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Wildfire survival plans in theory and practice

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Abstract

Bushfire survival plans are a valuable tool for residents living in fire-prone landscapes. Plans include assigning trigger points for action, roles for all household members, and alternate approaches should the original plan fail. Fire agencies advocate that residents write, practise and discuss these plans before the fire season. In this study we use a multiple-methods approach to examine the theoretical and actual application of bushfire survival plans in south-east Australia. First, we review agency advice regarding survival plans to determine the consistency, clarity and specificity of the advice. Second, an online survey of residents examines the relationships between types of plans, with the planned action during a wildfire, gender and past experience with fire. Finally, semi-structured interviews with residents who have experienced wildfire examine the reality of decision-making, triggers used for actions and the role of survival plans. The study concludes that: a) fire agencies provide clear and concise information around survival plans despite some variation between states; b) preparation of survival plans is limited by the same range of factors that limit the extent of overall wildfire preparedness; and c) without a written, discussed and practised plan, decision-making during a wildfire may be impaired with potentially fatal consequences.

Keywords

practice, wildfire, plans, survival, theory

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

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Running head

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Abstract

Wildfire survival plans are a valuable tool for residents living in fire-prone landscapes. Plans include assigning trigger points for action, roles for all household members, and alternate approaches should the original plan fail. Fire agencies advocate that residents write, practice and discuss these plans before the fire season. In this study we use a multiple-methods approach to examine the theoretical and actual application of wildfire survival plans in southeast Australia. First, we review agency advice regarding survival plans to determine the consistency, clarity and specificity of the advice. Secondly, an online survey of residents examines the relationships between types of plans, with the planned action during a bushfire, gender and past experience with fire. Finally, semi-structured interviews with residents who have experienced wildfire examine the reality of decision-making, triggers used for actions and the role of survival plans. The study concludes that: a) fire agencies provide clear and concise information around survival plans despite some variation between states; b) preparation of survival plans is limited by the same range of factors that limit the extent of overall wildfire preparedness; and c) without a written, discussed and practiced plan, decision-making during a bushfire may be impaired with potentially fatal consequences.

29

30 **Brief summary**

31 This paper examines how wildfire preparedness differs between residents with respectively a mental,
32 written or no survival plan, and the implications of plans having been discussed and practised with
33 others. It highlights why explicit and consistent official preparedness advice is important for risk
34 communication and communities at risk.

35

36 **Keywords**

37 Wildfire (bushfire), resilience, risk engagement, preparedness, survival plans, Australia

38

39 **Introduction**

40 The continuing growth of housing developments at the wildland-urban interface and the increasing
41 occurrence of extreme fire weather have resulted in an increasing number of residents being exposed
42 to wildfire (Gibbons *et al.* 2012; Syphard *et al.* 2012; Gill *et al.* 2013). While fire management
43 agencies attempt to reduce the impact of wildfire on residents through preventative (e.g. fuel
44 treatments) and responsive (e.g. fire suppression) actions, they cannot prevent all wildfires from
45 causing harm to life and property (Gill and Stephens 2009). When exposed to wildfire, residents can
46 reduce the probability of house loss and increase the probability of survival by being well prepared
47 (Wilson and Ferguson 1986; Blanchi and Leonard 2008).

48

49 Being ‘well prepared’ for wildfire comprises two theoretically explicit aspects: physical preparation
50 (to provide structural protection from a wildfire threat) (Penman *et al.* 2013) and mental preparation
51 (that encompasses adequate planning and the development of a psychological capacity to respond)
52 (Eriksen and Prior 2013). Post-fire studies have found that last-minute disagreements between family
53 members on what to do and where to go heightened emotional distress and anxiety, increased
54 exposure to danger, and in worst-case scenarios resulted in fatalities (Proudley 2008; Handmer *et al.*
55 2010; Haynes *et al.* 2010; Blanchi *et al.* 2014; Eriksen 2014a). In the wake of the catastrophic 2009
56 ‘Black Saturday’ wildfires in Victoria, Australia, research found that ‘the extreme nature of the fires

tested the extent of people's planning and preparedness. An important aspect of this was psychological preparedness, which influenced peoples' capacity to cope with the fires and their ability to plan and think clearly' (Whittaker *et al.* 2009, pg. 13).

Preparing a 'bushfire survival plan', i.e. a plan of action, is a vital guide to decision making during a wildfire (Bushnell and Cottrell 2007; Penman *et al.* 2013; Towers 2013). A completed plan requires actions and roles are identified and assigned for all individuals in the household, regardless of whether they intend to stay and defend or leave early (Eriksen 2014b). Multiple contingencies must be included in the survival plan to account for the highly variable nature of wildfire, e.g., fallen trees or power lines resulting in closure of potential escape routes, fires impacting on the property from an unexpected direction, equipment failure and some or all residents being at home (Penman *et al.* 2013; Whittaker *et al.* 2013). Triggers for action must be included in the plan and may come from a range of sources including visual cues (smoke or flames), or information received via television, social media or radio. Most importantly any survival plan must identify pathways for exiting the property safely to travel to a place of last resort (Tibbits and Whittaker 2007).

Australian fire management agency advice to residents emphasises the need to prepare appropriately regardless of their planned actions on the day of the fire. The Australasian Fire and Emergency Services Authorities Council's (AFAC) position statement on 'Bushfires and Community Safety' argues that the safety of residents can be improved if they prepare a bushfire survival plan and strongly encourages fire management agencies to engage and communicate this to at-risk communities (AFAC 2012). Responsibility for implementing these strategies lies with the various state fire management agencies. While these agencies all broadly follow the recommendations within the AFAC position statement and the 'Prepare. Act. Survive.' policy (which superseded the 'Prepare, Stay and Defend or Leave Early' policy in 2010), there is no uniform approach to community engagement and education regarding bushfire survival plans.

In this study we use a multiple methods approach to consider the application of bushfire survival plans in southeast Australia. Firstly, we review the agency advice regarding bushfire survival plans to determine the consistency, clarity and specificity of the advice. Specifically we test whether agencies require a bushfire survival plan to be written, practised and discussed, as this is considered vital for a household to be prepared (Penman *et al.* 2013). Secondly, we conduct an online survey of residents in fire-prone communities in Australia to examine the relationships between the various types of plans (written, mental or no plan) with the planned action on the day, gender and past experience with fire, all of which have been proven to influence residents preparedness and may therefore influence the type of plan they have (Eriksen and Gill 2010; Bihari and Ryan 2012; Prior and Eriksen 2013; Dunlop *et al.* 2014; Eriksen 2014a; Paveglio *et al.* 2014). In addition, we examine whether these patterns vary between states. Finally, we conduct semi-structured interviews with residents who have experienced wildfire to examine decision-making during a bushfire, triggers used for actions and the role of bushfire survival plans. This assessment of the role of survival plans allows for an assessment of the extent to which the theory of preparedness overlaps with the reality of dealing with wildfires, something that is lacking in the current literature (McLennan *et al.* 2013).

Methods

The study was conducted in southeast Australia during the 2012-2013 wildfire season, considering the states of New South Wales (NSW), Victoria (VIC), South Australia (SA), Tasmania (TAS), and the Australian Capital Territory (ACT). The statutory 'Bushfire Danger Period' runs from October 1 to March 31 in Australia, and public awareness of wildfire is generally heightened during this period due to the increased media coverage and the sense of danger related to hot and dry weather conditions and/or actual wildfires (Collins 2006). South Australia and Tasmania experienced severe wildfires during the survey-period. Different methods were used to address the key questions outlined in the introduction. Each method is presented in detail below.

Fire management agency advice

The study reviewed the literature provided by Australian fire management agencies in relation to bushfire survival plans for all states and territories in southeast Australia. For the purposes of this study, we focus on the agencies with the primary responsibility of protecting property from the threat of wildfire or unplanned fire. The agencies were the NSW Rural Fire Service (www.rfs.nsw.gov.au), Victorian Country Fire Authority (www.cfa.vic.gov.au), South Australian Country Fire Service (www.cfs.sa.gov.au), Tasmanian Fire Service (www.fire.tas.gov.au) and the ACT Rural Fire Service (www.esa.act.gov.au/actrfs/). All communication material pertaining to bushfire survival plans available to the public on each of the five Australian state/territory fire agency websites was reviewed. Whilst the number of documents and formats varied between each agency, they all had a key household bushfire survival plan document, which provided advice and information about bushfire preparation and planning, usually in a booklet format. This material, and associated documents such as planning templates, were analysed and categorised according to whether they provided advice on a written plan, practising of the plan and discussion of the plan with household members.

Online household survey

The online survey covered a range of topics, including type of property (rural, urban, interface), property exposure (location, access, vegetation), perception of risk, personal level of wildfire preparedness, plan of action, direct personal wildfire experience, and social, environmental and lifestyle values. The survey design was based on a tried and tested survey model (Eriksen 2010, 2014). The questions relevant to this study are presented in the supplementary material.

The online survey was created via SurveyMonkey[®] and advertised through the email lists and social media of community engagement groups of the fire management agencies throughout Australia, social media of the authors and their institutional affiliations, and additional media coverage in the states of South Australia and Tasmania. It was necessary to use these networks in order to access the range of residents living in fire-prone landscapes. As a result, the survey is potentially biased towards people already interested in fire management to some extent. Therefore, the data does not represent a completely randomised sample, and represent a more optimistic scenario for the extent of planning.

A total of 607 completed surveys were returned from across Australia. The majority of these came from New South Wales (n=345), Tasmania (n=107) and South Australia (n=104). Considerably lower numbers were received from the other states and territories, and the survey results presented in this paper therefore explicitly focus on New South Wales, Tasmania and South Australia.

Traditional analytical approaches do not allow for correlated predictor variables, which cause multicollinearity (Chatterjee *et al.* 2000). Research in this area has focused on direct relationships with the key drivers and preparedness (McGee and Russell 2003), without directly accounting for the interrelatedness between the predictor variables. Bayesian Networks were selected as the primary method for analysis as they allow for the relationships between all the predictor and response variables to be explored. Arising from graph theory, Bayesian Networks are comprised of nodes and arrows that form an influence diagram where nodes represent the variables and arrows the direction of influence (Pearl 1986). Each node is a random variable represented by a conditional probability table, which contain the joint probability distributions for the variables (Korb and Nicholson 2011). Nodes at the top of the model (i.e., root nodes) have a conditional probability table, which contains a single probability value for each state in that node. Child nodes are variables influenced by one or more variables and have a conditional probability table that represents the probability of a given state in the child node given the states in the parent node(s). Probability distributions and hence uncertainties in relationships are then propagated throughout the network.

Model structure and the conditional probability tables were learnt from the survey data using the PC algorithm (Sprites *et al.* 1993). The PC algorithm begins with a fully connected model and removes arcs based on conditional independence (Korb and Nicholson 2011), and has been demonstrated to work well for small models (Dai *et al.* 1997). By learning from the data, the algorithm results in a model that best represents the data structure and directionality of the relationships. Variables included in the analysis were based on prior research in this area (see introduction) and were State of residency, gender, perceived level of risk from wildfire, type of direct personal wildfire experience, respondents

planned action in case of a wildfire, planned action of other household members in case of a wildfire, type of property, distance from vegetation, the self-assessed level of preparation, and type of survival plan. Bayesian Network analyses were conducted using the GeNie v.2.0 package (Decision Systems Laboratory, University of Pittsburgh, <http://genie.sis.pitt.edu>, accessed July 2013).

Semi-structured interviews

Survey respondents from the online survey could volunteer to further contribute to the study by participating in a face-to-face interview. Due to the significant survey responses from New South Wales, Tasmania and South Australia, a focus on these three states was deemed appropriate for the follow-up interviews. The survey results were used as the basis for the selection of a purposive interview sample of residents with direct personal experience(s) of leaving early or staying and defending property from wildfire (Hay 2005; Creswell 2007).

Twenty-two interviews were carried out with 31 residents (13 individuals and 9 couples) on their properties using an in-depth, interactive, semi-structured interview approach (Bryman 2008). The interview schedule was designed to guide the conversation along three themes: 1) participants' awareness of living in a bushfire prone area, 2) recounts of personal bushfire experiences, and 3) the extent to which participants have changed their outlook and preparedness post-fire. Basic characteristics of the survey and interview participants are summarised in Table 1. The interviews were audio recorded and transcribed verbatim, followed by thematic analysis of the transcripts in the Computer Assisted Qualitative Data Analysis Software (CAQDAS) NVivo v.10. The primary focus of the qualitative analysis was to highlight similarities and differences across the sample of *a priori* themes, such as priorities pre-, during- and post-fire, and emerging themes, such as emotional responses (Bazeley 2007; Riessman 2008). The interview quotations illustrate common attitudes, beliefs and concerns amongst research participants.

Table 1. Demographic characteristics of research participants.

	New South Wales		South Australia		Tasmania	
	Interviews (n)	Survey (n)	Interviews (n)	Survey (n)	Interviews (n)	Survey (n)
Number of interviews	6	-	10	-	6	-
Number of research participants by gender (F = female, M = male)	9 (5 F, 4 M)	345 (204 F, 141 M)	15 (7 F, 8 M)	104 (75 F, 29 M)	7 (6 F, 1 M)	107 (56 F, 51 M)
Direct personal experience of leaving early/evacuating	1	43	5	24	1	10
Direct personal experience of staying and defending	8	45	10	15	6	19
Considered wildfire safety issues when buying, building or moving home	4	166	8	49	6	56
Bushland within 30m of house	2	71	4	20	3	34
Bushland within 31-100m of house	4	110	8	27	4	36
Bushland within 101-500m of house	6	50	9	13	5	10
House located on ridge or hill	3	219	8	53	5	70
Property has more than one access road	2	93	7	47	1	33
Cleared Asset Protection Zone (firebreak)	4	106	7	32	6	39
Insurance that covers loss from wildfire	6	258	10	75	6	83
Rates wildfire threat to property as high, very high or extreme	4	125	8	56	4	48
Rates personal level of preparedness as satisfactory or better	5	173	10	64	6	64

Results

Fire management agency advice

Seventeen documents were reviewed across the five Australian state and territory fire management agencies, including web pages, and downloadable PDF fact sheets, booklets and survival plans (Table 2). All agencies provide planning templates for residents to create both a plan for leaving early and staying and defending, thus emphasising the importance of having a back-up plan. There are differences in the degree of emphasis and explanation provided by each agency with regards to the importance of the written, discussed and practised aspects of survival plans (Table 2). Victoria and South Australia have the most detailed information in regards to having a written plan that is practised and discussed. Tasmania does include information regarding a written, practised and discussed plan, but fewer examples were present in the document compared to Victoria and South Australia. The Australian Capital Territory and New South Wales never explicitly state the value of writing the plan,

209 but infer this by providing a planning template with space for written text. However, these agencies
210 do state the importance of practicing and discussing the plan.

211

212 Table 2. Consistency of official 'Bushfire Survival Plan' guidance in southeast Australia.

State Agency	Bushfire Survival Plan / Planning Templates	In text emphasis on written, practised and discussed plans (bold font added by authors to highlight words that directly link to recommended practices)
Australian Capital Territory (ACT) Rural Fire Service	<i>Bushfire Survival Plan: Prepare. Act. Survive.</i> (2013; 24 pages, same booklet as in NSW). Planning templates for Leave Early Plan (1 page) and Stay & Defend Plan (1 page).	Only indirectly by encouraging people to complete the templates included in the document and a photo (p.2) of a family filling out the templates. p.8 'What you should do: Very high, high, low moderate Finger Danger Rating: Review your Bush Fire Survival Plan with your family.' p.10 'On days of increased fire danger... Review your Bush Fire Survival Plan with your family... Talk to your neighbours, family and friends... Make sure your whole family knows what your trigger is and be ready to put your Bush Fire Survival Plan into action.' p.15 'You should keep your Emergency Survival Kit in a waterproof storage container in a location that is easy to get to and that the whole family knows about. This will make it quick and easy to find when you need it.'
New South Wales (NSW) Rural Fire Service	<i>Bushfire Survival Plan: Prepare. Act. Survive.</i> (2013; 24 pages, same booklet as in ACT). Planning templates for Leave Early Plan (1 page) and Stay & Defend Plan (1 page).	Only indirectly by encouraging people to complete the templates included in the document and a photo (p.2) of a family filling out the templates. p.8 'What you should do: Very high, high, low moderate Finger Danger Rating: Review your Bush Fire Survival Plan with your family.' p.10 'On days of increased fire danger... Review your Bush Fire Survival Plan with your family... Talk to your neighbours, family and friends... Make sure your whole family knows what your trigger is and be ready to put your Bush Fire Survival Plan into action.' p.15 'You should keep your Emergency Survival Kit in a waterproof storage container in a location that is easy to get to and that the whole family knows about. This will make it quick and easy to find when you need it.'
South Australian (SA) Country Fire Service	<i>Your Guide to Bushfire Safety. Prepare. Act. Survive.</i> (2013; 32 pages). Planning templates for Bushfire Survival Plan Checklist (1 page), Leaving Early Plan (1 page), and Stay & Defend Plan (1 page).	p.2 'Prepare and practise your Bushfire Survival Plan well before the fire season' p.3 ' Written and practised bushfire survival plan' p.5 'Fire Danger Ratings: Prepare, know and practise a plan for: a) How you will respond to the FDR, b) How you will respond to an emergency warning for a bushfire, c) How you will respond to a bushfire given no warning, d) How you will communicate information, e) Who will be in charge.' p.11 'Spring: Review, update and practise your Bushfire Survival Plan. Summer: Prepare and practise your Bushfire Survival Plan well before the fire season.' p.13 'A good Plan: a) is prepared well before the Fire Danger Season, b) is written down so that the details are to hand when you need them, c) has been practised , so you know how it will go on the day, d) is created with the whole family and covers everyone, including the young and elderly. It includes what to do: 1) before the Fire Danger Season, 2) on a Total Fire Ban day, 3) during a bushfire, 4) after a bushfire, and 5) can adapt to unforeseen circumstances. p.19 Lack of planning: Fires can be very frightening and may make it hard to think clearly or make good decisions. Sometimes people find out too late they don't have essential resources to enact their plans. It is vital that you have a written and practised Bushfire Survival Plan.' p.22 'It is as important to have a written and practised plan if you decide to leave as it is if you decide to stay.' p.29 'Once the plan is completed, it is important that you practise and review the plan regularly. This will mean that if you need to activate the plan in a real bushfire, you will have already gone through the thought processes and be able to respond appropriately.'
Tasmanian (TAS) Fire Service	<i>Bushfire Survival Plan. Know your Risk. Make a Plan</i> (2013; 24 pages). Planning templates for	p.8 'A written plan will help you think through the actions logically, and give you something to refer to if a bushfire breaks out nearby.' p.8 'Let your family, friends and neighbours know what you are planning to do.'

State Agency	Bushfire Survival Plan / Planning Templates	In text emphasis on written, practised and discussed plans (bold font added by authors to highlight words that directly link to recommended practices)
	Leave Early Checklist (1 page), Leave Early Plan (1 page), Stay and Defend Checklist (1 page), and Stay and Defend Survival Plan (1 page).	p.18 'Practice using the [fire fighting] equipment regularly.' p.20 'Because everyone's Bushfire Survival Plan will be different, complete the Stay and Defend Survival Plan for you and your family's circumstances and keep it in a safe and easily accessible place.'
Victorian (VIC) Country Fire Authority	<i>Prepare. Act. Survive. Fire Ready Kit</i> (2013; 76 pages). Planning Templates for Leaving Early (8 pages) and Stay and Defend (17 pages) included as tear outs in hardcopy. Separate downloadable PDF document online.	p.12 'Not everyone thinks clearly in an emergency. A written , and preferably well- practised plan, will help you remember what needs to be done during a crisis.' p.15 'Why write down your plan? Would you remember a plan that's just in your head if you're surrounded by smoke, heat and flames? A written plan will take the pressure off you, and avoid arguments and delays. In Victoria the bushfire season is long, and a written plan will help reduce uncertainty and anxiety. Having a written plan will reduce the stress and disruption to your family routine on every occasion you need to leave early – even if there is no fire. REMEMBER: Any bushfire plan – written or not – is better than no plan.' p.15 ' Practise packing your car so you know how long it will take.' p.18 'Depending on the conditions, you will need to move quickly and efficiently if a fire starts near you. Make sure you include the 'Getting ready to go' steps in your plan. Make a point of practicing them so you know how long each step will take. Doing all of these things could take hours.' p.68 'Not everyone thinks clearly in an emergency. Write your plan down and discuss it with all family members, and make sure everyone knows which responsibilities are allocated to them. Everyone should be aware that staying to defend involves a high risk of psychological trauma, injury or possibly death.' p.75 'The best way to prepare yourself mentally is to have a written and practised plan that everyone in your household understands and has agreed to.'

Online household survey

Analysing the survey data by type of survival plan (written, mental, no plan) reveals a significant difference between the three states of New South Wales, South Australia and Tasmania (Table 3) ($\chi^2 = 20.6$, $df = 4$, $p\text{-value} = 0.0004$). Significantly more South Australian respondents have a written plan compared with New South Wales and Tasmania. More respondents in Tasmania have mental plans than in the other two states, and New South Wales has the highest number of respondents with no form of survival plans.

Table 3. Type of Bushfire Survival Plan.

	NSW ($n=292$) (%)	SA ($n=88$) (%)	TAS ($n=96$) (%)	Total ($n=476$) (%)
<i>Written Plan</i>	12	26	11	14
<i>Mental Plan</i>	62	63	72	64
<i>No Plan</i>	27	11	17	22

When survival plans are examined by degree of detail (Table 4), the South Australian respondents again have more detailed plans: 16% of respondents have a written plan that has been both discussed and practised with other household members, with a further 8% who have a written plan that has been discussed but not practised, and 2% who have a written plan that has been neither discussed nor practised. The most common response for all three states is for mental survival plans that have been discussed but not practised with others.

Table 4. Type of Bushfire Survival Plan by degree of detail.

	NSW (n=292) (%)	TAS (n=96) (%)	SA (n=88) (%)	Total (n=476) (%)
<i>No plan</i>	27	17	11	23
<i>Mental plan discussed and practised with other household members</i>	13	16	16	13
<i>Mental plan discussed with other household members but not practised</i>	40	45	36	40
<i>Mental plan not discussed with other household members</i>	9	11	10	9
<i>Written plan discussed and practised with other household members</i>	5	5	16	7
<i>Written plan discussed with other household members but not practised</i>	7	6	8	7
<i>Written plan not discussed with other household members</i>	0	0	2	1

Bayesian Network analysis of the survey data found that the type of plan a resident has is influenced by the property type, the perceived level of risk from fire to the property and the self-assessed level of preparedness (Figure 1). Other variables tested such as distance from vegetation and insurance type were found to be unrelated to any node in the model and are not discussed further. Rural properties were more likely to have a mental or written plan compared to both the interface properties and urban properties. Urban properties had 41% of respondents without any plan and only 6% with a written plan (Figure 2a). The majority of residents who considered themselves not to be at risk from fire (n=17) had no plan, and as the perceived level of risk increased the percentage of residents with mental and written plans increased (Figure 2b). The exception is for the “extreme” category, which is likely to be a function of low numbers in this group in the survey data resulting in individual survey responses having high influence on the proportional data. Only a small number of respondents (n=<30) ranked their risk to the property as extreme compared with more than 60 respondents in

every other category. Residents self-assessed level of preparation influenced the type of survival plan they had. As the ranking of preparation increased so did the number with either a written or mental plan (Figure 2c).

Figure 1: Bayesian Network model predicting the type of plan a resident has based on the online survey data. Bar plots and values represent the mean condition for the model based on the survey data.

Figure 2: Primary relationships in the Bayesian Network model predicting the percentage of residents with no survival plan, a mental plan or a written plan. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

There were also inter-relationships between the factors. Respondents in urban areas had lower perception of risk from wildfires compared with counterparts on interface or rural properties (Figure 3). Residents who perceived their property at greater risk from fire also perceived they were better prepared (Figure 4).

Figure 3: Relationship with the property type and the perceived risk to the property from wildfire. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Figure 4: Relationship with the perceived risk to the property from wildfire and the self-assessed level of preparation. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Residents who had experience defending their own property or neighbours property(s) ranked the risk to the property higher than those with no experience or experience evacuating (Figure 5).

Figure 5: Relationship with the past experience with fire and the perceived risk to the property from wildfire. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

The majority of respondents had no experience with fire at their property, although there were state and gender differences between those that had experience in terms of evacuating from and defending property during a bushfire. Females in South Australia are more likely to have evacuated than males in South Australia or male and female respondents from other states. In contrast, females in Tasmania are more likely to have defended their own or neighbouring property from fire compared to females in New South Wales or South Australia, and marginally higher than males in all states (Figure 6).

Figure 6: Relationship between the state of residency, gender and the experience with fire. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Self-assessed level of preparation was higher in those who planned to stay and defend compared with those whose plan was to either wait and see or leave early (Figure 7). Past experience with fire and gender influenced the future planned response (Figure 1). There is a trend where those who have stayed to defend their home or a neighbours, are more likely to stay and defend in the future. Similarly, those who have evacuated in the past are more likely to do so in the future. However, we do note only a very small proportion of males (2%) reported experience of evacuating in the past. The vast majority of the respondents (70%) have no experience in fire (Figure 8).

Figure 7: Relationship between planned response to future fire and the self assessed level of preparedness. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Figure 8: Relationship between gender, planned response to future fire and the past experience with fire. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Relationships exist with the planned response of the respondent and the planned action of others in the house (Figure 1). For both males and females, many households had shared responses. However, for males who were planning to stay and defend, 51% of other householders planned to leave early and 5% planned to wait and see. In contrast, for females planning to stay and defend only 17% of respondents had other householders who planned to leave early and less than 2% who planned to wait and see (Figure 9).

Figure 9: Relationship between gender, planned response to future fire and other householders' response to fire. Values presented are the modelled data within the Bayesian Network model based on the raw survey data.

Semi-structured interviews

A total of 22 semi-structured interviews with 31 participants were undertaken in New South Wales, South Australia and Tasmania. Of these, seven had experience of leaving early/evacuating their property due to the threat of wildfire and 24 had direct personal experience of staying and defending their property. Nine had a written plan (all of which had been discussed with other household members, and seven had also been practiced), 12 had a mental plan (ten of which had been discussed with other household members but only three had also been practiced), and one participant had no plan. Five participants planned to leave early in the event of a future wildfire threat (for three this was also the plan for other household members), one planned to wait and see (which was also the plan for the rest of their household), and 16 planned to stay and defend (for 12 this was also the plan for other household members). This group provides a range of experiences to examine the practical application of survival plans during wildfires. These experiences are illustrated with interview quotes that are representative of the key themes highlighted in the qualitative data analysis with regards to how a

survival plan (or the lack thereof) effects how residents react to trigger points, make decisions, and cope with the threat.

Overall, the interview participants showed a high level of awareness of detailed weather characteristics on days of high fire danger; characteristics that often formed 'trigger points' for decisions made during high fire danger days and bushfires, and, for some participants, in pre-determined survival plans. In addition, health concerns, visible cues, embers, and fire behaviour knowledge were also discussed by respondents as possible trigger points in decision-making:

We've done it [left early] a few times. There's no real trigger as such, more just looking at the weather. You know, if it's really crappy, like really hot, dry and windy weather. Dry and windy are probably the two most important ones. Yeah, I tend to be quite nervous. It's like, 'right the dog's coming to work with me'. I suppose because we don't have much stuff that we want to take, it's not that hard. So, yeah, there's nothing specific. Total fire bans normally make me feel a bit uneasy. (Female, Tasmania, May 2013, Leave early experience, Mental plan discussed with others but not practiced, <30m proximity to bushland)

A friend whose son was subject to asthma, as soon as it began getting smokey, they left because of his asthma. So they weren't thinking 'oh the fire front's going to...'. And I don't think they did [worry about the actual fire threat] because they didn't take a lot with them and then they were stuck out not knowing if their house was burning down. (Female, New South Wales, March 2013, Stay and defend experience, Mental plan discussed with others but not practiced, 101-500m proximity to bushland)

I believe in waiting and assessing, but then I also believe in acting really. So the other day the big trigger point [for leaving] was tiredness. Well, that and it [the fire] being visible! (Female, South Australia, May 2013, Leave early experience, Mental plan discussed with others but not practiced, 31-50m proximity to bushland)

Interview participants identified several factors that impacted their decisions during a bushfire, including unexpected problems, relying on familiarity with common trends in wildfire behaviour, ignoring known warnings, feelings of disempowerment and anxiety, and discussing and practicing a plan. Many participants had either encountered or observed unexpected problems during wildfires due to mental survival plans that had not been thought through in sufficient detail. Inconsistent intentions can lead to potentially dangerous situations. This is evidenced by the following two interview conversations about the participants' plan of action. One resident who had fought wildfires many times as part of his rural upbringing, illustrate not only the unpredictability of fire behaviour on severe weather days but also the importance of teamwork in the heat of the moment. It is also noteworthy how years of wildfire experience can contribute to a sense of preparedness that negates the perceived need for a written plan. Solely relying on familiarity with common trends in wildfire behaviour is clearly shown to not be a fail-safe plan.

[Interviewer (I)] *Have you got a plan that's written down?* [Male Participant (MP)] *No, not as a written plan. We just, I suppose, make sure we've taken care of things ... Make sure we have things sort of sitting and waiting. Make sure the pumps have been run. ... Of course you still could get caught short, if you were away and you come home and things are on fire, you're not going to make it. Not that I think, I mean, we're fairly well prepared. We've got a lot of cleared area down to the house. We've got [garden] sprinkler systems too. ... The back of our place, it's all trees. The understorey is not very thick but if there was something to ignite the top when you've got those winds, those flames, one little puff goes a couple hundred metres. [I] So was it unexpected that it came from that way [south] in 2006?* [MP] *Well, it was sort of unexpected. My concern was 'cause of the vegetation down there is not cared for at all so there's a lot of fire material in here. So if a fire got in down there and if for some reason we had more or less a southerly blowing, we would be, I feel, fairly vulnerable. But from this direction [pointing west, north-west] I swear that's where I thought it would come, because it could have run through the grass. So that's where I was preparing some sort of*

382 *protection. It was, yeah, it was pretty surprising 'cause [my wife] came running down to say*
383 *it was on fire [around the southern/back side of the house]. And I wasn't expecting things to*
384 *turn on down there. But it was pretty smoky too, you couldn't see real well. (Male, New South*
385 *Wales, February 2013, Stay and defend experience, Mental plan not discussed with others or*
386 *practiced, 51-80m proximity to bushland)*

387
388 Another couple who had their bags packed on a 'catastrophic weather warning' day, also revealed that
389 they had simultaneously decided to stay and defend despite knowing that no property is considered
390 defendable under catastrophic weather conditions. They both had knowledge of fire behaviour and
391 emergency procedures, learnt as part of their training as volunteers of their local bushfire brigade:

392
393 [I] *The bushfire survival plan that you've got hanging on your fridge, have you actually filled*
394 *it out? [Female Participant (FP)] Verbally [laughs]. [MP] We're one of those who plan to*
395 *make a plan one day. No we hadn't written it down but we have instigated, like on the*
396 *catastrophic day we had our bags packed. We had our plan worked out. We had our, what*
397 *we're going to do with the pets. We had umm various, we had decided we were going to stay*
398 *and defend. We had our various water supplies and water points already pre-made the day*
399 *before. (Couple, New South Wales, March 2013, Stay and defend experience, Mental plan*
400 *discussed with others but not practiced, 81-100m proximity to bushland)*

401
402 Unexpected problems as well as inconsistencies and/or inadequacies in people's intended plan of
403 action highlight the need for explaining *why* it is important to write down, discuss and practise a
404 detailed survival plan as a household. Not having an agreed plan in place is not only potentially
405 dangerous. It can also result in feelings of disempowerment and anxiety, as evident in the following
406 quote, which describes how being under threat from the 2009 Black Saturday wildfires in Victoria
407 catapulted this interview participant into action. However, the plan she developed for her home in
408 Victoria, which she subsequently 'relocated' to their new home in Tasmania, where they were
409 evacuated during the 2013 Tasmanian wildfires, never roused the interest of her family. The

emotional distress caused by this lack of support, particularly in the context of the wildfire scare only a few weeks before the interview, was profound.

No. Never. Never felt at risk and then when the fires came [on Black Saturday], it was quite horrific – what I saw and what I knew was happening. I just felt a real idiot [for not having a written plan] and so within a week I had developed a detailed fire plan. ... They [family] thought I was a bit crazy. I was probably to some extent. I was very pedantic about planning. I was very methodical and very pedantic. I had the plan on the table and I said, “You need to know what this plan is. You need to know where this kit is. You need to know that’s your kit”. They wouldn’t sit, well my sons wouldn’t sit down and look at the plan, and my husband humoured me. ... The worst thing after Black Saturday in 2009 was the lack of support I actually got from my own family about, you know, “Why are you doing this” kind of thing. I said, “Hey! Look out the window. This is why we’re doing this!” [visibly upset]. (Female, Tasmania, May 2013, Stay and defend experience, Mental plan discussed with others but not practiced, 501-1000m proximity to bushland)

Similarly feelings of disempowerment and anxiety are evident in the description by another female participant of the uncertainty, chaos and distress that unfolded as the 2003 Canberra bushfires impacted her home while her husband was away fighting another fire front at their second home. With only a rudimentary mental plan in place at the time of the bushfires, uncertainty and fear instead resulted in a series of actions that were potentially dangerous and caused much distress.

The power was cut fairly soon after we got home and we had the radio on in the car. We kept racing out to the car in the drive to see if we could get more information, as the smoke thickened and the embers started falling in the garden. Like glowing embers and the sky got really dark and there was a howling gale of a wind and neighbours didn’t know what was going on. Increasingly, the reports were that streets were being evacuated and these were places really close by and then it started mentioning streets in [our suburb]. By this time it

438 *was 3 o'clock in the afternoon and it was black as night and there was hail of embers and,*
439 *well um the experience of defending the property was extremely full-on ... I was completely*
440 *and utterly unprepared in spite of all the stories I'd heard and [my husband] talking about it*
441 *so much over the years from being in the fire brigade. I felt the whole house was completely*
442 *unprepared. ... Things were just utterly chaotic in my mind. I felt I was really on the back foot*
443 *really with all of it. The thing about packing a few things, I mean I'd got that and I'd done*
444 *some thinking at some prior time about what I would take in an emergency. I was able to grab*
445 *a few things and put that in a bag but then that was very haphazard I was really stressed;*
446 *I didn't have a bag packed or anything. I was stressed, you know, thinking about what those*
447 *things should be and what I should take and we didn't know whether we should be evacuating*
448 *or not, we didn't have a plan. We couldn't really take seriously the idea that the house really,*
449 *really, really was threatened even though we were behaving as if it was. (Female, Australian*
450 *Capital Territory, March 2013, Stay and defend experience, Mental plan discussed and*
451 *practiced with others, 101-500m proximity to bushland)*

452
453 That a discussed and practised written plan better enables resident to cope when things do not go to
454 plan is evidenced in the following quote from a couple who stayed and defended when their house
455 was in the direct line of attack of a fire front. While success was pinned to the interdependence of the
456 planned actions of all household members, the fact that they had discussed, agreed and practised their
457 plan, meant they did not panic – individually or as a family – when, pressed for time and with embers
458 raining down on them, the family was temporarily separated in order to move their valuable musical
459 instruments to a safer place.

460
461 *[MP] We sent our [musical] instruments away; the important instruments went. [I] At which*
462 *point did you send them away? [MP] Well before, more or less. [FP] Oh about half an hour,*
463 *because I was driving back up the driveway with the embers coming towards us. [MP] Was it*
464 *really that late? [FP] Yeah. They were landing up where the power lines are. [MP] See the*
465 *other thing was, because we had a plan, we didn't have to work together. We basically went*

466 *and did things with other people because we knew what was going on. ... [FP] When you live*
467 *somewhere like this, we'd always thought we wouldn't depend on services coming to help,*
468 *because it's not a suburb and if you're going to live here you've got to be prepared to either*
469 *go or do what you can and stay. Yeah and nobody was afraid. [PM] We very deliberately*
470 *gave people things to do. That's why I had played games with [our son] in the workshop, so*
471 *we'd know how to crawl. Smoke really does hover and there's heaps of space you can crawl*
472 *around in. Early in the piece we allocated people in pairs, etc. (Couple, New South Wales,*
473 *June 2013, Stay and defend experience, Written plan discussed and practiced with others,*
474 *<30m proximity to bushland)*

475
476 A prepared, discussed and practiced plan also provides a sense of calm and control that the more
477 vulnerable aspects of living in a fire-prone landscape have been accounted for. As explained by one
478 participant being prepared and ready to leave, and understanding good and bad fire, assists her mildly
479 autistic son to cope with the stress during a fire:

480
481 *The basics [of the plan] were that when it became a 'Watch and Act' warning, the kids' bags*
482 *were already packed for summer [the fire season] and so was my husband's and my stuff, it*
483 *just sits there, our fire stuff, you know, a bag full of clothes and the works sits there. The kids*
484 *love getting their stuff ready and they're very quick. Then it's a case of we send them to a*
485 *friend's place and then if I can get back, I get back. As soon as the warning comes through,*
486 *the kids go and then it's our plan to stay and defend. Yeah, but if it gets to [a] catastrophic*
487 *[warning], we go too. ... We gave [our child] a slogan 'If the fire's out go in, if the fire's in*
488 *go out'. That's all he needs to know because he panics. When he was seeing smoke around,*
489 *"Mum there's smoke over there". So when they started fuel reduction burning I had to*
490 *explain to him, "Look it's not windy today, it's really calm, it's quiet, that's a safe fire". We*
491 *purposefully took them up the road to show them what was going on. So they felt comfortable*
492 *with it. The fire was there, that they felt safe and that they understood what the helicopters*
493 *were doing. I could show them the fire truck – they're just watching it, like the smokes coming*

over, just so they knew what was going on. Because they have to see things. Telling them is not really going to register. (Female, Tasmania, May 2013, Stay and defend experience, Mental plan discussed and practiced with others, <30m proximity to bushland)

Discussion

Adequacy of agency advice

The results of the review of official agency advice reveal a variety of material that relays information in a passive manner. The objective of this form of communication is primarily to inform people, increase wildfire salience, and provide information that agencies believe individuals and communities can use to increase their self-sufficiency and resilience to wildfire (Eriksen and Prior 2011; Steelman and McCaffrey 2013). However, this risk communication technique is founded on information dissemination that relies on the receivers recognising the information is important and meaningful to them. Such deficit models of communication have been found in risk-science communication to be of limited value (Brossard and Lewenstein 2010).

Passive communication mechanisms are generally based on an agency assumption that proximity to naturally vegetated areas, as well as objective estimation of fire risk, are the main determinants of residents' protective action (Lindell and Perry 2000; Grothmann and Reusswig 2006). Our paper supports the assumption that perceived risk influences survival plans but found no relationship between survival plans and proximity to vegetation. However, it should be noted that recent research examining the socio-cognitive determinants of wildfire preparation shows that perception of risk can play a relatively minor role in decision-making in the context of competing everyday priorities, environmental values, financial constraints and perceptions of responsibility. Instead, other factors like perceived benefit of preparedness actions, desire for the maintenance of native vegetation or sense of community can provide stronger incentives (Carroll *et al.* 2004; Brenkert-Smith *et al.* 2006; Eriksen and Gill 2010; Prior and Eriksen 2013; McCaffrey *et al.* 2014; McNeill *et al.* 2014).

Passive methods of communicating about practical preparedness measures may serve to confound the

act of being well prepared. Studies show that this is particularly evident in the unrealistic optimism of some at-risk residents using preparation checklists, where many actions are undertaken simply because they are included on the checklist and not because the respondents have any knowledge of the reasons why these actions are advocated (Burger and Palmer 1992; Weinstein and Klein 1996; Paton and Wright 2008; Ascher *et al.* 2013). Official fire agency advice explicitly promotes the creation of a 'Bushfire Survival Plan' with checklists being a means towards achieving this end. The results from the interviews demonstrate that residents who go beyond checklists and prepare, discuss, document and practice a detailed survival plan appear to cope better under duress.

Despite all agencies providing planning templates for residents to create both a plan for leaving early and staying and defending, we found differences in the degree of emphasis and explanation provided by each agency with regards to the importance of the written, discussed and practised aspects of survival plans. The greater degree of detailed explanation provided in the South Australian *Your Guide to Bushfire Safety: Prepare. Act. Survive.*, and the significantly higher numbers of written, discussed and practised survival plans in the South Australian survey sample, suggest that attention to detail in the community engagement efforts of wildfire management authorities may be paying off in terms of residents' developing thorough survival plans. However, we did not demonstrate a causal link that can verify this result.

Drivers of preparation of survival plans

There was consistency between the factors predicting preparedness and if a resident had a survival plan, and if so, whether that was a mental or written plan. The interrelatedness of the variables examined through the Bayesian Network framework allowed for a more complete understanding of the system. Planned actions for future fires are influenced by past experiences, but planned actions also influence the extent of preparation and hence the probability of having a mental or written plan. Similarly, past experiences shape perceptions of risk from fire and hence the probability of having a mental or written plan.

People who planned to stay and defend were more likely to have a written plan, a commendable result of fire management agencies' efforts. However, survival plans are also relevant to residents who are planning to leave. The semi-structured interviews demonstrated this. Residents who do wish to leave early often do not create survival plans or prepare their property believing they will be adequately protected by emergency services, disaster funding or insurance (Beringer 2000; Winter and Fried 2000; McGee and Russell 2003; Collins 2009). However, residents who plan to leave their property may have access routes cut off and may be required to stay at the property during the main fire front. Having planned for such a scenario increases the chance of survival for the residents (Tibbits and Whittaker 2007; McLennan *et al.* 2013; Whittaker *et al.* 2013). This point is also emphasised in the agency literature.

Past experiences also influence the probability of residents preparing survival plans through the influence on risk perception and planned actions. Commonly residents who have experienced wildfire at a property report that the conditions faced were far more difficult than they expected (Whittaker *et al.* 2009; McLennan *et al.* 2012; McLennan *et al.* 2013). As a result, these residents may be in a better position to judge the true risk from wildfire and their ability to physically and mentally cope with fire in the future (although see Arvai *et al.* 2006). Results of our study support this with many residents electing to stay and defend their property having done so in the past. However, the majority of the residents had not experienced fire at their own or their neighbouring property highlighting the need for appropriate contextual and localised information from fire management agencies.

Survival plans in action

Regardless of awareness levels or perceptions of the immediate risk at hand, a written, practised and discussed plan can mean the difference between life and death (Eriksen 2014). This was supported by the results of the semi-structured interviews with people surviving direct wildfire attacks. However, it is not always the plan *per se* that makes the difference. Rather, it is the additional benefits of the cognitive processes that are stimulated by the proactive behaviour of acquiring knowledge about safety issues, and the characteristics and (often unpredictable) behaviour of an approaching wildfire.

The knowledge gained through such proactive behaviour can enable individuals to think and act in a more informed and safe way even when things do not go to plan – a common scenario in wildfires.

The mental action that is exercised while thinking, writing, planning, discussing and practicing what to expect, what to do and how to do it increases resilience, as contextual knowledge is stored that can be retrieved and applied in different situations (Eriksen and Prior 2013). Our results demonstrate that while not bullet proof, these cognitive processes can aid people's ability to suppress fear and panic and instead think and act more safely and decisively. Having a plan that has been written down, practised and discussed furthermore aids memory and decision-making when heat, smoke, noise, wind, embers or flames trigger adrenaline, fear and panic.

Detailed survival plans are also important, as recent research has shown that both residents and emergency service personnel have difficulties describing and relating to what being *both* mentally and physically prepared means (Bushnell and Cottrell 2007; Sjoberg 2007; McGee *et al.* 2009; Eriksen and Prior 2013). Communicating the need to be psychologically prepared, for example, is greatly challenged by the individualistic nature of, and context-specific influences over, psychological processes (Eriksen and Prior 2011; Eiser *et al.* 2012). Psychological preparedness has been linked to 'disaster subcultures' in communities with previous or routine experience of a disaster, which have developed a certain familiarity with, and collective knowledge of, how to act before, during and after the event (Perry and Lindell 1978; Floress *et al.* 2011; Prior and Eriksen 2013). Community risk mitigation efforts can also increase residents' capacity to understand and address the inherent uncertainty and challenges (Hardin and Higgins 1996; Lion *et al.* 2002; although see Arvai *et al.* 2006 who found this was not always the case). However, our research indicates that inadequacies and/or inconsistencies in individuals' and families' survival plans play a significant factor in overall coping capacity.

Conclusion

Wildfire survival plans are a valuable tool for residents living in fire-prone landscapes. Our work showed that survival plans need to account for actions of all household members, multiple contingencies and should consider both leaving and staying at the property. The value increases through the processes of writing, discussing and practicing the plan. Without these steps, decision-making may become impaired due to the impact of uncertainty, fear and adrenaline on cognitive function with potentially fatal consequences. All fire agencies considered in our study provide a great deal of clear and concise information around survival plans despite some variation between states. Preparation of survival plans was found to be limited by the same range of factors that limit the extent of overall preparedness for wildfires. Fire management agencies need to continue, and potentially increase, active engagement with communities to contextualise the fire risk and develop appropriate strategies to include in individual survival plans. This will ensure the greatest chance of survival for residents in fire-prone landscapes.

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