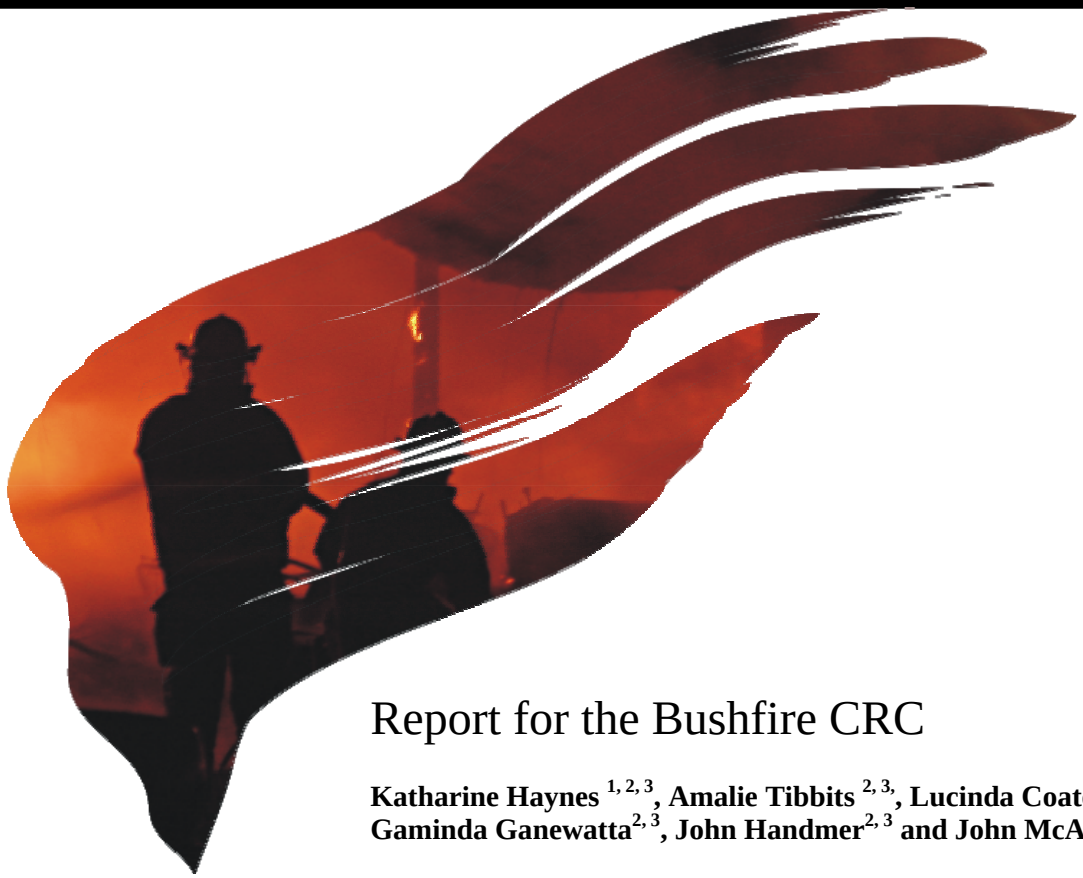
100 years of Australian civilian bushfire fatalities: exploring the trends in relation to the 'stay or go policy'



Report for the Bushfire CRC

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bushfire CRC

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> *"I was fairly sure that we would die there, as I didn't think we could stand up to the flames and the heat. I don't know how long we remained in the gutter. It couldn't have been more than an hour. Throughout the time that I was there I felt I was expecting help from some outside quarter. It wasn't until the time that I decided to get up that I realised fully that our only help lay with ourselves….."*

Survivor and witness of the Ash Wednesday Bushfires. Coronial Inquiry. No. 125/1983 Victorian Archives Office.

Abstract

Australian bushfire policy for community safety is unique. Rather than attempting to evacuate all those who may be in the path of a bushfire, fire authorities in all States allow the public to make a choice: either get out of the area early, or prepare to stay and defend homes and property from the fire. However, apart from a handful of post-fire investigations, no detailed research has ever been carried out into the circumstances of all recorded bushfire deaths in Australia. A detailed database of Australian bushfire fatalities has been created by Risk Frontiers as part of a larger database of Australian natural hazards. This was augmented through a thorough documentary analysis of forensic, witness and police statements within coronial inquest reports. The database includes details of 552 civilian fatalities over the last 100 years. It provides a unique opportunity to assess the circumstances in which people perished and the suitability of the 'stay and defend or leave early' policy.

Analysis of the data clearly shows the dangers of being caught outside during a bushfire, with the majority of fatalities occurring whilst victims flee the flames during late evacuations. The minority of deaths which occurred inside buildings were due to the inhabitants sheltering in place and not defending from ember attack. In addition to substantiating the 'stay and defend or leave early' policy, the analysis has demonstrated the heightened vulnerability of women, children and the elderly. This is due to their propensity to evacuate late and their greater reliance on others for assistance. In particular, there is evidence of a gendered division of roles and responsibilities during bushfires that contribute to these vulnerabilities. While men are most often killed outside, while at work or attempting to protect assets, most female fatalities occur while sheltering in the house or attempting to flee. The number of men killed by bushfires has decreased; however, this is not the case for women and children, who in recent years have died in relatively high numbers. Where possible, the decisions leading to fatalities have been examined based on people's awareness of

the fires and warnings and the effectiveness of the actions that they took to reduce their risk.

This report will cover the main trends emerging from an analysis of Australian bushfire fatalities over the past 100 years. Attention will be paid to the last 50 years and, in particular, to large fires within this time period. This work is funded by the Australian Bushfire Co-operative Research Centre.

Keywords: Vulnerability, gender and youth, wildfires, evacuation, policy.

1.0 Introduction

In Australia in the past century, bushfires have rated as the fourth most hazardous type of disaster in terms of death after heatwaves, tropical cyclones and floods (Coates, 2008). With the advent of climate change and predictions that the bushfire season is likely to become longer and bushfires more frequent and more intense (Hennessy *et al* 2006), it is crucial we are equipped with the best knowledge of how to reduce the risks to life presented by bushfires.

Australian bushfire policy for community safety is unique. Rather than attempting to evacuate all those who may be in the path of a bushfire, fire authorities in all States allow the public to make a choice: either get out of the area early, or prepare to stay and defend homes and property from the fire. In other countries with a high bushfire risk, such as the USA and parts of Europe, evacuation is still seen as the safest emergency management approach.

The Australian and Fire Authorities Council (AFAC) 'prepare, stay and defend or leave early'[1] policy is based on evidence from reports into some of Australia's worst bushfire tragedies, including the Hobart bushfires in February 1967 in which 64 civilians were killed and the Ash Wednesday fires in 1983 in which 60 civilians[2] were killed across South East Australia. Investigations into these deaths have revealed that (a) people were more likely to be killed by radiant heat or a vehicle accident while evacuating and (b) well-prepared houses can be successfully defended from bushfires and can provide safe refuge for people during the main passage of the fire front (McArthur and Cheney, 1967; Miller *et al*, 1984; Wilson and Ferguson, 1984; Lazarus and Elley, 1984; Leonard and McArthur, 1999; Leonard, 2003; Handmer and Tibbits, 2005; Tibbits *et al* 2008; Blanchi and Leonard, 2008).

However, despite the apparent robustness of the AFAC policy position, no detailed studies have examined the causes and circumstances of civilian deaths during a

[1] Henceforth the (AFAC) 'prepare, stay and defend or leave early' policy will be termed the 'AFAC policy position

[2] A number of volunteer fire-fighter personnel were killed in the Ash Wednesday fires in 1983, including the first female volunteer to be killed. This paper does not deal with fire-fighter deaths as we are interested in civilian actions: however the great sacrifice made by all fire-fighters is recognised.

number of different bushfires over a significant time-period. For the first time ever, this paper will detail an analysis of the circumstances leading to all civilian bushfire related deaths in Australia over the last 100 years.

A number of reports, books and website sources document the number of people, livestock and properties destroyed in various bushfires and the financial costs: however, none of these examine the circumstances of these deaths in any useful detail. Reputable electronic examples of these sources include the Emergency Management Australia (EMA) website (http://www.ema.gov.au/ema/emaDisasters.nsf) and the United States (US) National Interagency Fire Centre website (http://www.nifc.gov/fire_info/historical_stats.htm). There have been few detailed investigations of the circumstances of these deaths. Limited examples include an investigation by the US Texas Department of State Health Services (TDSHS) after the Texas wildfires on 12 March 2006, which killed eleven civilians (TDSHS, 2007). This study identified five separate incidents that led to the deaths: eight were killed directly or indirectly because of vehicular accidents, two because of late evacuation and one from refusal to evacuate (sheltered passively in the home). An investigation in Australia by Krusel and Petris (1999), which examined the 1983 Ash Wednesday civilian deaths in Victoria, is the only study to examine coronial records in order to carry out a detailed examination of the actions of bushfire victims before their deaths. This study identified that the majority of victims died during a late evacuation as the fire front arrived or because they were incapable of implementing a safe strategy due to inadequate warning, age and infirmity.

2.0 The Risk Frontiers natural hazard datasets

Databases on the occurrence and consequences of natural hazards in Australia have been compiled by researchers at Risk Frontiers (formerly the Natural Hazards Research Centre) since 1994, covering the period from white settlement to the present. These databases are distinguished from other similar databases by the wealth of descriptive detail (garnered from newspaper and government reports) concerning data about any fatalities including names of the deceased and also the hazard impact. Examples of other natural hazard databases within Australia include EMA Disasters Database; Geoscience Australia (landslide, earthquake, tsunami); Insurance Council of Australia Historical Catastrophe Disaster List and Bureau of Meteorology Severe Weather Database. Other natural hazard databases within the USA include the NOAA Natural Geophysics Data Center (NGDC (earthquake, volcano and tsunami) and various datasets held by FEMA, the. However, as Blong (2004) noted, very few, if any, other countries have such a sound assessment of the impacts of natural hazards integrated into a single database as that held by Risk Frontiers.

In 1999 the separate databases were integrated into one large Natural Hazards Database at Risk Frontiers via Access, a relational database.

The Natural Hazards Database, refined and screened, underlies the PerilAUS CD-Roms, which were created in order to make the information available to the insurance industry for use in the formulation of underwriting strategies. PerilAUS 1 focussed on historic and recent information on the incidence, consequences and insurance losses of nine natural perils in Australia – tropical cyclones, floods, bushfires, wind gusts, hail storms, earthquakes, tornadoes, landslides and tsunamis. It included event summaries and analyses, damage indices, insurable tangible damage, risk assessments, maps, illustrations, newspaper clippings and references to salient literature for nearly 5,000 events.

In order for meaningful data on the magnitude, frequency, occurrence and consequences of a particular hazard to be determined, a record length of 100 years (1900 to 1999) was adopted. The inclusion of metadata (data about the data - hazard information, in this case) means that not only are we able to estimate the one in one hundred year event, we can also be reasonably sure of how accurate that estimation is.

As well as containing information on the physical characteristics of the hazard and the damage caused, these databases can be interrogated for trends in fatalities. Lines of investigation have concentrated on population vulnerability with respect to location and seasonality of the hazard event and the gender, age and activity of the victim at the time of death. The Flood Fatalities Database illustrates some of these trends. In terms of loss of life (from 1900 to 1999), heatwaves have been the most significant natural hazard in Australia (with the possible exclusion of disease hazards). Floods and tropical cyclones tie for second place and bushfires rank third. (The fatalities data within the tropical cyclone database is as yet incomplete.)

The Bushfires Database was one of the first databases created. The Sydney Morning Herald (SMH) and, before it, the Sydney Gazette (dating from 1831 and 1803 respectively) were rigorously searched for any mention of bushfires (and other natural hazards) within Australia that caused fatalities and/or damage to buildings, agriculture and farm fixtures, infrastructure and lifelines. Where available, data was also collected on the economic, social and environmental impacts of the event and on the number of people injured, evacuated and/or homeless. Information on the physical characteristics of each bushfire event was included. Due to the very many different ways reporters described the magnitude of bushfires, the Blanche Scale of Bushfire Magnitude was developed.

This scale ranges from 1 (mild) to 5 (extremely severe). A fire scored a "Blanche" scale of 1 (mild) if it was of slow spread, low intensity, low level of spread and involved a small area burnt (depending on duration) and usually only one ignition point. Such fires would often be associated with low temperatures, high humidity (noting wind direction), low wind speed, recent high rainfall, level or undulating terrain, a vegetation type not prone to prone, moist fuel and/or low fuel build-up. A fire scored a "Blanche" scale of 5 (extremely severe) if it was of rapid spread, high intensity (fireballs), high level of spread (crowning) and often involved an extensive area burnt and many ignition points. Such fires would often be associated with high

temperatures, low humidity (noting wind direction), high wind speed, drought, steep slopes or mountainous terrain, fire-prone vegetation types, dry fuel and/or high fuel build-up. Fires were ranked scale 2 (moderate) if they were similar to a mild fire but with some mention of a factor likely to make the fire greater than mild – eg dry fuel, or rapid spread, or wind-assisted spread etc. Fires were ranked scale 3 (moderately severe) if they were similar to a mild fire but with some mention of several factors likely to make the fire greater than mild or moderate – eg build-up of dry fuel and high temperatures and strong wind. Fires were ranked scale 4 (severe) if they were similar to an extremely severe fire but there was no mention of crown-spreading or fireballs.

The wealth of descriptive detail collected was extended by reference to an extensive series of nationwide major and local newspaper reports collated by the CSIRO, dating from 1940 to 1987, in order to counter any spatial bias created by basing entered events on the major newspaper for Sydney, NSW. Newspaper reports, while containing valuable narrative detail, can contain inaccuracies, especially when passing on unfounded reports and can be biased towards more newsworthy events. This was balanced, as much as possible, by the inclusion of government and other reports – for example, for the earlier years, the Bureau of Meteorology Bulletin no. 48 (Foley, 1947) and, for the later years, the severe weather summaries of the Bureau of Meteorology's Significant Weather series (1996-2008).

For the present study, Risk Frontier's Bushfire Database was updated to January 2006. Death rates have been explored with a view to examining any trends in the vulnerability to bushfire hazards. By incorporating population figures (from ABS census and annual population estimates data), a death rate per 1,000,000 population was estimated.

2.1 Investigation of coronial records to augment the bushfire fatality database

As the bushfire database was now being considered in respect to the AFAC policy position, a purpose not envisioned when it was originally collected, it was decided, wherever possible, to re-examine each fatality. This involved searching coroners' reports for each death, using them to establish the circumstances of the death with respect to the AFAC policy position, and then coding the data according to these findings. As already stated, the Risk Frontiers datasets are unique as, unlike most other fatality data-sets, many names of the deceased had been recorded. This enabled a thorough documentary analysis of forensic, witness and police statements within coronial inquest reports from 1901 to 2007/08. The relatively high level of detail resulting from this comprehensive research provides a unique opportunity to assess the circumstances of each individual fatality, enabling a thorough analysis of their actions and also the socio-demographic relationships at play.

An example of the wealth of information obtained from the coronial files, in particular from the witness statements, is shown in the extract below (Box 1).

Box 1

On the 16th of January, 1962 the witness travelled to his friend's house to help defend it from the fires. These friends had their grandchildren staying.

'*as the fire was approaching I was hosing the outside of the house and the grass around the house. When the fire was about a quarter of a mile away sparks started falling around the house setting the grass on fire. My friend started to panic and said he was going to get his wife and grandchildren to safety. He drove off in his utility, I started to follow but considered that it was to be safer back at the house, so I reversed my car and remained at the house hosing the house, car and shed. All of which were saved. After the fire a person came and asked me if I knew that a man, woman and two children were dead in the centre of the road*'

Their car had crashed head on into a tree and their bodies were found 200 yards further down the road. [Coronial Inquiry No 1962/1495 Victorian archives office.]

The value of verifying stories in the database using coronial reports proved invaluable in achieving maximum accuracy and established reliable metadata for the majority of the fatalities. In practice, this means that for many of the entries there is a link to a detailed independent report that has legal status and is available for review or verification.

Data on deaths in general is notoriously unreliable in terms of the cause of death and numbers (e.g. see Mathers *et al*, 2005), and is almost always available only in aggregated form: that is, as statistics rather than individual incidents, making it impossible to re-analyse the exact circumstances surrounding individual deaths. For example, a publicly available US hazard related death dataset, SHELDUS, presents numbers of statistical deaths by 18 types of hazard but only at the county level. This dataset has other limitations such as an event threshold, which excludes many deaths. In addition, analysis of death data is typically bedevilled by statistical issues such as the problem of drawing inferences from small numbers.

The process for recording deaths is now a specialist task requiring extensive training and within Australia, since January 1997, multiple causes and underlying conditions may be recorded (ABS Information paper, 2005). Earlier death data was recorded as a single cause of death by a medical practitioner.

Despite increasing accuracy, it must be acknowledged that coronial reports may not be precise in their representation of events and findings, as they are based only on the information available. In addition, there are many inconsistencies with names, ages and dates, and some of the deaths investigated in this study did not have inquests, especially if death occurred some time after the fire event in hospital. In other cases, inquest reports are now missing. Often the information, when found, was disappointing due to a lack of detail or witnesses not disclosing a full account of the events. The impact of this on the database is a varying level of detail for each death and in particular the response from Western Australia was disappointing. Generally, more recent events have more detail and, in particular, coronial reports produced since the 1983 fires contain information directly relevant to the analysis in relation to the AFAC policy position .

The updated bushfire database includes details of 552 civilian fatalities between 1900 and the 2007/2008 fire season. The information pertaining to fire-fighter fatalities has been removed in order to concentrate on civilian deaths.

2.2 General information on fatality studies

A number of important issues have been raised in studies of fatalities from other hazards (dominantly floods).

Analyses of flood deaths have demonstrated that, in many cases, individuals become exposed to greater risk by attempting to flee the flood-affected area (Coates, 1999; Jonkman and Kelman, 2005; Reiter, 2000; Drobot *et al*, 2007; Ashley and Ashley, 2008). These deaths are often associated with motor vehicles as drivers attempt to cross flooded roads: such deaths account for more than half of all flood fatalities in the United States (Drobot *et al*, 2007).

A number of authors (Coates, 1999; Jonkman and Kelman, 2005; Ashley and Ashley, 2008) have identified a gender and age bias, with males and those aged between 10–29 and >60 overrepresented in flood death statistics. However, although flood fatalities have received greater attention than bushfire deaths, the trends within flood fatalities and the identification of vulnerable groups have not been well examined across several flood disasters (Jonkman and Kelman, 2005; Jonkman and Vrijling, 2008). In addition, despite the fact that the majority of flood deaths have occurred in developing countries, most studies have been limited to the US, with a few in Europe and Australia. Evidence from developing countries well demonstrates the increased vulnerability of women, children and the elderly to extreme events (Enarson and Lourdes, 2004; Fordham, 1999).

3.0 Analysis of the data [3]

The data was analysed in relation to informing the understanding of circumstances surrounding the deaths and how this information could best be utilised to inform improvements to and implementation of the AFAC policy position. The data was grouped into four broad groups: demographics, medical cause of death, transport and location of the deceased and activity and decision-making prior to death.

Demographics

Division into age and gender groups allowed the analysis to consider whether certain groups possess a heightened vulnerability.

Medical cause of death

This covered an assessment of the actual cause of death: that is, was the death caused by the flames and heat, leading to burns or asphyxiation (immediately or, in some cases, many weeks after the fire) or from the impact from a falling tree limb, a heart attack from overexertion or injuries received from a car accident, etc. As discussed above, it is understood that a victim's vulnerability to bushfires may be due to a number of reasons beyond a medical cause of death and these will be explored in as much detail as possible [3].

Transport and location of the deceased

This category determines if the deceased was in a car or another form of closed or open transport and if they remained in or on the vehicle or tried to evacuate from the vehicle on foot. Sargeant *et al* (2007) demonstrate that, although it is dangerous to be caught in a vehicle, there is an increased likelihood of surviving the passage of a bushfire if passengers remain inside and take protective action.

Activity and decision making prior to death

Where people were, what they were doing (inside the house defending or passively sheltering, defending wider property and livestock, evacuating from or to a shelter, travelling through an area for work or pleasure, etc.) and why they made these decisions are crucial in gaining an understanding of why these deaths occurred. A key element of the policy is that people are prepared for bushfire and act on a prior decision to stay and defend or leave early. This element of analysis looks in detail at the types of warnings victims received and how they responded to the threat. However, deciding whether people had sufficient warning or not and then, based on this, examining people's survival decisions is problematic. Although the available information is limited, we have tried where possible to categorise people's decision-making using two coding schemes. The varying levels of detail available for each fatality sometimes required a small number of assumptions to be made, particularly concerning the defendability of the property. This made the coding a balance between the need to maximise the usefulness of the information extracted without diminishing the accuracy of the interpretation of the data. Those fatalities for which there was not

[3]Please email the corresponding author for a detailed copy of the coding scheme.

enough information available to make a judgment were labelled as unknown. The categories are as follows:

Activity at time of death

- **Late evacuation**
  - from a shelter which is thought to be defendable
  - from a place of work outside
  - destination or origin unknown
  - from an undefendable shelter

- **Defending property outside**
  - in a suburban location - saving livestock, livelihood or defending wider property, i.e. caught just outside their home, friend's home, local community or place of work
  - in a rural location - saving livestock, livelihood or defending wider property or place of work, i.e. large farm or timber mill

- **Inside a defendable property**
  - actively defending
  - very meagre and unsuccessful attempts to defend
  - passively sheltering
  - activities unknown

- **Travelling through the area for work unrelated to fire and unaware of the fire**
- **Travelling through the area for pleasure e.g. picnic and unaware of the fire**
- **Left safe area and deliberately entered fire area, i.e. to defend or rescue property or loved ones**
- **Waiting to be rescued or assisted**
- **Assisting fire fighting operations in a professional capacity, i.e. forestry worker**
- **Returned into burning building to rescue loved ones or possessions**
- **In an undefendable shelter**
- **Unknown activity at time of death**

Decision making at the time of death
These categories are loosely adapted from the scheme devised by Krusel and Petris (1999) for their analysis of the Victorian Ash Wednesday deaths in 1983.

1. Physically and/or mentally incapable of implementing an effective survival strategy (also includes shock, drugs and alcohol).
2. Aware there was a fire in their area with enough time to save their lives and were proactive, carrying out a premeditated action which was ineffective.

3. Aware there was a fire in their area with enough time to save their lives and either had no plans or didn't follow them and acted in panic.
4. Unaware there was a fire and only realised when it was too late to implement an effective survival strategy.
5. Extenuating circumstances affected plans, e.g. heart attack.
6. Unknown.
7. All children with their parents/guardians at the time of death.

The key assumptions made within this category concern the warnings received, the level of preparedness and the ability of the deceased. Much of the data is not detailed enough in respect to timing and types of warnings the deceased received, their level of preparedness or their previous fire experience and/or knowledge. In these cases, other information recorded in the files was used to ascertain why people took certain actions. Where people were actively trying to defend their house or wider property, or make preparations to do so, it has been assumed they fitted into Category 2. People who were actively defending or making preparations to do so, but then attempted a last minute evacuation or changed their actions were generally placed in Category 3. Where there was just a last minute attempt to flee with little defensive action taken, Category 4 was adopted. All children who were with their parents or guardian were placed into Category 7, as children are often not in control of what happens to them and follow the instructions of their parents or guardians.

Where there is little detail of the circumstances of a death, it has been assumed that those aged 70+ would not be physically capable of defending their homes. It is acknowledged that this is a simplistic inference and the complexities are discussed in further detail below.

4.0 Results

Data will be displayed for the total time period (1900 to 2007/08) and also divided into two in order to look in detail at the most recent 52 years (1956 to 2007/08) and compare this with the first 56 years of the last century (1900 to 1955). Although not an equal division in terms of time, these two time periods are considered a fair comparison as the information up to 1905 is very sparse. In addition, as the data is skewed by large fire events, it is sensible to examine these events rather than looking at finer divisions of time. We will therefore consider the Hobart, Tasmania fires of 1967, the Lara, Victoria fires of 1969, the Ash Wednesday fires in Victoria and South Australia of 1983 and the Eyre Peninsula, South Australia fires of 2005.

Demographics

Table 1: Gender and age of those killed in bushfires over different time periods

Time period	**1900 to 2007/08**		**1900 to 1955**		**1956 to 2007/08**	
Total number killed	552		295		257	
Gender	Male	373 (67%)	Male	227 (77%)	Male	146 (57%)
	Female	147 (27%)	Female	48 (16%)	Female	99 (38%)
	Unknown	32 (6%)	Unknown	20 (7%)	Unknown	12 (5%)
Age	0-11	56 (10%)	0-11	35 (12%)	0-11	21 (8%)
	12-17	29 (5%)	12-17	13 (4%)	12-17	16 (6%)
	18-29	58 (11%)	18-29	32 (11%)	18-29	26 (10%)
	30-39	55 (10%)	30-39	24 (8%)	30-39	31 (12%)
	40-49	45 (8%)	40-49	21 (7%)	40-49	24 (9%)
	50-59	51 (9%)	50-59	17 (6%)	50-59	34 (13%)
	60-69	60 (11%)	60-69	20 (7%)	60-69	40 (16%)
	70>	59 (11%)	70>	23 (8%)	70>	36 (14%)
	Unknown	139 (25%)	Unknown	110 (37%)	Unknown	29 (11%)

From Table 1 it is clear that males are the dominant group killed in bushfires with some decrease apparent over time while the proportion of female deaths has increased. Figure 1 shows this distribution over time.

Figure 1: The distribution of male to female deaths since 1900

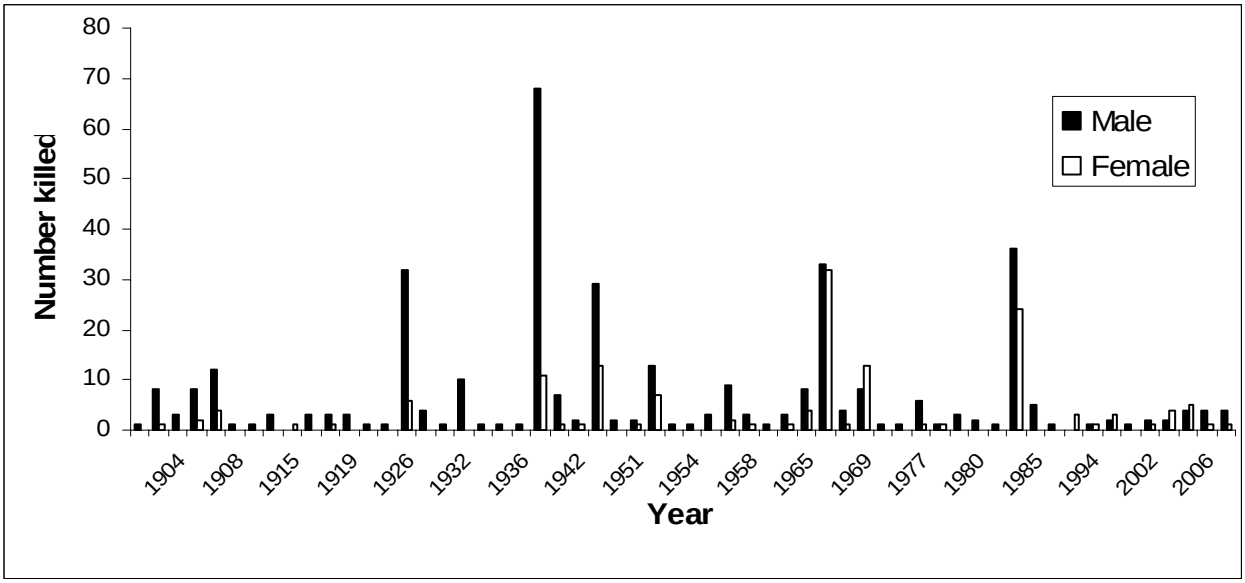


Table 2 illustrates the death rates by gender and decade. The overall and male death rates (and, to a lesser extent, the female death rate) show an overall downwards trend with time although this is not clearly defined. The male:female death rate ratio approaches equality in the more recent years and, in fact, was 0.4 for the decade 1990-99.

Table 2: Death rates with respect to gender

Decade	Male	Female	Total	Male:Female
1900-1909	16.4	3.7	12.3	4.4
1910-1919	4.9	0.8	4.1	6.1
1920-1929	12.7	2.1	7.7	6.0
1930-1939	24.1	3.3	14	7.3
1940-1949	10.8	4.1	8	2.6
1950-1959	7.4	2.2	4.8	3.4
1960-1969	9.9	9.1	10.2	1.1
1970-1979	1.7	0.3	1.2	5.7
1980-1989	5.7	3	4.5	1.9
1990-1999	0.3	0.8	0.6	0.4
2000-2007	1.7	1.2	1.4	1.4

The breakdown of the age of the victims (Table 1) shows no increased vulnerability of any age group, apart from a slight increase in the mortality rate of those in the 50 plus age groups during the most recent 50 years. Death rates were applied to the data, which was again divided this into decades (Table 3).

Table 3: Death rates with respect to age

Year	<18	18-29	30-39	40-49	50-59	60-70	> 70	Unknown	Total
1900-1909	3.3	0	0	0.3	0	0.5	0.8	7.5	12.3
1910-1919	0	0.2	0	0	0	0.2	0.4	3.3	4.1
1920-1929	2.0	0.5	0.5	0.3	0.2	0.2	0.2	3.7	7.7
1930-1939	1.9	3.1	2.2	1.5	0.8	1.2	0.9	2.4	14.0
1940-1949	0.5	0.8	0.5	0.7	1.2	0.8	1.0	2.4	8.0
1950-1959	1.0	0.2	0.7	1.0	0.3	0.3	0.4	0.9	4.8
1960-1969	1.2	0.4	1.1	0.5	1.0	2.1	2.1	1.8	10.2
1970-1979	0.2	0.2	0.2	0.2	0.1	0.1	0	0.5	1.2
1980-1989	0.6	0.9	0.5	0.3	1.0	0.7	0.5	0	4.5
1990-1999	0.2	0.2	0	0.1	0.1	0	0.1	0	0.6
2000-2007	0.2	0.1	0.3	0.2	0.3	0.2	0.2	0.1	1.5

This shows a marked decrease in death rates for the below 18 years age group and a slight decrease overall and in most other groups with time. Comparing the periods 1900-1955 and 1956-2007/08 gives a slightly lower average death rate for the latter period for most age groups, with the exception of the 50-59 and 60-69 age groups. The Hobart fires of 1967, where many older people were killed, had a marked effect on this result (this will be discussed further below).

Table 4 shows the total deaths by specific large fires or fire seasons where over 20 people were killed or a large area was burnt during severe fire weather conditions.

Table 4: Fatalities in severe fire seasons

Year (or fire season)	Numbers killed
1926	39
1939*	79
1944	46
1952	20
1967*	64
1969*	21
1983*	60
2003	6
2005*	9
2006/7	5

***** These fires were single devastating events: 1939, Black Thursday; Hobart, February 1967; 1969 Lara, Melbourne to Geelong highway on 8th January killing 18; 1983, Ash Wednesday; 2005, Black Tuesday, Eyre Peninsula, South Australia.

Table 5: Number of fatalities per state

State	Number	%
Victoria	296	54
New South Wales	105	19
Tasmania	67	12
South Australia	44	8
Queensland	17	3
Western Australia	17	3
Australian Capital Territory	5	1
Northern Territory	1	0
Total	552	100

The spatial distribution of the fatalities (Table 5) shows the majority of deaths have occurred in Victoria, followed by NSW and Tasmania. However, death rates tell a slightly different story.

Table 6: Death rates per 1,000,000 population per state

State	1900-2007	1900-1955	1956-2007
Victoria	27	27	8
New South Wales	102	120	22
Tasmania	203	9	151
South Australia	47	11	29
Queensland	19	13	8
Western Australia	12	0	6
Australian Capital Territory	9	11	2
Northern Territory	50	83	22

Table 6 shows that, over the period studied, Tasmania has by far the highest death rate, followed by Victoria (where the death rate is half of Tasmania's) and then the Australian Capital Territory and South Australia (where the death rate is halved

again). In the period 1900-1955, Victoria was the riskiest state in which to live with respect to dying in a bushfire, followed by the Australian Capital Territory. In the period 1956-2007, Tasmania was the riskiest by far and then South Australia (with one fifth the death rate), followed closely by Victoria and the Australian Capital Territory. These results reflect the fact that, although Australia's most severe fires, with respect to the human population, occur in the south-eastern states, two of those states (Victoria and New South Wales) have relatively large populations, thus tempering the raw spatial distribution data.

Table 7: Medical cause of death

Medical cause	Number	%
Flames, heat	427	77
Smoke	29	5
Heart attack, overexertion	27	5
Tree/limb fall	10	2
Vehicle accident	13	2
Drowned or fell	2	0.4
Unknown	44	8
Total	552	99.4

The data shows that the vast majority of victims succumbed to flames and heat. However, it is likely that the numbers of those who died from other medical causes - in particular, from smoke inhalation and heart-attacks - may be underrepresented in the data. Coronial examinations during the first half of the last century, if undertaken at all, were not as thorough as those of more recent times and the causes of many of these early deaths were simply labelled as 'burns received during a bushfire'.

Activity at the time of death and decision making

Table 8: Activity at time of death

Activity	1900 to 2007/08	1900 to 1955	1956 to 2007
Late evacuation	**176 (31.9%)**	**110 (37.3%)**	**66 (25.7%)**
Of these:			
- from shelter	100 (56.8%)	42 (38.2%)	58 (87.9%)
- from a place of work outside	53 (30.1%)	51 (46.4%)	2 (3.0%)
- destination or origin unknown	20 (11.4%)	16 (14.5%)	4 (6.0%)
- from an undefendable shelter	3 (0.8%)	1 (0.9%)	2 (3.0%)
Defending property outside	**145 (26.3%)**	**82 (27.8%)**	**63 (24.5%)**
Of these:			
- In a suburban location	42 (29%)	14 (17.1%)	28 (44.5%)
- In a rural location	103 (71%)	68 (83%)	35 (55.6%)
Inside defendable property	**46 (8.3%)**	**11 (3.7%)**	**35 (13.6%)**
Of these:			
- Actively defending	1* (2.2%)	0 (0.0%)	1* (2.9%)
- Meagre and unsuccessful attempts to defend	5 (10.9%)	1 (9.1%)	4 (11.5%)
- Passively sheltering	35 (76.1%)	9 (81.8%)	26 (74.3%)
- Activities unknown	5 (10.9%)	1 (9.1%)	4 (11.5%)

Activity	1900 to 2007/08	1900 to 1955	1956 to 2007
Travelling through the area unaware	**35 (6.3%)**	**7 (2.4%)**	**28 (10.9)%**
Of these:	6 (17.2%)	2 (28.6%)	4 (14.3%)
- Travelling for work	29 (82.9%)	5 (71.4%)	24 (85.7%)
- Travelling for pleasure			
En route to defend or rescue	**25 (4.5%)**	**10 (3.4%)**	**15 (5.8%)**
Waiting rescue	**8 (1.4%)**	**1 (0.3%)**	**7 (2.7%)**
Assisting fire fighting operations eg forestry worker	**12 (2.1%)**	**2 (0.7%)**	**10 (3.9%)**
Returned into burning building	**8 (1.4%)**	**2 (0.7%)**	**6 (2.3%)**
In an undefendable shelter	**8 (1.4%)**	**8 (2.7%)**	**0 (0.0%)**
Unknown activity at time of death	**89 (16.1%)**	**62 (21.0%)**	**27 (10.5%)**
Total	**552**	**295**	**257**

***** Died from a heart attack while defending in 1967

Table 8 shows that late evacuation is the dominant activity at the time of death. Although overall numbers of fatalities have decreased in recent times, particularly those who died while evacuating from working outside, the number of those who died while evacuating from shelter have increased. Defending property outside is the second most dominant activity, with the majority of deaths overall occurring in rural locations. However, while fatalities in rural locations (while saving livestock, livelihood or defending wider property or place of work, e.g. a large farm or timber mill) have halved during the most recent 50 years, those occurring in suburban locations have doubled. These suburban or semi-rural fatalities include those who were caught just outside their home, friends' home, local community or place of work.

For the 8% of bushfire fatalities who were inside a defendable property over the total time period, only one was in a defendable shelter and defending and the cause of death was a heart attack (Hobart fires, 1967). The vast majority were killed as they were passively sheltering, with most of these fatalities occurring in the more recent fires, particularly the 1967 Hobart fires.

Most of those who were killed while travelling through the area (predominantly in vehicles) and unaware of the fires were engaged in activities other than paid employment. Again the majority of these occurred during more recent fires, for example the 1969 Lara fires (where fires trapped a number of motorists on the Geelong to Melbourne highway).

Over the total time period the other victims include: 5% (25) en route to defend or rescue home, property or loved ones (i.e. left safe area and deliberately entered fire area); 1% (8) awaiting rescue; 1% (8) who returned to a burning building to rescue possessions or a loved one; and 1% (8) found in an indefendable shelter (e.g. dugout). No victims were killed while sheltering in an undefendable shelter in the

last 50 years. 2% (12) were killed while assisting in fire fighting operations, e.g. forestry employees.

Regarding Table 8, it can be seen that most males have been killed whilst defending property outside, mainly in rural locations (although in the last 50 years this approaches equality with the numbers killed in suburban locations). The next riskiest action is late evacuation: in the period examined, this occurred mostly from a place of work outside. In the latter period, however, this changed to evacuation from places of shelter. Most females were killed due to late decisions to evacuate and most of these from a place of shelter. The next riskiest action was to stay inside a defendable property – most of these deaths occurred while passively sheltering. Most under 18s also died from late decisions to evacuate, and mainly from shelter. The next riskiest action of this group was, for the first 50-year period, defending property outside and, for the most recent 50-year period, travelling through the fire area unaware of the danger. These figures are possibly a reflection of the higher responsibility placed on youths in former years with respect to defending property and livelihood.

Table 9: Relationship between gender, age and activity at time of death. (figures in brackets are percentages)

Activity [4]	1900 to 2007/08			1900 to 1955			1956 to 2007		
	Male	**Female**	**< 18**	**Male**	**Female**	**< 18**	**Male**	**Female**	**< 18**
Late evacuation	**81 (17.5)**	**48 (10.4)**	**47 (10.2)**	**60 (25.8)**	**20 (8.6)**	**30 (12.9)**	**21 (9.2)**	**28 (12.2)**	**17 (7.4)**
Of these:									
- from shelter	24 (29.6)	38 (79.2)	38 (80.9)	9 (15)	11 (55)		15 (71.4)	27 (96.4)	16 (94.1)
- from a place of work outside	44 (54.3)	5 (10.4)	4 (8.5)	42 (70)	5 (25)	22	2 (9.5)	0 (0.0)	0 (0.0)
- destination or origin unknown	10 (12.3)	5 (10.4)	5 (10.6)	8 (13.3)	4 (20)	(73.3)	2 (9.5)	1 (3.6)	1 (5.9)
- from an undefendable shelter	3 (3.7)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)	4 (13.3)	2 (9.5)	0 (0.0)	0 (0.0)
						4 (13.3)			
						0 (0.0)			
Defending property outside	**127**	**9 (1.9)**	**9 (1.9)**	**73 (31.3)**	**4** (1.7)	**5 (2.1)**	**54 (23.6)**	**5 (2.2)**	**4 (1.7)**
Of these:	**(27.5)**								
- In a suburban location		6 (66.7)	2 (22.2)	11 (15.1)	2 (50)	1 (25)	23 (42.6)	4 (75)	1 (25)
- In a rural location	34 (26.8)	3 (33.3)	7 (77.8)	62 (84.9)	2 (50)	4 (75)	31 (57.4)	1 (25)	3 (100)
	93 (73.2)								
Inside a defendable property	**15 (3.2)**	**27 (5.8)**	**4 (0.9)**	**4** (1.7)	**4** (1.7)	**3 (1.3)**	**11 (4.8)**	**23 (10.0)**	**1 (0.4)**
Of these:									
- Actively defending	1 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)
- Meagre and unsuccessful attempts to defend	0 (0.0)	5 (18.5)	0 (0.0)	0 (0.0)	1 (25)	0 (0.0)	0 (0.0)	4 (17.4)	0 (0.0)
- Passively sheltering	10 (66.7)	21 (77.8)	4 (100)	3 **(75)**	3 **(75)**	3 **(100)**	7 (63.6)	18 (78.3)	1 (100)
- Activities unknown	4 (26.7)	1 (3.7)	0 (0.0)	1 (25)	0 (0.0)	0 (0.0)	3 (27.3)	1 (4.3)	0 (0.0)
Travelling through the area unaware	**13 (2.8)**	**8 (1.7)**	**13 (2.8)**	**4** (1.7)	**1 (0.4)**	**2** (0.9)	**9 (3.9)**	**7 (3.1)**	**11 (4.8)**
Of these:									
- Travelling for work	6 (46.2)	0 (0.0)	0 (0.0)	2 (50)	0 (0.0)	0 (0.0)	4 (44.4)	0 (0.0)	0 (0.0)
- Travelling for pleasure	7 (53.8)	8 (1.7)	13 (100)	2 (50)	1 (100)	2 (100)	5 (55.6)	7 (100)	11 (100)
On route to defend or rescue	**18 (3.9)**	**3 (0.6)**	**4 (0.9)**	**10 (4.3)**	**0** (0.0)	**0** (0.0)	**8 (3.5)**	**3 (1.3)**	**4 (1.7)**
Waiting rescue	**2 (0.4)**	**6 (1.3)**	**0** (0.0)	**1** (0.4)	**0** (0.0)	**0** (0.0)	**1 (0.4)**	**6 (2.6)**	**0** (0.0)
Assisting fire fighting operations eg forestry worker	**12 (2.6)**	**0** (0.0)	**0** (0.0)	**2** (0.9)	**0** (0.0)	**0** (0.0)	**10 (4.4)**	**0** (0.0)	**0** (0.0)
Returned into burning building	**3 (0.6)**	**5 (1.1)**	**0** (0.0)	**1** (0.4)	**1** (0.4)	**0 (0.0)**	**2 (0.9)**	**4 (1.7)**	**0** (0.0)
In an undefendable shelter	**6 (1.3)**	**2 (0.4)**	**0** (0.0)	**6 (2.6)**	**2** (0.9)	**0** (0.0)	**0** (0.0)	**0** (0.0)	**0** (0.0)
Total	**277**	**108**	**77**	**161**	**32**	**40**	**116**	**76**	**37**

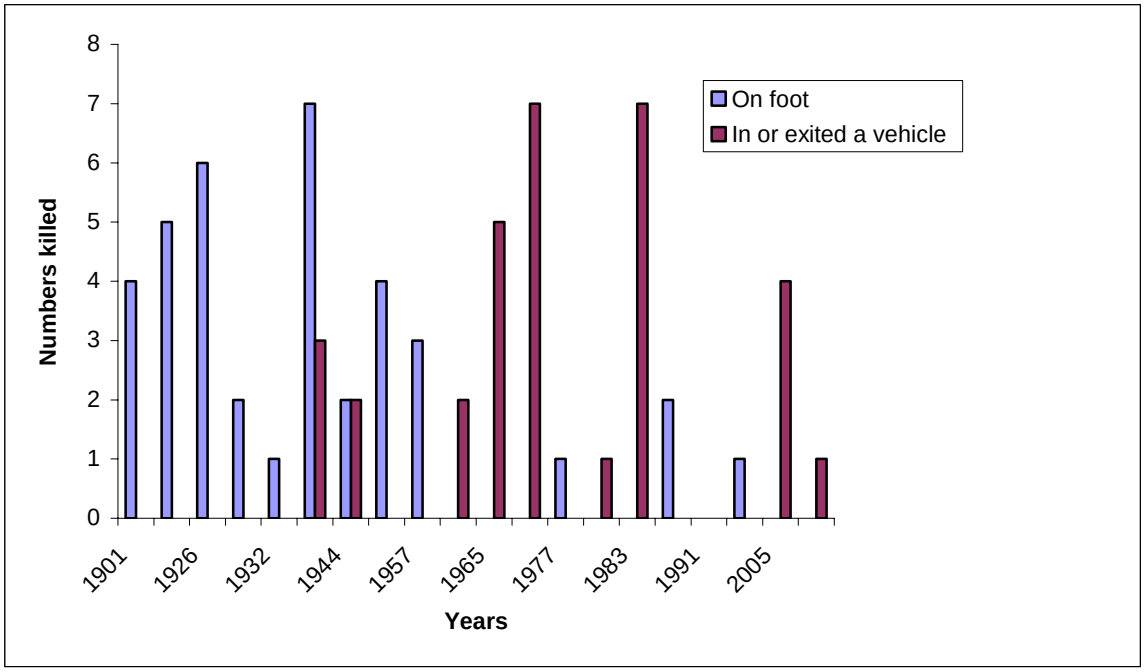
[4] "Male" and "Female" denotes those who are 18 or over and also those for whom age was unknown although it is highly probable from their description that they were adults.

Table 9 divides the data presented in Table 8 into adult males, adult females and under-18s. These data indicate that males tend to risk death through late evacuation from a place of work outside; females and under-18s from shelter. In more recent years, the majority of males who died due to late evacuation did so from shelter. Defending property outside has been the province of males, whether in a rural or a suburban location, and this has not changed over time. Interestingly, most fatalities that occurred inside a defendable property did so in the more recent 50-year period and, of these, most were passively sheltering – possibly a reflection on the greater relative value placed on livelihood in the first half of last century. Many more fatalities have occurred in the more recent 50-year period due to travelling for pleasure through an area subject to bushfire, unaware of the fire.

Table 10: Transport at time of death – all age categories

	1900 to 2007/08		1900 to 1955		1956 to 2007	
	No	%	No	%	No	%
On foot	255	46	176	60	79	31
Inside a closed vehicle	36	7	4	1	32	12
Exited a closed vehicle or found with the door open	70	13	16	5	54	21
On open transport or ran from	23	4	13	4	10	4
Transport not applicable i.e. found inside their house or died from exhaustion or shock	90	16	27	9	63	25
Unknown	78	14	59	20	19	7
Total	552	100	295	100	257	100

Figure 2: Transport at time of death - those under the age of 18



This includes the data for 70 fatalities under the age of 18. It does not include those who were inside the home or other cases where transport is not applicable or unknown (15).

From Table 10 and Figure 2 it is apparent that, of those who were killed while travelling, most were on foot. However, in more recent times there has been an increasing trend for

people to be killed while in or exiting a vehicle, with higher numbers dying while exiting a vehicle. This trend is well shown by the under-18 group, where less fatalities are occurring on foot and more whilst in or exiting a vehicle.

Decision making

Table 11: Decision making for all groups

	1900 to 2007/08		1900 to 1955		1956 to 2007	
	No	**%**	**No**	**%**	**No**	**%**
Physically and/or mentally incapable	24	4	8	3	16	6
Aware of the fire and carrying out a premeditated action	152	28	73	25	79	31
Aware of the fire but had no plans or didn't follow them	110	20	54	18	56	22
Unaware of the fire and realised too late	59	11	28	9	31	12
Extenuating circumstances eg heart attack	25	5	10	3	15	6
Children who followed adults' decisions	60	11	39	13	21	8
Unknown	122	22	83	28	39	15
Total	552	100	295	100	257	100

Table 12: Gender of and decision making for those over the age of 18

	1900 to 2007/08		1900 to 1955		1956 to 2007	
	Male	Female	Male	Female	Male	Female
Physically and/or mentally incapable	13 (2.8%)	11 (2.4%)	6 (2.4%)	2 (0.8%)	7 (3.2%)	9 (4.1%)
Aware of the fire and carrying out a premeditated action	123 (26.3%)	20 (4.3%)	62 (25.1%)	6 (2.4%)	61 (27.7%)	14 (6.4%)
Aware of the fire but had no plans or didn't follow them	54 (9.6%)	48 (10.3)	37 (15.0%)	14 (5.7%)	17 (7.7%)	34 (15.5%)
Unaware of the fire and realised too late	37 (7.9%)	16 (3.4%)	25 (10.1%)	3 (1.2%)	12 (5.5%)	13 (5.9%)
Extenuating circumstances eg heart attack	22 (4.7%)	2 (0.4%)	9 (3.6%)	1 (0.4%)	13 (5.9%)	1 (0.5%)
Missing	121 (26%)		82 (33%)		39 (18%)	
Total	467		247		220	

Of those known cases (refer to tables 11 and 12), most fatalities that occurred were aware of the fire and carrying out a plan (mainly males) for each time period examined. The next riskiest decision was to be aware of the fire and either having no plan or not following it – again, for each time period examined. More males were casualties of this decision in the first 50 year period; mainly females in the more recent 50 year period. The third most riskiest action was, for the most recent 50 year period, to be unaware of the fire and, overall and for the first 50 year period, for children who followed adults' decisions.

No relationship was found between age and decision making.

Table 13: Specific fires

		Hobart 1967		Lara 1969		Ash Wednesday 1983			Eyre Peninsula 2005		
Total number killed		64		18		60			9		
Gender [5]											
	Male	32 (50%)		5 (28%)		36 (60%)			4 (44%)		
	Female	32 (50%)		13 (72%)		24 (40%)			5 (56%)		
	Unknown	-		-		-			-		
Age	0-11	-		5 (28%)		5 (8%)			3 (33%)		
	12-17	-		2 (11%)		3(5%)			1 (11%)		
	18-29	3 (5%)		-		12(20%)			-		
	30-39	6 (9%)		2 (11%)		8 (13%)			2 (22%)		
	40-49	3 (5%)		3 (17%)		4 (7%)			-		
	50-59	8 (12%)		2 (11%)		11 (18%)			3 (33%)		
	60-69	18 (28%)		3 (17%)		9 (15%)			-		
	70>	19 (30%)		1 (6%)		8 (13%)			-		
	Unknown	7 (11%)		-		-			-		
Activity [6]											
Late evacuation		20 (32%)		1 (6%)		18 (30%)			8 (89%)		
Of these:		Male	Female	Male	Female	Male	Female	<18	Male	Female	<18
- from shelter		6	11	1	-	5	7	6	2	2	4
- from a place of work outside		2	-	-	-	-	-	-	-	-	-
- destination or origin unknown		-	-	-	-	-	-	-	-	-	-
- from an undefendable shelter		1	-	-	-				-	-	-
Defending property outside		15 (24%)				16 (27%)					
Of these:		Male	Female			Male	Female				
- In a suburban location		13	1			5	1		-	-	
- In a rural location		1	-			10	-		-	-	
Inside defendable property		12 (19%)				11 (18%)			1 (11%)		
Of these:		Male	Female			Male	Female		Male	Female	
- Actively defending		1	-			-	-		-	-	
- Meagre and unsuccessful attempts to defend		-	4			-	-		-	-	
- Passively sheltering		-	6			2	7		-	1	
- Activities unknown		1	-			2	-		-	-	

[5] Includes those under 18
[6] Figures for male and female do not include those aged 18 and under

	Hobart 1967	Lara 1969	Ash Wednesday 1983	Eyre Peninsula 2005
	Male Female			
Travelling through the area unaware	- -	17 (94%)	3 (5%)	
Of these:	- -	Male Female <18	Male Female <18	
- Travelling for work	- -	-	1 - -	
- Travelling for pleasure	- -	2 8 7	2 - -	
On route to defend or rescue	- -	- - -	3 3 2	
Waiting rescue	1 3	- - -	- 2 -	
Assisting fire fighting operations i.e. forestry worker	2 -	-	2 - -	
Returned into burning building	1 3	-	- - -	
In an undefendable shelter	-	-	- - -	
Unknown	7 (11%)	-	- - -	
Decision Making				
	7 (11%)		8 (13%)	
Physically and or mentally incapable	Male Female		Male Female	
	2 5		4 4	
Aware of the fire and carrying out a premeditated action	16 (25%)		22 (37%)	2 (22%)
	Male Female		Male Female	Male Female
	11 5		18 4	2 -
	19 (30%)	1 (6%)	19 (32%)	3 (33%)
Aware of the fire but had no plans or didn't follow them	Male Female	Male Female	Male Female <18	Male Female
	6 13	- 1	6 12 1	- 3
Unaware of the fire and realised too late	6 (9%)	10 (72%)	2 (3%)	
	Male Female	Male Female	Male Female	
	3 3	2 8	1 1	
Extenuating circumstances i.e. heart attack	7 (11%)		1 (2%)	
	Male Female		Male Female	
	6 1		1 -	
Children who followed adults' decisions	-	7 (22%)	7 (12%)	4 (44%)
Unknown	9 (14%)	-	2 (3%)	-

Table 13 shows that, for the specific fires examined, most fatalities were caused by late evacuation, especially in the case of the Eyre Peninsula fires of 2005. A large number of fatalities were also caused when people (the vast majority being males) were defending property outside, for the 1967 and 1983 fires. The big exception is the 1969 fires near Lara, where the vast majority of fatalities occurred amongst those travelling for recreation, being unaware of the fires (or, at least, of the magnitude of the fires) until it was too late.

In relation to decision making, approximately one third of those killed were aware of the bushfire but had made no plans (again, those of the Lara fires of 1969 being the exception). A large proportion were unaware of the bushfires. A relatively large proportion (most of these males) were aware and were carrying out a plan: this was the largest category in the 1983 fires.

Salient issues from each of these case studies will now be presented.

Social capital and local knowledge: Hobart fires, 7 February, 1967. 64 killed.

A combination of extremely high temperatures, very low humidity and very strong winds from the north-west drove small fires which had been burning for many days into the tinder-dry bush around Hobart's outer suburbs. The unprecedented speed and ferocity of the fire left many people confused and panic-stricken. According to Appendix D of the online COAG Bushfire inquiry (2005), approximately 1,400 houses, 128 major buildings, 1,500 vehicles, 50,000 sheep, 1,350 cattle and 4,800km of fences were lost.

Fifty-four people died on the day and ten others succumbed to their injuries over subsequent days in hospital. Eight of these deaths were attributed to natural causes, heart attacks brought on due to the exertions of fire-fighting or the stress of the environment. Fifty-three deaths were due to the direct effects of the fire, one to drowning while evacuating (victim was trying to move livestock when they were overcome by the flames and tried to cross a watercourse) and one to falling debris (victim had been protecting their home when the chimney from the burning building next door fell). The circumstances of a further three deaths are unknown.

There are thirty two men and thirty two women listed. This equal number is unusual, as all previous fires in the 20th century had been dominated by male fatalities. However, this trend of increasing female vulnerability has continued in recent decades.

The age distribution shows that over half of the fatalities were 60 years of age or more, a third within 30-59 years and only 5% within 18-29 years. There were no fatalities under the age of 18.

The majority of deaths occurred just outside their own or a neighbours home. All the female fatalities died while evacuating late or passively sheltering. In comparison, men were dominantly engaged in defensive activities outside of the home when they were overcome by the fire.

This case study clearly shows that people were aware of elderly or frail people in their community but, because of a lack of planning and urgency, they had to look after themselves and their immediate family. This had disastrous consequences for their vulnerable neighbours. They therefore had the social capital and local knowledge (factors that are increasingly

discussed within the literature as important for reducing bushfire risk[7]) but were waiting to see, acting only when it was too late. In some cases people had tried to persuade neighbours to leave but they refused, either deciding to shelter in place or thinking they could defend their properties. Many severely underestimated the fires and their lack of preparations.

Dangers of exiting a vehicle: Lara Fires, 8 January, 1969. 18 killed.

According to Risk Frontiers' Bushfire Database, 230 homes and 34 major buildings were destroyed, 267,000ha were burnt and 77,000 stock and 10,000km of fencing were lost in these fires. There were 44 injuries, 1,000 homeless and 6,000 others affected. In one instance, 17 people were badly burnt on the Melbourne to Geelong Expressway at Lara when a grassfire crossed the road. These victims were travelling through the area unaware of the fires and only realised they were in danger as they became engulfed in smoke and flames. In the confusion that followed, these victims alighted from their cars. Some tried to outrun the fire while another group sheltered behind one of the cars. Eight died immediately, two on the way to hospital and seven over the next few days. It is believed that, had these victims remained in their cars as the fire front passed, they would have survived.

Another elderly female in the area was warned to leave her house but had refused to evacuate. After sheltering passively in the house, she ran outside and was overcome by the radiant heat in her front garden.

Late evacuation: Ash Wednesday fires 16 February, 1983. 60 killed.

This bushfire is largely regarded as Australia's most notorious: over 100 fires, driven by strong winds, swept across the states of Victoria and South Australia. According to Appendix D of the online COAG Bushfire inquiry (2005), the fires burned over 400,000 hectares, killed more than 27,000 stock and destroyed 2,000 houses and 21,000 hectares of pine plantations. 36 men and 24 women were killed. The dominant activities at the time of death were late evacuation from shelter in which 18 were killed: five men, seven women and six children. Fifteen men and one woman were killed while defending property outside and seven women and two men were killed while passively sheltering inside their home. Women were dominantly evacuating late or sheltering in the home, mostly aware of the fire but either had no plans as to what they should do or didn't follow them. In comparison, the majority of men died while defending property outside, well aware of the fire and carrying out a premeditated action. Although aware of the fires, many of these people were taken by surprise by the sudden wind change in the early evening. These people were not prepared to defend their homes and it was too late for a safe evacuation.

This sentiment is well described by two statements from a survivor and police sergeant at the coronial inquiry, in Box 2.

[7] See chapters three and four in *Handmer and Haynes (2008) Community Bushfire Safety. Edited volume. CSIRO publishing.*

Box 2.

'In a split second everything changed. Day turned into 90% darkness, soot and ash and burning sparks came blowing across the top of my house and landing at the back. A helicopter came over with a siren screaming and that is when we decided to get out. From that moment we went for our lives everyone was running and there was a sense of extreme urgency, panic you might almost say.'
Survivor and witness of the Ash Wednesday Bushfires. Coronial Inquiry. No. 125/1983 Victorian Archives Office.

'I am certain that events occurred very suddenly and very dramatically when the wind changed on the night in question. Daylight almost instantly turned into total blackness and burning bark and leaves showered every person and animal not undercover. People who had been hosing their homes or clearing gutters in case the fire did threaten them suddenly felt compelled to flee. Concern which had existed in the minds of many people for some time suddenly turned to extreme urgency.'
Police Sergeant, Ash Wednesday Coronial Inquiry. No. 125/1983 Victorian Archives Office.

Late evacuation in vehicles: Eyre Peninsula fires, 11th of January, 2005. 9 killed.

According to the Risk Frontiers' Bushfire Database, over 145,000ha were burnt and 250,000 sheep, over 80 (including 15 caravans), a shop, 80 vehicles (including two buses) and four boats were destroyed. 113 people were reported injured, including five seriously. One female victim died while sheltering in her home; four children, two women and two fire-fighters (not with their brigade and in their own vehicle – essentially civilians) died while fleeing in cars at the last minute. These deaths are the largest number in one fire since Ash Wednesday and are a stark reminder that Australia's bushfire emergency management policy has a number of implementation problems.

5.0 Discussion

Analysis of detailed coronial reports and witness statements from the standpoint of our current perspective of bushfire risk management demonstrates that fatalities relate to the roles that people take on in fire-prone environments and the resources (including warnings and preparations) that are at hand.

The high distribution of deaths within the southeast of Australia is to be expected as this area is one of the most fire prone regions in the world and is also the most densely populated region of Australia. The area experiences a Mediterranean style of climate, with hot, dry summers and mild, wet winters. As Lucas *et al* (2007) explain, vegetation often grows well during winter and spring and the summer heat then dries this growth. Periodic droughts are also a normal feature, exacerbating the risk of severe fire danger periods.

Death rates have, overall, declined over time, although the trend is not strongly defined. This decline is largely due to two factors: firstly, improvements in bushfire risk management and secondly, a change in working and living trends. Bushfire risk management improved particularly from the post-war period with the inception of the bushfire brigades. There has been an increasing focus on community education and awareness about bushfire preparedness and response (self sufficiency), and improvements in communication and technology have enabled better access to information by the public. The second factor concerns the fact that there has been a profound shift in population trends and working conditions around Australia, with less people living in simple dwellings in isolated locations. For example, during the 1939 fires a majority of fatalities were forestry workers, who lived and worked at timber mills in isolated bush settings.

This factor also helps to explain the decrease of the male to female death ratio (which is in fact approaching equality) with time. When activities at the time of death are examined, it becomes clear that the numbers of men dying while evacuating from work outside or defending property outside has fallen dramatically while female numbers have increased slightly.

The gender distribution of the activities undertaken at the time of death highlights the increased vulnerability of women in recent years. Men often take on defensive activities, while women and children are left to shelter passively in the home or evacuate at the last minute. Although the Australian approach to bushfire risk reduction, namely an approach which fosters community self-reliance and resilience is advanced, gender and youth issues have, bar a couple of studies concerning gender, been completely neglected. An in-depth qualitative investigation by Goodman and Proudly (2008), examined the influence of gender and family relationships on actions during the Wangary fire in South Australia, Tuesday the 11th of January 2005. They reported a gender bias with men often directing wives and female family members on how to respond. While this sometimes encouraged women to assist their husbands in the active defence around their property it more dominantly led to women taking on more passive caring roles for other family members (including watching over the husband who was defending outside). Many women were also identified to have evacuated late from their rural locations for the perceived sanctuary of the nearby town. These actions were not viewed with regret as respondents reported feeling happier to be with other loved ones in the town or that the removal of the car from the fire danger was a positive outcome.

Examination of the Hobart fires in 1967 demonstrated the vulnerability of the elderly. A naïve perusal of the statistics or the locations of death of the deceased might lead one to simply conclude that the majority of the fatalities occurred due to age and infirmity. This tells only half of the story. Instead, the current study demonstrates the importance of clear planning for people unable to defend or self evacuate. While some elderly and infirm people had made plans with neighbours to help or pick them up, this did not occur due to panic and hasty evacuations, rather than because of infirmity.

This study has not been able to include comparative figures of successful defence of a property compared to all those attempts at defence. However, it is clear from the analysis conducted that most bushfire fatalities have resulted from the activity of late evacuation (or, in the case of males, defending property outside). Only one out of 46 known fatalities inside a defendable property (the third most common activity of bushfire fatalities) was actively defending and that one died of a heart attack (i.e. this was not directly due to the effects of the bushfire). In terms of decision making, the majority of fatalities have been among those aware of the fire and carrying out a plan (mostly males), followed by those aware but either with no plan or a plan that was not followed (mostly females) followed by those unaware of the fire and children following the decisions of adults.

6.0 Conclusion and policy relevance

Translating the stay or go message into practice is complex, with a great deal of ambiguity in the 'leave early' advice and gaps in peoples' perceptions of the actions they should take. Many people still consider late evacuation as a valid last resort option: waiting to see how the fire develops and then fleeing at the last minute. Recent evidence also shows that people frequently retain a 'fall-back plan', with children, valuables or pets being loaded into cars so that they can be evacuated if the situation is deemed too dangerous (Tibbits and Whittaker, 2007). In other cases, people expect the emergency services to provide help, information, warning, guidance or assistance.

Recent inquiries have focused on whether people had enough official warnings to make a decision to stay or leave (e.g. Canberra, 2003 and Wangarry, 2005). However, a clear intention of the AFAC policy position is one of community self reliance, where people are encouraged to prepare both mentally and physically for a situation in which they may have no warnings and therefore no choice but to stay and defend their homes.

Our study demonstrated that some victims were not mentally or physically prepared to stay and defend their properties, often not knowing what an effective survival strategy would be or misunderstanding the messages (e.g. people sitting in baths of water or sheltering passively in their house). Many others underestimated the ferocity of the fire. Although these are issues the fire agencies now try very hard to rectify, this study yields some difficult examples for the 'prepare, stay and defend' argument. For example: how do we know how much preparation to fight the fires is enough? Even those who plan to stay are often not well-prepared: they do not expect to lose electricity or water, have no back-up plan and do not wear adequate protective clothing. Of primary importance is the need to recognise and target vulnerable groups such as men who die attempting to defend property outside and women and children who die fleeing or sheltering in an undefended home.

Although this study has shown that men's lives are equally endangered, these risks have been considerable reduced through a male-orientated gender blind risk management campaign. Policy, outreach and long term community based projects must also now be 'gendered' and 'aged' in order to that women and children can equally reduce their risks and vulnerability to disaster.

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