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Community safety during the 2009 Australian 'Black Saturday' bushfires: an analysis of household preparedness and response

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Abstract

On Saturday 7 February 2009, 173 people lost their lives and more than 2000 houses were destroyed in bushfires (wildfires) in the Australian State of Victoria. The scale of life and property loss raised fundamental questions about community bushfire safety in Australia, in particular the appropriateness of the 'Prepare, stay and defend or leave early' policy. This paper presents findings from research undertaken as part of the Australian Bushfire Cooperative Research Centre's (CRC) '2009 Victorian Bushfires Research Taskforce'. The research examined factors influencing patterns of life and property loss and survival across the fires through mail surveys (n = 1314) of fire affected households. Just over half of the respondents (53%) stayed to defend their homes and properties, whereas the remainder left before or when the fires arrived (43%) or sheltered in a house, structure, vehicle, or outside (4%). Results reveal a survival rate of 77% for houses that were defended by one or more household members, compared to 44% for unattended houses. The paper identifies inadequate planning and preparedness and the tendency for people to wait until they are directly threatened before taking action as major factors leading to late evacuation, failed defence and passive shelter.

Keywords

preparedness, household, analysis, bushfires:, response, saturday', community, 'black, australian, 2009, during, safety

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Community safety during the 2009 Australian ‘Black Saturday’ bushfires: an analysis of household preparedness and response

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Abstract:

On Saturday February 7, 2009, 173 people lost their lives and more than 2000 houses were destroyed in bushfires (wildfires) in the Australian state of Victoria. The scale of life and property loss raised fundamental questions about community bushfire safety in Australia, in particular the appropriateness of the 'Prepare, stay and defend or leave early' policy. This paper presents findings from research undertaken as part of the Australian Bushfire Cooperative Research Centre's (CRC) '2009 Victorian Bushfires Research Taskforce'. The research examined factors influencing patterns of life and property loss/survival across the fires through mail surveys (n=1314) of fire affected households. Just over half of the respondents (53%) stayed to defend their homes and properties, while the remainder left before or when the fires arrived (43%) or sheltered in a house, structure, vehicle, or outside (4%). Results reveal a survival rate of 77% for houses that were defended by one or more household members, compared to 44% for unattended houses. The paper identifies inadequate planning and preparedness and the tendency for people to wait until they are directly threatened before taking action as major factors leading to late evacuation, failed defence, and passive shelter.

Brief summary:

This paper examines household preparedness and responses to the 2009 'Black Saturday' bushfires in Victoria, Australia. Results from a mail survey indicate that while leaving early is the safest response to bushfires, staying to defend can be a viable alternative to evacuation for some people.

Keywords: bushfire; wildfire; evacuation; emergency response; community safety.

1 **1. Introduction**

2 On Saturday February 7 2009, 173 people lost their lives and more than 2000 homes were
3 destroyed in bushfires in the Australian state of Victoria. Fires burned under the most severe
4 fire weather conditions on record in Victoria, with a record high maximum temperature of
5 46.4°C (115.5°F) in Melbourne, record low relative humidity, and strong winds throughout
6 the state (Karoly 2009). These conditions were accurately forecast, and Victorians had been
7 warned to prepare for ‘the worst [fire danger] day in the history of the state’ (Premier of
8 Victoria, John Brumby, cited in Moncrief, 2009). The day saw more than 400 fires across
9 Victoria, with most of the major fires started by fallen powerlines or arson (Teague *et al.*,
10 2010). Fires quickly burned out of control as communities came under threat with little or no
11 official warning. The speed, intensity and extent of the fires meant that firefighting capacities
12 were stretched and, in line with official advice for all bushfires, most residents responded
13 without direct assistance from fire services.

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Fire	Cause	Fatalities	Houses destroyed	Area burnt
Kilmore East	Electrical failure	119	1,242	125,383
Murrindindi	Undetermined	40	538	168,542
Churchill	Suspected arson	11	145	25,861
Beechworth-Mudgegonga	Electrical failure	2	38	33,577
Bendigo	Suspected arson	1	58	341
Redesdale	Undetermined	0	14	7,086
Horsham	Electrical failure	0	13	2,346

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Figure 1: The 2009 Victorian bushfires (January – February)

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Under the ‘Prepare, stay and defend or leave early’ (PSDLE) policy, Australian fire services had advised residents to prepare to stay and defend their homes and properties against bushfire, or to prepare and leave well before a fire arrived in their area (AFAC, 2005a). This advice was based on evidence that residents can protect houses from bushfires, provided they are prepared to do so, and that a large number of deaths have occurred during late

27 evacuations.¹ However, with police reports that 113 people had died inside their homes in the
28 February 7 fires (AAP, 2009a) the colloquially termed ‘Stay or go’ policy came under
29 scrutiny (AAP, 2009b). Questions were raised about the adequacy of warning systems; the
30 preparedness and responses of residents and of fire and emergency services; and the
31 effectiveness of the land use planning system that controls development in high-fire risk
32 areas. These and other issues were investigated by the 2009 Victorian Bushfires Royal
33 Commission, which handed down 67 recommendations in its final report to the Victorian
34 Government in July 2010 (Teague *et al.*, 2010).

35
36 This paper presents findings from research undertaken as part of the Bushfire Cooperative
37 Research Centre’s (CRC) ‘2009 Victorian Bushfires Research Taskforce’. The Taskforce was
38 established to provide the Royal Commission and Australian fire and emergency services
39 with an independent analysis of the factors that contributed to the fires’ severity and impacts.
40 Research covered three broad areas: fire behaviour; human behaviour and community safety;
41 and building and planning issues. This paper presents findings from the human behaviour and
42 community safety research, which investigated factors that influenced patterns of life and
43 property loss/survival across the fire affected areas. The paper begins with an overview of the
44 Australian approach to community bushfire safety, before discussing the research questions
45 and methods that were used to conduct the research. Key findings are then presented and
46 discussed. The paper concludes by considering the implications of the research for
47 community bushfire safety – in particular, the applicability of the PSDLE approach.

48

49 **2. Community bushfire safety in Australia**

¹ We use the term ‘evacuation’ to refer to the act of leaving when bushfires threaten. In Victoria, authorities may advise residents to evacuate; however, responsibility for the decision and act of leaving lies with the resident.

50 In 2009, the Australian approach to community bushfire safety centred on the PSDLE policy.
51 Under the policy, adopted by all Australian fire services, residents were advised to prepare to
52 stay and defend their homes and properties from bushfires, or to prepare and leave well
53 before a fire arrived in their area (AFAC, 2005a). The policy was underpinned by evidence,
54 discussed below, that: (i) well-prepared houses can be successfully defended against
55 bushfires and provide safe refuge during the main passage of the fire front; and (ii) that late
56 evacuation is an inherently dangerous response to bushfires. Importantly, the policy
57 recognised that fire and emergency services are unable to help everyone during a fire,
58 whether through firefighting or assisted evacuation, and that residents must be prepared to
59 respond without assistance. It also recognised that there are people who will want to stay with
60 their homes and others who will want to leave. In effect, the policy simply formalised an
61 approach to bushfire safety long adopted by Australians, while emphasising the dangers of
62 late evacuation.

63
64 A number of studies have documented the dangers associated with late evacuations (e.g.
65 Wilson and Ferguson, 1984; Krusel and Petris, 1992; Handmer and Tibbits, 2005). Late
66 evacuations are typically triggered by the appearance of flames and/or heavy smoke nearby.
67 By this time it is likely that driving a vehicle will have become very difficult, with flames,
68 smoke, strong winds, fallen trees, traffic and the urgency of the situation increasing the
69 likelihood of accidents (Tibbits and Whittaker, 2007). An analysis of recorded bushfire
70 fatalities in Australia between 1900 and 2008 (Haynes *et al.*, 2010) found that late evacuation
71 was the most common activity at the time of death, accounting for around one-third (32%) of
72 all fatalities. Another 11% was found to have been travelling through fire affected areas at the
73 time of death. For example, in the 2005 Eyre Peninsula bushfires in South Australia, eight of
74 the nine fatalities occurred in or near cars after attempts to flee the fire (Deputy State

75 Coroner, 2005). Similar evidence has been compiled in the United States. Mutch (2007), for
76 example, notes that many of the 22 residents who died in the 2003 southern Californian fires
77 were attempting to flee.

78
79 Research has shown that well-prepared houses can be successfully defended by occupants
80 and provide safe refuge during the main passage of a fire front (e.g. Lazarus and Elley, 1984;
81 Wilson and Ferguson, 1984, 1986; Ramsay *et al.*, 1987; Cohen, 2000; Handmer and Tibbits,
82 2005). Studies have found that embers – rather than direct flame contact or radiant heat – are
83 the most common source of building ignition before, during and after the passage of a
84 bushfire (Leonard and McArthur, 1999; Leonard, 2003). Consequently, some research has
85 shown that residents can shelter inside well-prepared houses during the main fire front, going
86 outside to extinguish small ignitions before and after. For example, a study of the 1983 Ash
87 Wednesday fires in Victoria’s Otway Ranges found that residents ‘were able to save their
88 houses by extinguishing small ignitions of the house itself before these fires became
89 uncontrollable’ (Ramsay *et al.* 1987, p. 50). At Mt Macedon, also during the Ash Wednesday
90 fires, Wilson and Ferguson (1984) recorded a 90% survival rate for houses that were actively
91 defended by able-bodied occupants, compared to 82% for attended but not actively defended
92 houses, and just 44% for unattended houses. Considering the risks associated with late
93 evacuations, they concluded that: ‘provided they are adequately informed of the danger and
94 risks involved, mature, able-bodied residents can minimise loss of life, and probably save
95 their houses, by staying within the safety of their homes’ (Wilson and Ferguson 1984, p.
96 235). Further evidence that people can and do protect their homes by staying to actively
97 defend them has been compiled by Handmer and Tibbits (2005; see also Tibbits *et al.*, 2008).

98

99 Alternatives to wildfire evacuation have also been debated in the United States. A 1995 issue
100 of *Wildfire* magazine presented a number of perspectives on evacuation under the header
101 ‘Fight or flee?’ At issue was whether residents should have the option to stay and defend their
102 homes from wildfire, which some U.S. citizens had done in the past, or whether the practice
103 of mandatory evacuation should prevail. Queen (1995) argued that several of the fatalities in
104 the 1991 Oakland firestorm could have been prevented if the victims had waited until the fire
105 front had passed before leaving the area. He went on to note that: ‘What may work in
106 Australia may not work in the U.S. However, evacuation is clearly not the only option. The
107 decision to evacuate is a difficult one to make. The responsibility of making this decision
108 rests with the occupants, not the firefighter’ (Queen, 1995, p. 23). In contrast, McMeekin
109 (1995) outlined an approach to ‘population protection’ that, despite involving greater
110 community engagement and planning, is largely focused on facilitating agency-led
111 evacuations. Decker (1995) emphasised the needs for residents to ‘... create defensible space
112 around their homes and to respond immediately to evacuation orders rather than waiting until
113 the last moment’. More recently, the National Fire Protection Association published a feature
114 article presenting arguments for and against the PSDLE approach in the USA (see Schorow,
115 2011).

116
117 The Australian approach has served as a reference point for debates over alternatives to
118 evacuation in the United States. Scholars have generally agreed that ‘Prepare, stay and
119 defend’ may be a viable alternative to evacuation in some situations, but that contextual
120 differences – including the characteristics of wildfires and populations at risk – may mean
121 that it is inadvisable in some locations (Paveglio *et al.*, 2008; McCaffrey and Rhodes, 2009;
122 Stephens *et al.*, 2009). Another key difference is that, in Australia, the PSDLE approach
123 arose from a tradition of rural self-reliance and household firefighting practices, rather than

124 policy. Significant institutional challenges have also been identified – such as redefining
125 agency roles and responsibilities, educating and building the capacities of communities, and
126 promoting ‘shared responsibility’ for wildfire risk – that would need to be overcome for the
127 strategy to be successful (Paveglio *et al.*, 2008; McCaffrey and Rhodes, 2009). Unlike in
128 Australia, where it has been emphasised that staying requires active defence, passively
129 ‘sheltering-in-place’ has been considered an alternative to evacuation (Cova *et al.*, 2010). In
130 southern California, for example, Rancho Santa Fe has been actively promoted as a
131 community that is designed to enable residents to ‘shelter-in-place’ during wildfires
132 (Paveglio *et al.*, 2008).

133

134 Although the PSDLE policy had not undergone formal evaluation prior to the Black Saturday
135 fires, fire services and many residents considered it a sound approach for reducing losses of
136 life and property. Nevertheless, a number of studies had identified problems concerning its
137 implementation. In a study of residents’ understandings of the policy, Rhodes (2005) found
138 that while most people believed that ‘stay and defend’ was a viable strategy for protecting
139 property, most did not see it as a strategy for protecting life. He argued that this is why most
140 people prefer to ‘wait and see’ what a fire is like before they decide whether to stay or leave,
141 which creates the potential for late evacuation. Tibbits and Whittaker (2007) found high
142 levels of awareness and support for the policy following the 2003 Victorian bushfires, but
143 identified two critical issues concerning its implementation. First, there was considerable
144 confusion over the meaning of ‘leave early’, with many residents unsure of when to leave and
145 unable to recognise when leaving was no longer a safe option. Second, many of those who
146 had planned to stay and defend were not fully committed to doing so. They consciously or
147 subconsciously retained late evacuation as an option despite recognising the dangers of this
148 strategy. Research reported in this paper and elsewhere identifies ‘wait and see’ strategies as

149 a fundamental challenge for implementation of the policy (see Whittaker and Handmer,
150 2010).

151

152 **3. Methods**

153 The Bushfire CRC established the ‘2009 Victorian Bushfires Research Taskforce’ to provide
154 the Royal Commission and Australian fire and emergency services with an independent
155 analysis of the factors that contributed to the fires’ severity and impacts. The scope of the
156 Taskforce was determined by the Bushfire CRC, Country Fire Authority (CFA) and
157 Department of Sustainability and Environment (DSE). The research covered three key areas:
158 fire behaviour; human behaviour and community safety; and building and planning issues.

159

160 The human behaviour and community safety research was designed with distinct qualitative
161 and quantitative phases. The qualitative phase involved semi-structured, in-depth interviews
162 with residents; the quantitative phase involved a mail survey of households within fire-
163 affected areas. A team of researchers began interviewing residents on 12 February, with more
164 than 600 interviews conducted over a 12 week period (see Whittaker *et al.* 2009a). The mail
165 survey comprised a range of questions concerning community safety issues, including
166 awareness of bushfire risk prior to Black Saturday, the information and warnings people
167 received, actions taken to plan and prepare, intended and actual responses to the fires,
168 impacts of the fires on households, and basic demographic information (see Whittaker *et al.*
169 2009b). Surveys were mailed to 6000 addresses in areas affected by the bushfires in October
170 2009. Addresses that fell within the ‘burnt area’, as defined by DSE, were extracted from the
171 Vicmap database (see State Government of Victoria, 2012). Residents were given three
172 weeks to complete and return the survey. A response rate of 25% was obtained, with 1314
173 surveys received from residents within each of the major fire complexes. Men and women

174 were more or less equally represented in the sample (53% women), with the majority of
175 respondents (59%) aged between 35 and 54. Ethics approval was obtained from RMIT
176 University's Human Ethics Research Committee, with measures taken to ensure the safety
177 and rights of participants and researchers.

178
179 This paper focuses on the results of the mail survey. Results are presented for five key factors
180 influencing community bushfire safety: pre-fire awareness of bushfire risk; planning and
181 preparedness; intended responses; warnings; and actual responses to the fires.

182

183

184 **4. Research findings**

185 **4.1 Pre-fire awareness of bushfire risk**

186 The survey results suggest high levels of bushfire awareness prior to the Black Saturday fires.
187 It is important, however, to recognise that hindsight bias - where outcome information
188 influences people's recollections of their prior knowledge or beliefs (Bradfield and Wells,
189 2005) – is likely to have influenced these results. More than three-quarters (78%) of
190 respondents reported they had previously thought it likely or very likely that a bushfire could
191 occur in their town or suburb and more than two-thirds (67%) said they had perceived a high
192 or very high level of threat. The proportion of respondents that thought it unlikely that a
193 bushfire would occur in their town or suburb (22% overall) was considerably higher in the
194 Horsham (72%) and Bendigo (53%) fires. Fires impacted on the suburban fringes of these
195 regional cities, where many residents did not have past experience of bushfires and did not
196 consider themselves at risk.

197

198 These high levels of reported hazard awareness did not necessarily translate into high levels
199 of preparedness or protective action. As discussed below, many respondents were aware of
200 the risk, yet did little to plan and prepare.

201

202 **4.2 Planning and preparedness**

203 More than two-thirds of respondents (69%) claimed to have had a ‘firm’ plan for what they
204 would do in the event of a bushfire. Again, results suggest considerably lower levels of
205 awareness and preparedness in Bendigo and Horsham, where around half (56% and 50%,
206 respectively) of all respondents had not considered what to do in the event of a bushfire, or
207 had decided they didn’t need to do anything. Of all respondents, most (78%) reported
208 discussing their intended response with other members of their household and more than two-
209 thirds (68%) had planned for what each household member would do. Fewer respondents had
210 considered how things could change if members of the household were not at home during
211 the fire (42%) or had written down important things to do and remember (26%).

212

213 Residents had taken a range of actions to physically prepare their homes and properties. The
214 most common preparations were actions normally undertaken as part of general property
215 maintenance, such as clearing leaves, grass and other debris from around the house (92%),
216 clearing leaves from gutters (88%) and obtaining and preparing equipment such as ladders,
217 buckets and mops (73%). Many residents had moved combustible materials such as firewood
218 and garden furniture away from their homes (70%) and obtained and prepared firefighting
219 equipment such as water pumps and hoses (66%). Less common were actions to protect
220 vulnerable points on houses from ember attack, such as installing seals and draft protectors
221 around windows and doors (35%), covering gaps and vents (31%), installing gutter protection
222 (25%) and covering underfloor spaces (20%).

223

224 Survey results concerning planning and preparedness should be interpreted with caution.
225 Respondents' assessments of their preparedness are inevitably framed by their degree of
226 knowledge about bushfires and of how to prepare, as well as their capacity to implement
227 preparatory measures effectively. Almost half of the survey respondents (46%) rated their
228 level of preparedness as high to very high, with the remainder assessing their preparedness as
229 average (36%) or low to very low (17%). Despite this, almost three-quarters (72%)
230 acknowledged that they could have been better prepared.

231

232 **4.3 Intended responses**

233 A broad range of factors influenced intended responses, including: age; physical capacity,
234 mobility and health; responsibility for children, the elderly and others who require assistance;
235 responsibility for pets and livestock; the location of property; perceptions of preparedness and
236 capacities to defend; and the presence or absence of household members during the fire.
237 Respondents were asked what, prior to February 7 2009, they had thought they would do if
238 confronted by a bushfire. Half reported their intention to stay and defend throughout the fire
239 (50%), while less than a fifth (19%) intended to leave *before* they came under threat (i.e.
240 'early'). Just 22 respondents (< 2%) had intended to leave their homes because it was a day of
241 high fire danger (regardless of whether a fire had started).

242

243 Analysis revealed a gender dimension to intended responses. A greater proportion of men
244 (56%) intended to stay and defend throughout the fire than women (42%), who more often
245 wanted to leave as soon as a fire was threatening than men (23% and 11%, respectively). A
246 chi-square test confirmed that the association between these variables was statistically
247 significant, $X^2(7, N = 1134) = 50.25, p = < .0001$. These findings are consistent with research

248 on gendered responses to bushfire, which has found that women are more likely to want to
249 evacuate when confronted by bushfire (see Eriksen *et al.*, 2010).

250
251 Significantly, more than one-quarter of survey respondents (26%) were effectively
252 undecided, intending to stay and defend but leave if they felt threatened (17%) or to wait and
253 see what the fire was like before deciding to stay or leave (9%). Those who were not fully
254 committed to leaving early or staying to defend were effectively adopting a ‘wait-and-see’
255 strategy. ‘Wait-and-see’ strategies greatly increase the risk of late and dangerous evacuations.
256 As noted above, the opportunity for safe evacuation is likely to have passed once a fire has
257 reached or is in close vicinity of a person’s home or property.

258

259 **4.4 Warnings**

260 Warnings played a pivotal role in household responses to the fires. As noted above, the
261 extreme fire weather experienced on February 7 had been accurately forecast, and authorities
262 had warned of the potential for the worst fire danger in Victoria’s history. Indeed, 99% of
263 survey respondents claimed to have known that February 7 was a day of Total Fire Ban.
264 However, interviews revealed that these warnings did not necessarily lead to greater alertness
265 or pre-emptive action (see Whittaker *et al.* 2009a).

266

267 While the majority of respondents (62%) did not receive an ‘official’ warning from police,
268 fire or emergency services, many (63%) received an ‘unofficial’ warning from family, friends
269 or neighbours. Environmental cues such as seeing flames and smoke were also important in
270 alerting people to the fires. However, the extreme heat on February 7 appears to have reduced
271 people’s receptiveness to warnings and environmental cues, with many taking shelter from
272 the heat inside their darkened, air-conditioned homes.

273

274 **4.5 Actual responses**

275 The majority of respondents (53%) stayed to defend their homes and properties from the
276 fires. Of these, around one-third left during the fire because of perceived danger, failure of
277 equipment or utilities, or because the house caught fire. 43% of respondents left their homes
278 or properties either before or when the fires arrived in their area. A small proportion (4%)
279 reported that they sheltered inside a house, in a structure other than a house, in a vehicle, or
280 somewhere outside.

281

282 *Those who left*

283 A greater proportion of women (54%) left their homes and properties before or during the
284 fires than men (35%). Just over half of these respondents (54%) considered themselves to
285 have left late or very late, with 16% leaving within 20 minutes of the fire arriving and one
286 quarter (25%) leaving once the fire had arrived. The vast majority (80%) perceived the level
287 of danger to be high or very high when they left, with many experiencing difficulties
288 associated with smoke (55%), poor visibility (35%), traffic (30%), embers (29%), flames
289 (26%) and fallen trees (16%).

290

291 The vast majority of those who undertook late evacuations arrived at their destination
292 unharmed. Consequently, most indicated they would take the same action if there was a
293 similar fire in the future (74%). They often explained that life is more important than
294 property, and that staying to defend is not worth the risk. Importantly, however, most did
295 express an intention to leave earlier. Those who said they would stay and defend against
296 future fires often explained that their circumstances had changed (e.g. no longer responsible
297 for children or the elderly) or that they were now better prepared and able to defend.

298

299 *Those who stayed*

300 Reflecting the data on intended responses, a greater proportion of men (62%) stayed and
301 defended than women (42%). Most stayed to protect assets from the fires (83%); however,
302 some stayed because they felt it was too late to leave (9%) or because their attempts to leave
303 were unsuccessful (3%). Those who stayed because it was too late to leave, or because they
304 were unable to leave, suffered double the rate of house destruction (31%) than those who
305 stayed because they wanted to protect their house and other assets (16%), highlighting the
306 importance of prior planning and preparedness. Nevertheless, most had felt confident they
307 could do what was required to protect themselves and others (78%) and their house and
308 property (69%).

309

310 Many of those who stayed to defend received help from members of their household (50%),
311 family, friends and neighbours (48%) and/or fire and emergency services (13%). Such help
312 appears to have influenced patterns of property loss, with higher rates of house destruction
313 among those who did not receive help (3 in 10 destroyed) than those who were helped by
314 household members (1 in 10), family, friends and neighbours (1 in 10) and fire and
315 emergency services (3 in 100).

316

317 One-third (38%) of those who stayed to defend left at some stage while their property was
318 under threat. The most commonly cited reason for leaving a house or property was that it was
319 too dangerous to stay and defend (44%). Other reasons were that there were flames in the
320 immediate vicinity of the property (33%) and to remove other household members or visitors
321 from danger (26%). One-quarter left because utilities or equipment failed (26%) and/or
322 because their house caught fire (18%). Many of these residents reported encountering the

323 same dangers as those who evacuated late, such as smoke (74%), embers (59%), poor
324 visibility (56%), flames (56%) and fallen trees (37%).

325
326 The majority of respondents who stayed with their home or property indicated that they
327 would take the same action if there was a similar fire in the future (76%). This is reflective of
328 the success of the PSDLE approach for most people during the February 7 fires, and the fact
329 that many now feel better prepared and more capable of defending against bushfire. Those
330 who said they would leave in the future tended to have negative experiences of staying, and
331 were not willing to risk their or others' lives to protect property.

332

333 *Relationship between intentions and actions*

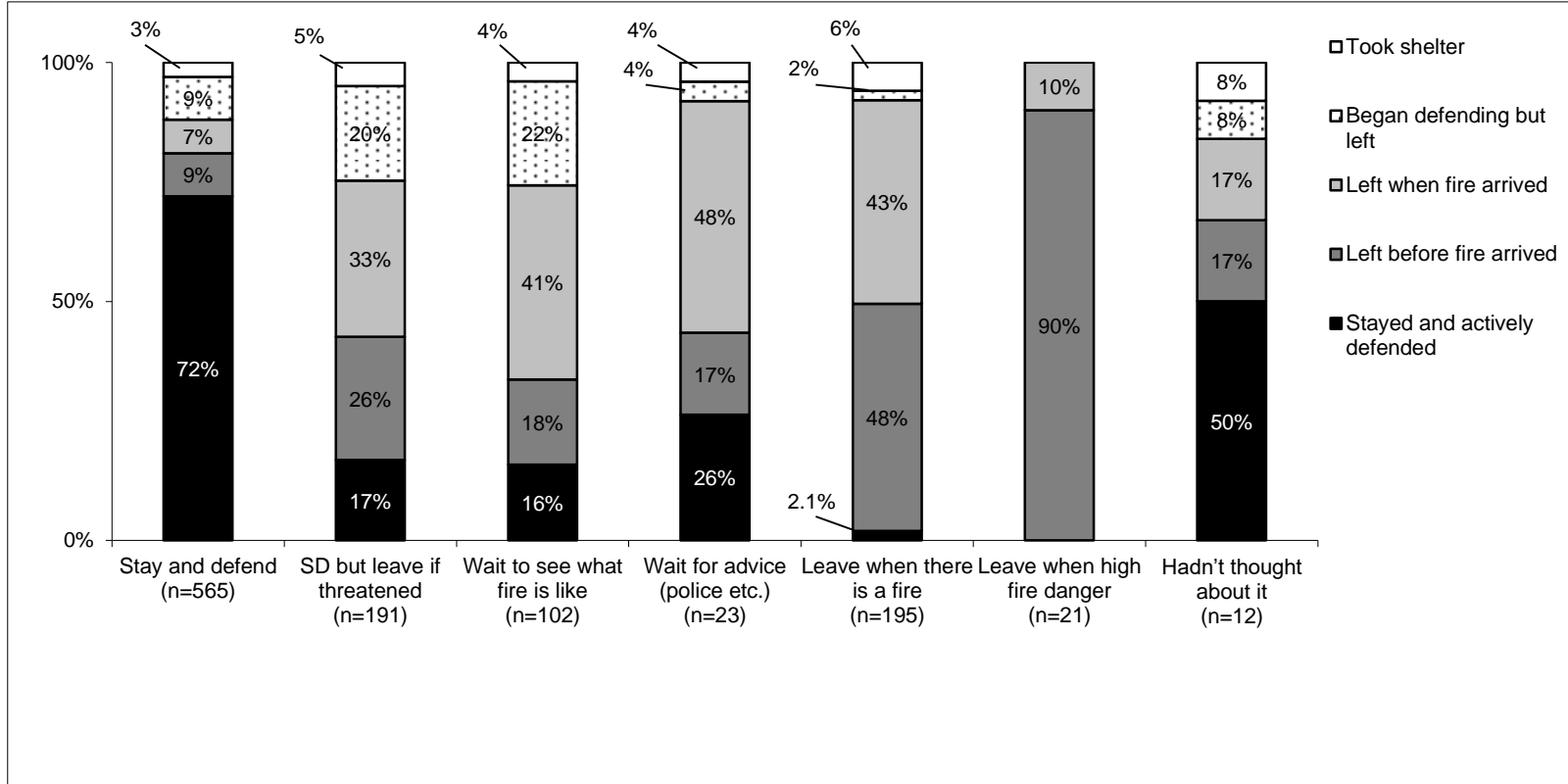


Figure 2: Action taken, by intention²

² Percentages may not total 100% due to rounding.

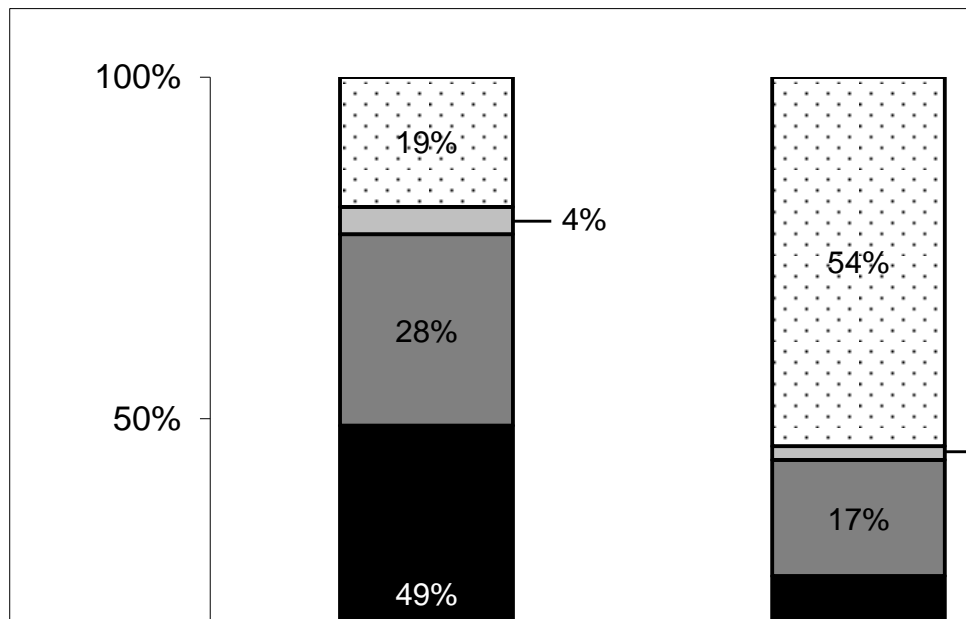
1 Figure 2 charts intended responses against actual responses to the February 7 fires. The majority
2 of those who intended to stay and defend throughout the fire did so (72%). Importantly, the
3 majority of those who intended to stay and defend but leave if threatened ended up leaving
4 (79%). Similarly, most of those who intended to see what the fire was like, or wait for advice
5 from emergency services, left once the fire had arrived (63% and 52%, respectively). Those who
6 intended to leave as soon as they became aware of a fire most often left, either before or when
7 the fire arrived (48% and 43%, respectively). It is significant that the majority of those who
8 intended to leave on all high fire danger days (n=22), regardless of whether there was a fire, left
9 before the fire arrived (91%).

10

11 *Relationship between household response and house damage*

12 One-third (33%) of survey respondents reported that their house was destroyed in the fires,
13 with the highest rates of destruction (the percentage of houses lost in each area) in the
14 Murrindindi (47%), Churchill (39%) and Kilmore East (33%) fires.

15



17

18 Figure 3: House damage, by household action³

19

20 Rates of house damage and destruction were considerably lower among households where
 21 residents stayed and defended (Figure 3). In households where at least one person stayed and
 22 defended, just two in ten houses were destroyed. In households where all householders left,
 23 or sheltered without defending, five in ten houses were destroyed. A chi-square test
 24 confirmed that the association between these variables was statistically significant, $X^2(3, N =$
 25 $1264) = 167.01, p = < .0001$.

26

27 5. Discussion and conclusions

28 The findings in this paper largely reinforce past bushfire research, while providing new
 29 insights into a range of community safety issues. Arguably the most important debate
 30 following the Black Saturday fires concerned the appropriateness of the PSDLE policy and
 31 its implementation by authorities and residents. The fact that 113 of the 173 fatalities

³ 'Stay and defend' includes households where at least one person stayed and defended, while 'Leave / shelter' includes households where all members left and/or sheltered without defending.

32 occurred inside houses meant that the policy and its evidence base were scrutinised. Critics
33 argued that the policy, as implemented, had contributed to fatalities by encouraging people to
34 stay and defend homes that were not defensible under such extreme conditions. However,
35 critics typically assumed that those who died had been defending at the time of death.
36 Subsequent analysis of the fatalities found that more than two-thirds (69%) had been
37 sheltering passively when they perished (Handmer *et al.* 2010). While some of these people
38 may have attempted to defend before taking shelter, ‘... few fatalities were found near
39 evidence of the means of firefighting... and positions of bodies, such as bodies found in a
40 lying position, or in the bath, suggest passive sheltering rather than active defence’ (Handmer
41 *et al.* 2010, p. 25). More broadly, the analysis revealed a lack of fire risk awareness among
42 those who died, and a limited degree of planning and preparedness (Handmer *et al.* 2010).
43
44 Results presented in this paper suggest varied levels of awareness, planning and preparedness
45 among those affected by the fires. As has already been noted, these results must be
46 interpreted cautiously due to the possible effects of hindsight bias (Bradfield and Wells,
47 2005) and highly varied perceptions of what constitutes adequate planning and preparedness.
48 Most respondents claimed they had previously thought it likely that a bushfire would occur
49 where they lived (78%) and rated the threat as high or very high (67%). Lower levels of
50 bushfire awareness were recorded in more suburban locations (e.g. in or on the outskirts of
51 towns or regional cities) where many residents did not have prior experience or knowledge of
52 bushfire and had not considered themselves at risk. These results probably exaggerate
53 awareness levels prior to Black Saturday and certainly say little about people’s
54 *understandings* of bushfire risk. In any case, research has shown that awareness of risk does
55 not necessarily spur planning and preparedness (Berringer, 1998; McGee and Russell, 2003;
56 Eriksen and Gill, 2010; Prior, 2010).

57

58 Findings related to planning and preparedness are similar to those for awareness, with most
59 respondents assessing their preparedness level as ‘high’ to ‘very high’ (46%) or ‘average’
60 (36%). Clearly, these findings obscure considerable variation in the quality of people’s plans
61 and preparation, which was apparent in the qualitative component of the research (see
62 Whittaker *et al.*, 2009a). As has been found in other studies (e.g. Bushnell *et al.*, 2007;
63 Rhodes 2007), the most common preparations undertaken by residents were low-cost and
64 ‘easy to do’ actions such as clearing leaves and grass from around the house and obtaining
65 equipment such as ladders, buckets and mops. These actions are often part of general
66 property maintenance and may not be undertaken with the intent of preparing for bushfire. It
67 is significant that almost three-quarters of the survey respondents thought they could have
68 been better prepared.

69

70 Media coverage and public debate after the fires understandably focused on the many deaths
71 and property losses. Less prominent were the stories of people who stayed and successfully
72 defended their homes and properties. The research reported in this paper revealed a survival
73 rate of 77% for houses that were defended by one or more household members, and 44% for
74 houses that were unattended.⁴ These results are comparable to the house survival rates
75 recorded by Wilson and Ferguson (1984) in the Ash Wednesday fires at Mt Macedon (90%
76 for houses that were actively defended; 82% for attended but not actively defended houses;
77 and 44% for unattended houses). There are, of course, many other factors that influence
78 house survival in bushfires. Research has identified links between house loss and weather
79 conditions (e.g., Bradstock and Gill, 2001; Blanchi *et al.*, 2010), fire severity (Wilson and
80 Ferguson, 1986), distance to bushland (Crompton *et al.*, 2010) and the design and

⁴ These figures exclude the small proportion of houses that sustained major damage (4% of defended and 2% of unattended houses).

81 construction of buildings (e.g. McArthur and Lutton, 1991; Blanchi and Leonard, 2008).
82 While in-depth investigation of these factors is beyond the scope of this paper, resident
83 planning and preparation was investigated as a means for reducing risks to property. Results
84 indicate a higher rate of house survival among households where there was a firm, pre-
85 existing intention to stay and defend. Houses were also more likely to survive when defended
86 by more than one person. The fact that 77% of those who stayed to defend were able to
87 protect their house from the fires reinforces that ‘stay and defend’ is a viable alternative to
88 evacuation when residents have undertaken appropriate planning and preparation, and are
89 assisted by others.

90
91 Clearly, however, the results of this study highlight a number of problems and challenges for
92 the PSDLE approach and for community bushfire safety more broadly. Although late
93 evacuation is an inherently dangerous response to bushfires (Wilson and Ferguson, 1984;
94 Krusel and Petris, 1992; Handmer and Tibbits, 2005; Haynes *et al.*, 2010), it was an effective
95 response for the majority of those who did so in the Black Saturday fires. Most of those who
96 undertook late evacuation arrived at their destination unharmed, despite 80% perceiving the
97 danger to be high or very high when they left and more than half encountering dangers
98 associated with flames, embers, smoke and fallen trees. Importantly, however, 24 (14%) of
99 those who perished in the fires were fleeing on foot or by car (Handmer *et al.*, 2010),
100 highlighting that late evacuation remains a dangerous response to bushfire.

101
102 The viability of the PSDLE policy was a key issue for the Royal Commission. It
103 acknowledged that ‘... the central tenets of the stay or go policy remain sound’ but concluded
104 that the February 7 fires had exposed weaknesses in the way it was applied’ (Teague *et al.*,
105 2010, p. 5). The Commission found that the policy did not account for ‘ferocious’ fires, and

106 recommended greater emphasis on the increased risks to life and property ‘on the worst days’
107 and on leaving early as the safest option. These are now key messages in the national
108 ‘Prepare. Act. Survive.’ strategy (AFAC, 2009). To better communicate the risks to life and
109 property on the days of highest fire danger, the Commission also recommended that Fire
110 Danger Ratings be revised to include a rating beyond ‘Extreme’. This led to the development
111 of the ‘National Framework for Scaled Advice and Warnings to the Community (AEMC,
112 2009) and the introduction of the ‘Catastrophic/Code Red’ rating. In Victoria, the CFA has
113 developed ‘scaled advice’ to more clearly communicate what residents can expect and what
114 they should do for different levels of fire danger (CFA, 2012). Residents are advised that
115 homes are not designed or constructed to withstand fires burning under ‘Catastrophic’
116 conditions, and that leaving high bushfire risk areas the night before or early in the day is the
117 safest option.

118

119 The tendency for people to wait until a fire arrives before deciding whether to stay and
120 defend or leave is a perennial challenge for fire services (Rhodes, 2005; Whittaker and
121 Handmer, 2010; Teague *et al.*, 2010). This study found that around a quarter of respondents
122 adopted a ‘wait and see’ strategy in the Black Saturday fires, a strategy that greatly increases
123 the likelihood that people will undertake late and dangerous evacuations or become trapped
124 in a shelter that cannot be defended. Importantly, the Royal Commission recognised that the
125 binary approach of ‘Prepare, stay and defend *or* leave early’ does not adequately reflect the
126 reality of what people do during bushfires: ‘... the reality [is] that people will continue to
127 wait and see, and a comprehensive bushfire policy must accommodate this by providing for
128 more options and different advice’ (Teague *et al.* 2010, p. 5). In response, the CFA and
129 Victorian local governments have designated ‘Neighbourhood Safer Places’ as places of last

130 resort, while the Australian Building Codes Board is developing standards for the design and
131 construction of bushfire bunkers for personal use.

132
133 Many of the changes initiated by the Royal Commission have the potential to increase
134 community bushfire safety. However, they are no panacea. As this and other research has
135 shown, having an intention to leave early does not necessarily mean that people will do so.
136 Confusion over the meaning of 'leave early' and difficulty recognising when it is too late to
137 leave (Tibbits and Whittaker, 2007) means that many of those who intend to leave early
138 undertake late evacuations. 'Code Red' warnings were introduced to alert residents to the
139 potential for catastrophic bushfires and to encourage them to leave early. However, research
140 following a Code Red declaration a year after Black Saturday found that very few residents
141 actually left their homes in the absence of a fire (see Whittaker and Handmer, 2010). The
142 frequency of high fire danger days in summer, and the relative infrequency of bushfires,
143 means that leaving when there is no fire is impractical for most residents (Tibbits and
144 Whittaker, 2007; Johnson *et al.*, 2012). The introduction of community refuges and personal
145 bunkers may have expanded the range of options available to residents in high bushfire risk
146 areas; however, the possibility of last minute evacuation to a nearby place of refuge may
147 serve to discourage appropriate planning and preparation.

148
149 The results presented in this paper indicate that staying to defend or leaving when threatened,
150 while not without their risks, were effective responses for most people in the Black Saturday
151 fires. Nevertheless, 173 people did lose their lives, including many inside houses. The results
152 of this study highlight that people who are inadequately prepared and who take action at the
153 last moment are more likely to be forced into dangerous responses such as late evacuation,
154 untenable defence and passive shelter.

155

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162

163

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