined in the AIRS database, with exceptions as outlined in Table 23.

**Table 23: AIRS codes and property use category used**

AIRS code	Property use
200 to 299	Educational property
300 to 399	Institutional property
400 to 499	Residential property
500 to 599	Shop, store, office
700 to 799	Manufacturing property
800 to 899	Storage property
100 to 109	Public assembly – other
110 to 119	Fixed use amusement
130 to 139	Churches/funeral parlours
140 to 149	Clubs
150 to 159	Libraries/museums/courts
160 to 169	Eating/drinking places
170 to 179	Passenger terminals/stations
180 to 189	Theatres/studios
600 to 609	Industry, utility, defence – unclassified
610 to 619	Nucleonics/energy production
620 to 629	Laboratories
630 to 639	Communication/defence
640 to 649	Utility/energy distribution
900 to 909	Under construction/demolition
910 to 919	Landfill/dump sites
920 to 929	Special structures
940 to 949	Water areas
950 to 959	Railway property
960 to 969	Road/parking
970 to 979	Aircraft areas
980 to 989	Equipment operating areas
1 to 99	Unknown
997	Unknown

### Type of property

**South Australian Metropolitan Fire Service:** The property use variable was not available in the dataset supplied by the SAMFS. However, it was possible to ascertain some information from the ‘premises’ variable. The following subcategories were generated: aged care, beach/marine/wharf, business, cemetery, child care, community centre, construction/demolition, correctional facilities, dump/rubbish, education, government organisation, hotel, mass transport, medical centre-hospital-ambulance, near non-marine waterway (includes near creek, canal, under bridges), other community facility, other open space, other organisation, recreation complex/sports ground or club, religious facility, reserve-park, residential, road complex, scrub/grassland, vacant or crown land, walkway/bike-path. To a certain extent these judgments were subjective. In several instances fires recorded as occurring ‘near a railway line at the back of such-and such school’ were coded as ‘school’ rather than ‘mass transport’.

All fires at educational facilities were further subdivided by the educational level, into kindergarten/preschool, primary school, high school and tertiary/adult. The tertiary/adult category included universities, TAFE and adult education centres. Where no information was available, the type of school was classified as unknown. Mass transport was subdivided into air, rail and bus. Where sufficient information was available, businesses were subdivided into shopping complex/supermarket, restaurant-fast food outlet, petrol stations, and other. The other category includes industrial businesses, and may include the above categories if no specific information was available.



## Timing

The year, week of the year and day of the week a fire occurred were calculated from the date variable list in Table 4. For all but the Northern Territory, fire seasons were based on the financial, rather than calendar, year to ensure that a particular bushfire season was not split between two successive years.

Detection times were subdivided into 24 x 1 hour blocks. There are potentially some inaccuracies between the actual time the fire started and the time the alarm was raised. The length of that delay may vary not only between the fires themselves but also between the type of agency concerned, as the detection of fires is highly dependent on the movement of people in the environment, which in turn is related to the remoteness of the locality and the time the fire occurred. Any time listed as 0 or where data was missing the time was treated as unknown.

## Area

The analysis of area burned was based on two types of information: the total area burned, and the frequency of fires that occurred within a particular size range (area category).

### Total area burned

The total area burned was used as provided although in some cases it was necessary to sum the area burned across tenure categories, as follows:

#### State Forests NSW:

Total area burned = 'area – State forests' + 'Loss plant' + 'Area – NPWS' + 'Area – other'

#### NSW National Parks and Wildlife Service:

Total area burned = 'area (NPWS)' + 'area Other'

#### NSW Rural Fire Service:

Total area burned = 'private ha' + 'local government ha' + 'national park ha' + 'state park ha' + 'forest reserve ha' + 'nature reserve ha' + 'other public ha' + 'defence department ha' + 'other federal ha'

#### Forestry Plantations Queensland:

Total area burned = 'Burnt OCL (ha)' + 'Burnt freehold (ha)' + 'Area burned (ha)'

### Total area categories

The following 'total area burned' categories were defined for all databases where area burned information was available for individual fires:

- Less than 1 ha
- 1–1.99 ha
- 2–2.99ha
- 3–3.99 ha 4–4.99 ha
- 5–9.99 ha
- 10–49 ha
- 50–99 ha
- 100–499 ha

- 500–999 ha
- 1000–1499 ha
- 1500–1900 ha
- 2000–4999 ha
- 5000–9999 ha
- 10,000–49,999 ha
- 50,000–99,999 ha
- Greater than 100,000
- Unknown: Missing, unknown cases.

## Vegetation

Many rural fire services and land management agencies provided information about the type of vegetation burned in the fire. This refers to the dominant type of vegetation. The data available for analysis, and in some cases the way that data were summarized, varied somewhat between agencies, as outlined below.

**NSW Rural Fire Service:** vegetation data provided by the NSWRFSS were summarised as outlined in Table 24.

**Victorian Department of Sustainability and the Environment:** Vegetation codes as provided.

**Victorian Country Fire Authority:** The vegetation fields used in the analysis were summarised as outlined in Table 25.

**Table 24: Vegetation categories provided and vegetation type used for New South Wales Rural Fire Service data.**

Vegetation type (provided)	Vegetation type (generated)
Orchards, vineyards	Crops, vineyards, orchards
Crops	Crops, vineyards, orchards
Heathlands (wallum), scrub (southern Australia)	Heathland
Mallee	Mallee
Native eucalypt forest <15m	Native eucalypt forest
Native eucalypt forest 15–35m	Native eucalypt forest
Native eucalypt forest >50m	Native eucalypt forest
Native eucalypt forest 35–50m	Native eucalypt forest
Native grasslands (may be grazed)	Native grassland
Native hummock grasslands, including spinifex, buttongrass	Native grassland
Vegetation type not applicable	Other
Alpine (woodland, herb field)	Other
Native forest, rainforest (generally non-burning)	Other forest
Native trees regenerated after harvesting	Other forest
Native cypress pine forest	Other forest
Grassland, scattered trees	Other grassland
Improved grasslands, grassed areas, grazing	Other grassland
Plantations – native hardwood (blue gum, mountain ash, blackwood)	Plantation – hardwood
Plantations – exotic softwood (pine)	Plantation – softwood
Plantations – native softwood (cypress)	Plantation – softwood
Vegetation type not classified	Unknown
Vegetation type; insufficient info to classify	Unknown
Vegetation type undetermined	Unknown

**Table 25: Vegetation categories provided and vegetation categories used for Victorian CFA data**

Provided	Used
Alpine (woodland, herb field)	Alpine/Sub-alpine
Sub alpine woodland	Alpine/Sub-alpine
Crops	Crops
Grassland, scattered trees	Grassland, scattered trees
Heathlands (wallum), scrub (southern Australia)	Heathlands/scrub
Improved grasslands, grassed areas, grazing	Improved grasslands
Mallee	Mallee
Native cypress pine forest	Native cypress pine forest
Native eucalypt forest <15m	Native eucalypt forest
Native eucalypt forest >50m	Native eucalypt forest
Native eucalypt forest 15–35m	Native eucalypt forest
Native eucalypt forest 35–50m	Native eucalypt forest
Native forest, rainforest (generally non-burning)	Native forest, rainforest (generally non-burning)
Native grasslands (may be grazed)	Native grassland
Native hummock grasslands, including spinifex, buttongrass	Native grassland
Native trees regenerated after harvesting	Native – regeneration
Orchards, vineyards	Orchards, vineyards
Plantations exotic softwood (Pine)	Plantation – softwood
Plantations native hardwood (Blue gum, Mountain ash, Blackwood)	Plantation – hardwood
Plantations native softwood (Cypress)	Plantation – softwood
Vegetation type not applicable	Vegetation – unknown
Vegetation type not classified	Vegetation – unknown
Vegetation type undetermined	Vegetation – unknown
Vegetation type; insufficient info to classify	Vegetation – unknown
Vegetation type not applicable	Not applicable

**Forestry Plantations Queensland:** The 37 vegetation species provided by the FPQ were summarised into 6 major categories as follows:

- *Grass*.
- *Hardwoods*: includes the Belah, Blackbutt, Blackdown stringybark, Broad-leaved Red ironbark, Bull oak, Forest red gum, Grey gum, hardwood, hardwoods, Narrow-leaved red ironbark, Scribbly gum, Southern silky oak, Spotted gum, and White Mahogany categories.
- *Introduced pine*: includes Caribbean pine (var. bahamensi), Caribbean pine (var. caribaea), Caribbean pine (var. hondurensis), Elliottii x Hondurensis, F1 hybrid, F2 hybrid, Loblolly pine, Patula pine, Radiata pine, and Slash pine categories.
- *Native pine*: includes Bunya pine, Coast cypress pine, Cypress, Hoop pine, Queensland kauri pine categories.
- *Other*: includes dry sclerophyll, other, rainforest, wallum, wet sclerophyll categories.
- *Unknown*: includes all unknown, missing and or improperly coded data.

**South Australia Country Fire Service:** vegetation categories used were as supplied except that the following categories – ‘not classified’, ‘undetermined’, ‘insufficient information’, ‘9’, and absent data were classified as ‘unknown’.

**Tasmanian Fire Service:** vegetation fields supplied by the TFS were summarised in the analysis as indicated in Table 26.

**Table 26: Vegetation categories provided and vegetation type used for Tasmanian Fire Service data**

Vegetation type (original)	Vegetation (generated)
Crops	Crops, orchards, vineyards
Orchards, vineyards	Crops, orchards, vineyards
Plantations exotic softwood (pine)	Forest – plantation
Plantations native hardwood (blue gum, mountain ash, blackwood)	Forest – plantation
Plantations native softwood (cypress)	Forest – plantation
Alpine (woodland, herb field)	Forest/woodland – native
Grassland, scattered trees	Forest/woodland – native
Heathlands (wallum), scrub (southern Australia)	Forest/woodland – native
Native cypress pine forest	Forest/woodland – native
Native eucalypt forest 15–35m	Forest/woodland – native
Native eucalypt forest 35–50m	Forest/woodland – native
Native eucalypt forest <15m	Forest/woodland – native
Native eucalypt forest >50m	Forest/woodland – native
Native forest, rainforest (generally non burning)	Forest/woodland – native
Native trees regenerated after harvesting	Forest/woodland – native
Sub alpine woodland	Forest/woodland – native
Improved grasslands, grassed areas, grazing	Grasslands – improved
Native grasslands (may be grazed)	Grasslands – native
Native hummock grasslands, including spinifex, buttongrass	Grasslands – native hummock
Mallee	Other
Vegetation type not applicable	Other
Vegetation type not classified	Other
Vegetation type undetermined	Unknown
Vegetation type; insufficient to classify	Unknown

**Department of Environment and Conservation (WA):** Vegetation categories as provided.

**Northern Territory Fire and Rescue Service:** The summarised vegetation fields used in the analysis of NTFRS data are provided in Table 27.

**Table 27: Vegetation categories provided and the vegetation type used for Northern Territory Fire and Rescue Service data**

Vegetation type (provided)	Vegetation (generated)
Crops	Crops
Native grasslands (may be grazed)	Grasslands
Improved grasslands, grassed areas, grazing	Grasslands
Native hummock grasslands, including spinifex, butt	Grasslands
Heathlands (wallum), scrub (southern Australia)	Heathlands, scrub
Mallee	Mallee
Native forest, conifer (e.g. cypress).	Native forest, conifer
Native forest, rainforest (generally non-burning)	Native forest, rainforest
Native sclerophyllous forest >50m, dominated by eucalyptus	Native sclerophyllous forest
Native sclerophyllous forest <15m, dominated by eucalyptus	Native sclerophyllous forest
Native sclerophyllous forest 15–35m, dominated by eucalyptus	Native sclerophyllous forest
Native sclerophyllous forest 35–50m, dominated by eucalyptus	Native sclerophyllous forest
Orchards, vineyards	Orchards and vineyards
Vegetation type not classified above	Other
Vegetation type not applicable	Other
Alpine (woodland, herbfield)	Other
Silvicultural regeneration	Other
Plantations native softwood	Plantation – hardwood
Plantations exotic softwood	Plantation – hardwood
Savannah	Savannah
Plantations native hardwood	Savannah
Vegetation type undetermined	Unknown
Vegetation type; I/I to classify further	Unknown

## Fire restrictions/fire bans

For the Queensland Fire and Rescue Service, Metropolitan Fire and Emergency Services Board, Fire and Emergency Services Authority, the data fields used in each analysis were as provided except that:

- fires within the 'fire restrictions not applicable ' and 'fire restrictions not classified above' have in some cases been combined into a single category titles 'not applicable/not classified'
- fires within 'fire restrictions and total bans undetermined' and 'fire restrictions and total bans not reported' have been combined into a single category titled 'undetermined/not reported'.

For the Victorian Country Fire Authority, data fields were as above, except that those where the fire restriction was listed as 'restrictions not classified' were incorporated into the unknown category.

## Fire danger index

The fire danger index rating used in Queensland Fire and Rescue Service, Metropolitan Fire and Emergency Services Board, and the Fire and Emergency Services Authority analyses were as reported, except that:

- fires in the 'Not applicable' and 'Not classified above' categories were combined into 'Not applicable/classified'
- fires in the 'Fire danger undetermined' and 'Fire danger not reported' categories were combined into 'Undetermined/not reported'.

**Forestry Plantations Queensland:** The numerical values provided were summarised as follows:

- Low: 1 to 5
- Moderate: 6 to 12
- High: 13 to 24
- Very high: 25 to 50
- Extreme: 51 to 200
- Unknown: 0 and greater than 200.

## Type of environment

In the ACT Parks Conservation and Lands analysis, a 'type of environment' variable was generated, with individual fires assigned to the urban, urban-fringe, rural, and remote using the name of the reserve on which they occurred.

*Urban:* Aranda Bushland, Black Mountain, Bruce Ridge, City Parks, CNP (6 units), Cooleman Ridge, CUPPs, CUPPs Mt Stranger, Farrer Ridge, Ginninderra Creek, Gossan Hill, Gungahlin, Gungahlin Grasslands, Gungahlin Hill, Horse Paddocks, Horse Paddocks – Illoura, Horse Paddocks – Kaleen, Horse Paddocks – Mt Taylor, Horse Paddocks – Rose Cottage, Horse Paddocks – Yarralumla, Isaacs Ridge, Jerra. Wetlands, Lyneham Ridge, Mt Ainslie, Mt Majura, Mt Mugga Mugga, Mt Painter, Mt Pleasant, Mt Rogers, Mt Taylor, Mulligans Flat, Oakey Hill, O'Connor Ridge, Oxley Hill, Red Hill, Simpsons Hill, The Pinnacle, Tuggeranong, Tuggeranong Hill, Urban, Wanniasa Hills.

*Urban fringe:* ACT Forests, ACT Forests – Pierces Creek, ACT Forests – Stromlo, ACT Forests – Melrose, Cotter River, Googong Foreshores, Kowen, Majura Field Firing Range, Molonglo, Molonglo Gorge, MRC, MRC Cotter Reserve, MRC Bullen Range NR, MRC Gigerline NR, MRC Lanyon /Lambrigg CR, MRC

Lower Molonglo NR, MRC Pine Island, MRC Point Hut, MRC Stony Creek NR, MRC Kambah Pool, Rob Roy/Tugg Hill/NSW, Stromlo, Tidbinbilla, Urambi Hills.

*Rural:* MRC Tharwa, Rural, Rural – Huntley, Rural – Kambah Pool Rd, Rural – Majura, Rural – Melrose, Rural – Oaks Estate.

*Remote:* MRC Woodstock NR, NNP, NNP Boboyan FMU, NNP Tennent, NNP Cotter FMU 1, NNP Gudgenby, NNP LowCotter, NNP LowCotter FMU 1, NNP Naas FMU, NNP Orroral, NNP Tennent FMU1, NNP Upper Cotter FMU 2, Paddys River, Scabby Nature Reserve.

*Unknown:* ACT, NSW.

It is emphasised that these can be only a rough approximation, as the rapid expansion of the city has meant that some areas which were largely rural 30 years ago are now classified as urban. Also, the urban fringe grouping may include some reserves or locations that are somewhat distant from urban residential Canberra, but which receive a high flow of recreational users because of their proximity.

## Sources of background information

ABS 2005. *Tourism region maps and concordance files, Australia, 2005*. ABS cat. no. 9503.0.55.001. <http://www.abs.gov.au/ausstats/abs@.nsf/cat/3235.3.55.001>

ABS 2001a. *Australian standard geographical classification*. ABS cat. no. 1216.0. <http://www.abs.gov.au/ausstats/abs@.nsf/cat/1216.0>

ABS 2001b. *Postal area to statistical local area concordance, Australia, 2001*. ABS cat. no. 1253.0. <http://www.abs.gov.au/ausstats/abs@.nsf/cat/1253.0>

AFAC 1997. *Australasian Incident Reporting System instruction manual*. Mount Waverley Vic: Australian Fire Authorities Council

Davies C 1997. *Analysis of fire causes on or threatening public land in Victoria 1976/77–1995/96*. Melbourne: Department of Natural Resources and Environment. <http://www.dse.vic.gov.au/DSE/nrenfoe.nsf/FID/-4AFB74B010B7E9844A256862001C6C1D?OpenDocument>