

Landscape Preferences, Amenity, and Bushfire Risk in New South Wales, Australia

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Abstract This paper examines landscape preferences of residents in amenity-rich bushfire-prone landscapes in New South Wales, Australia. Insights are provided into vegetation preferences in areas where properties neighbor large areas of native vegetation, such as national parks, or exist within a matrix of cleared and vegetated private and public land. In such areas, managing fuel loads in the proximity of houses is likely to reduce the risk of house loss and damage. Preferences for vegetation appearance and structure were related to varying fuel loads, particularly the density of understorey vegetation and larger trees. The study adopted a qualitative visual research approach, which used ranking and photo-elicitation as part of a broader interview. A visual approach aids in focusing on outcomes of fuel management interventions, for example, by using the same photo scenes to firstly derive residents' perceptions of amenity and secondly, residents' perceptions of bushfire risk. The results are consistent with existing research on

landscape preferences; residents tend to prefer relatively open woodland or forest landscapes with good visual and physical access but with elements that provoke their interest. Overall, residents' landscape preferences were found to be consistent with vegetation management that reduces bushfire risk to houses. The terms in which preferences were expressed provide scope for agency engagement with residents in order to facilitate management that meets amenity and hazard reduction goals on private land.

Keywords Bushfire (wildfire) · Landscape preferences · Fuel management · Amenity · Photo-elicitation

Introduction

Echoing trends elsewhere, increasing numbers of Australians are opting to settle in peri-urban areas directly bordering pasture, bushland, or forest (Abrams et al. 2012; Burnley and Murphy 2004; Gill et al. 2010; Luck et al. 2010). These areas, commonly referred to as the wildland–urban interface (WUI—used hereafter) or rural–urban interface (RUI), are often highly prone to fire (Gill and Stephens 2009). Since 2000, there have been over 200 lives lost and nearly 18,000 people requiring immediate assistance due to bushfires in peri-urban regions of south-eastern Australia (EM-DAT 2014). Most notable is the significant loss of 173 lives resulting from the February 2009 fires in Victoria (Blanchi et al. 2014). Residents are drawn to live in such locations for their amenity, recreational, and environmental values, despite the well-known and increasing risk of bushfires (Department of Environment 2010; Eriksen and Gill 2010).

This increased exposure to bushfire risk raises the question of how residents might manage and prepare their

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land in order to meet their amenity aspirations as weighed up against their perception of bushfire hazard and risk. For example, a key aspect of preparing conditions on the ground includes vegetative fuel management around built structures such as houses. Fuel load in the area immediately surrounding houses has been shown to be a key factor for potential property loss to fire (Penman et al. 2014). Penman et al. (2014) demonstrate the importance of fuel mitigation efforts given vegetation type, composition, and density within a 30–40 m zone from built structures in influencing rates of property loss. Thus, an important option in bushfire risk reduction is removing and/or reducing the amount of vegetation close to or in the vicinity of houses in the form of vegetation clearing, thinning, or removal through either mechanical means, grazing, or prescribed burning. It is, however, such vegetation around houses that residents may have sought proximity to or have planted in the course of realizing environmental or other goals for their land. Eliciting residents' landscape preferences using visual prompts can be a useful way to explore these issues and to gain insight into how bushfire risk mitigation measures may relate to the amenity that residents seek from their properties and neighboring land. Research on landscape preferences has identified common landscape characteristics that humans tend to prefer (e.g., Kaplan and Kaplan 1989). Broadly speaking, people tend to favor landscapes characterized by open forest or woodland that retain sufficient elements to generate interest or anticipation. Outside Australia, researchers have also investigated residents' views regarding vegetation management for fire risk reduction purposes, showing that, with social and geographical variation, residents are amenable to management actions such as vegetation thinning and prescribed burning (McCaffrey et al. 2013; McGee 2007; Nelson et al. 2005) and that this is not necessarily incompatible with esthetic considerations (McCaffrey et al. 2011).

Residents in fire-prone lands can reduce their probability of loss from fire by adequately preparing themselves, their houses, and properties for potential bushfire threat (Penman et al. 2013). Preparation involves a broad spectrum of activities including having equipments such as pumps ready, development of the physical and mental capacity among residents to defend their property from fire, preparing conditions on the ground (including vegetation management), and developing community cohesion (Eriksen and Prior 2013; Prior and Eriksen 2013). However, evidence suggests that, despite being bushfire aware, many residents still fail to prepare adequately for bushfire or underestimate the risk they are exposed to (Cotrell et al. 2008; Eriksen 2014; Paton and Wright 2008; Ryan 2012). This has led to the suggestion that WUI residents suffer from 'bush blindness' (Anonymous 2014). However, the reasons for

lack of preparation by residents living in bushfire-prone areas can come down to "the juggling of everyday procedures, dilemmas, and trade-offs between social, cultural, environmental and economic issues" rather than a lack of bushfire risk awareness *per se* (Eriksen and Gill 2010, p. 823).

Experience from the USA and, less systematically, from Australia indicate mixed reactions by residents to vegetation reduction or management for fire purposes, particularly on public land and in national parks, but also with respect to vegetation removal on private property (Brunson and Shindler 2004; Ellis et al. 2004; Gill and Stephens 2009; McCormick 2002; McGee 2007; Winter and Fried 2000; Winter et al. 2002). This has prompted a greater focus in social science studies on resident preferences for vegetation management *techniques* for fire mitigation purposes (Brunson and Shindler 2004; McCaffrey et al. 2013; McGee 2007). What is largely absent, from both work on fire risk perception and vegetation management techniques, is investigation into resident assessment of, and preferences for, the landscapes that *result* from management interventions. Research by Nelson et al. (2004, 2005) and Ryan (2012) suggests the value of visual methods to investigate such landscape assessments and preferences.

This paper adds to this currently growing but USA-centric body of literature on fuel management and residents' views at the WUI. It is concerned with vegetation management to reduce the risk of loss of life and property during bushfire. The primary focus of the paper is vegetation management preferences on private property. However, it has relevance to neighboring public lands; in that such lands form part of the landscapes valued by residents and are also subject to fuel management. It draws on two study areas in New South Wales (NSW), Australia and focuses on a photo-elicitation exercise conducted during interviews with landowners. We explore resident preferences for the appearance and structure of different vegetation arrangements in the landscape in relation to esthetic and recreational values as well as bushfire risk mitigation. Resident responses provide insights that assist in interpreting how vegetation characteristics inform preferences regarding amenity and bushfire risk mitigation, and into the extent to which mitigation measures align with the amenity that residents derive from the landscape around their houses.

Landscape Preferences and Vegetation Management at the Wildland–Urban Interface

There is a long history in landscape research of investigating human preferences for landscape composition and structure (Daniel 2001; Kaplan and Kaplan 1989). Grounded in

environmental psychology, this research and its methodologies has influenced research on vegetation management preferences and fuel reduction at the WUI (Ryan 2012). Elicitation of landscape preferences has mainly been via surveys or highly structured interviews that seek responses to a series of carefully chosen or manipulated photos of landscapes containing features such as trees, open areas, shrubs, and pathways in configurations that provide contrasts in vegetation structure and composition. For example, open and grassy areas under a forest canopy in comparison to the same or a similar area being shrubby and closed to access. There is often a park or open space management orientation to the research and the same scene may be chosen or digitally manipulated to show the results of different management options (Tahvanainen et al. 2001). Such research has shown that the visual elements are key to gaging vegetation and management preferences and, by implication, any subsequent resident or open space user engagement (Ford et al. 2009; Ryan 2012; Tahvanainen et al. 2001). With visual information, respondents are able to more effectively appraise the results of management, and are less prone to react on the basis of an existing disposition toward a particular intervention, such as mechanical thinning of forest.

At least two general frameworks continue to inform the general findings from landscape preference research and its application to fuel management at the WUI. In their influential work, Kaplan and Kaplan (1989) based their framework on two perceived human needs—understanding and exploration. They argue that the need to understand, to be able to make sense of what is going on, means that landscape preferences will be greater when environmental attributes facilitate comprehension. Furthermore, humans have an innate need to examine their surroundings and thereby acquire knowledge, understanding, and familiarity. Accordingly, preferences will be greater where environmental attributes facilitate exploration. The key environmental attributes of Kaplan and Kaplan's (1989, p. 52–56) framework are

Complexity	The number of different visual elements in a scene; how intricate the scene is; its richness
Coherence	Provides a sense of order and direct attention; coherence is enhanced by anything that helps organize the patterns of brightness, size, and texture into a few major units
Legibility	A legible space is one that is easy to understand and to remember; there is a promise of a capacity to comprehend and function effectively
Mystery	There is a promise that one could learn more by walking into the scene, something not immediately apparent from the original vantage point

This framework was proposed by Kaplan and Kaplan as a conceptual guide. They suggest that these various attributes may be present to varying extents in preferred scenes, not that any will, might or should be optimized. For example, a scene that is high in coherence but low in complexity may be clear and simple but also boring. The framework has been extensively applied and tested—with variation among attributes, studies, and approaches to testing—and has been found to offer significant, if variable, insights into landscape preferences (Herzog and Kropscott 2004; Stamps 2004; van der Jagt et al. 2014).

A second influential, and potentially overlapping, framework is prospect-refuge theory, proposed by Appleton (1975). As with Kaplan and Kaplan (1989), Appleton proposes that humans are predisposed to favor certain landscapes to meet certain, innate needs. He suggests that humans will favor those landscapes that offer prospect (an open view) and refuge (protection), as these places offer an aid to survival by providing a point from which to observe, respond, and defend (prospect) or protective spaces (refuge). Actual landscape preferences arise from the judgements that people make about the relative extents of indirect or secondary prospect and refuge offered by a place or setting—i.e., that which can be appraised by observing a scene from a vantage point. This approach has been used in work that deploys photographs to test the role of concepts such as mystery (Hagerhall 2000), and perceptions of safety and danger in urban areas and parks (for example, Andrews and Gatersleben 2010).

The general findings from landscape preference research are clear and consistent over time and generally also across countries and cultures (Gatersleben 2008). While expertise, knowledge, and association with industries such as forestry, has been shown to influence preferences, the evidence for this can be variable (Ryan 2012); an observation also made for the influence of demographic variables on fuel management preferences in WUI areas of the USA (McCaffrey et al. 2013). People tend to prefer scenes that are half-open forest or woodland, scenes that might be described as park-like and relatively easy to see and walk through (providing visual and physical accessibility). Scenes that are too open or 'blocked' by dense understorey vegetation are rarely preferred. This is consistent with prospect-refuge theory and with work that has set out to test the Kaplans' framework (see Dandy and Van Der Wal 2011 for a consistent but more qualified qualitative study; Herzog and Kutzli 2002). In terms of ground cover, preferences tend to favor relatively uniform or short ground textures, but not scenes with much dead wood or other material on the ground (Kaplan and Kaplan 1989; Lothian 2004; Ryan 2012; Tyrväinen et al. 2003; Williams and Cary 2002). This is consistent with findings that residents

prefer scenes that they perceive to be natural despite being the result of management intervention: ‘residents prefer managed forests, but prefer them without visible traces of human activity. Often, forests are thought to be in ‘a natural condition’ even when they are managed’ (Tyrväinen et al. 2003, p. 136). This has implications for fuel mitigation efforts, expanding the fuel management options that can meet residents’ desire for landscapes they perceive as natural.

McCaffrey et al. (2013) reviewed 64 articles on public acceptance of fuel management mainly in the US, finding an overall high level of public support for thinning and prescribed fire activities on fire-prone public lands, especially at the WUI. This support was mediated by a range of broader contextual factors, including trust in agencies, pre-planning, citizen participation, agency resources, and the manageability of area to be treated (Winter et al. 2002). Further, trust will be generated in part by agencies meeting residents’ expectations by taking into account local values, context, and experiences (McCaffrey et al. 2013). While this focus on public land is in contrast to our study, which considers residents’ views about management of their own property, it is relevant that many property owners discussed perceived risks of neighboring properties, including public land.

Overall, findings about general landscape preferences as discussed above are consistent with findings in the US regarding perceptions of fuel management at the WUI (McCaffrey et al. 2013). They also match official recommendations by fire agencies such as the New South Wales Rural Fire Service (NSW RFS), in Australia regarding Asset Protection Zones (APZs). The aim of APZs is to minimize bushfire fuels “such that the vegetation within the planned zone does not provide a path for the transfer of fire to the asset either from the ground level or through the tree canopy” (NSW RFS 2006, p. 3). The NSW RFS (2006) highlight that generally, the greater the density and flammability of vegetation, the greater the fire hazard. Yet, fuel reduction does not require removal of all vegetation. With respect to vertical arrangement and structure of vegetation in the landscape, they recommend

- ground fuels such as fallen leaves, twigs (less than 6 mm in diameter), and bark should be removed on a regular basis
- grass needs to be kept short and, where possible, green
- removing or thinning understorey plants, trees, and shrubs less than three meters in height
- removing more flammable species such as those with rough, flaky, or stringy bark
- planting or clearing vegetation into clumps rather than continuous rows

- pruning low branches two meters from the ground to prevent a ground fire from spreading into trees
- trees should be pruned or removed so that there is not a continuous tree canopy leading from the hazard to the asset
- tree crowns should be separated by two to five meters and a canopy should not overhang within two to five meters of a dwelling
- native trees and shrubs should be retained as clumps or islands and should maintain a covering of not more than 20 % of the area.

Landholders are not permitted to clear vegetation on neighboring public land, such as national parks, without written approval (NSW RFS 2006). Thus residents must rely on external authorities for fuel management on public lands.

Our intention in this study is not to formally test and apply Kaplan and Kaplan’s (1989) understanding and exploration framework nor Appleton’s (1975) prospect-refuge theory as is commonly done in quantitative landscape preference and environmental psychology research. Rather, our aim is to use these frameworks and their attributes as heuristic devices in our analysis of interviewee rankings of photographs. Ryan’s (2012) study is one of few (see also Daniel et al. 2002) to use photo prompts to specifically explore residents’ views on the results of different fuel reduction measures on forest structure and composition. Ryan (2012) found that most respondents preferred scenes with relatively open forest and little or no understorey, described by respondents in terms such as ‘neat,’ ‘open,’ and ‘good for people and forest.’ One scene that retained some understorey and received a moderately positive ranking, was described by respondents as ‘some overgrowth but managed’ and as a ‘good clearing with ground covers for wildlife.’ Less preferred scenes had more established understorey or woody debris on the ground and were perceived in terms such as ‘overgrown’ and ‘fire threat’ (Ryan 2012, p. 63). Our research builds on Ryan’s (2012) work by also using photos to explore residents’ views on fire risk, but additionally uses the same photo prompts to assess residents’ sense of esthetic and recreational amenity value as well as property management.

Methods

The research presented in this study was part of a broader project which modeled fuel loads and risk of property loss and investigated resident perceptions of bushfire risk, amenity, and vegetative fuel loads (Bradstock et al. 2014). It was conducted across two study sites (Online Resource

1) in New South Wales (NSW), Australia. One site comprised three proximate settlements in the Blue Mountains west of Sydney: Mount Wilson and Bilpin in the upper north-western part of the Blue Mountains and Bowen Mountain, located on the eastern edge of the northern Blue Mountains. The second site was in the Wamboin locality, located along the border of NSW and the Australian Capital Territory (ACT). Mount Wilson and Bilpin contain a high proportion of lifestyle-oriented residential properties that fringe large, rugged, and heavily vegetated areas, representing a significant bushfire threat. They contain a diverse range of community members on farming, suburban areas, and rural lifestyle blocks. Bowen Mountain is a suburban settlement with a similar bushfire-prone bushland fringe. Wamboin was also selected for the high levels of lifestyle-oriented properties, and for its value as a contrasting site to the Blue Mountains area in terms of climate (for example mean annual rainfall 595 mm at nearby Queanbeyan compared to a Blue Mountains mean of 1403 mm at nearby Katoomba), and its contrasting vegetation composition (open grassland and grassy woodland as well as dense bushland). Furthermore, there was evidence that Wamboin had been revegetated both actively by residents and also as a result of the retreat of grazing.

Given the relative lack of knowledge, particularly in Australia, of residents' landscape views and preferences with respect to weighing up and acting on property and vegetation management, amenity, and bushfire risk issues (Eriksen and Gill 2010), we took a predominantly qualitative approach. We used interviews that were a mix of semi-structured and structured components. This research methodology was aimed primarily at in-depth elicitation and exploration of interviewee views, preferences, and property management activities and our methods reflected our priority of generating information-rich interviews with a range of landholders (Baxter and Eyles 1999; Lincoln et al. 2011; Patton 2002). During May and June 2013, a total of 65 interviews were conducted across the study sites, 44 interviews with 67 residents were conducted in the Blue Mountains, and 21 interviews with 29 residents were conducted in Wamboin (some interviews were conducted with couples). Participants were recruited in a variety of ways. Local volunteer RFS brigades provided an important point of contact for learning about the range of residents and management practices, and to identify areas to focus on for recruitment (for example, varying exposure to risk due to topographic factors). The RFS brigades also provided some initial contacts with potential interviewees but we were mindful of the need to recruit beyond such recommendations. Thus, from August 2012, we also attended community meetings and events, advertised in local newspapers and community newsletters, and conducted letter box drops and door knocked in

specific areas. Respondents to these methods usually contacted us by phone and we recorded their details for later fieldtrips. Letter box drops and door knocking was undertaken to remedy gaps in recruitment in our identified areas for interviews in each settlement. No one of these methods yielded a large proportion of our interviewees and thus we also recruited via snowballing from interviewees. We thereby recruited interviewees with a range of interest, concern, and action relating to risk reduction and beyond contacts initially provided by the RFS brigades. While, like others (Brenkert-Smith et al. 2006), we experienced difficulties in recruiting interviewees with little interest in bushfire, our interviewees did include residents who were undertaking little or no risk mitigation activities as well as residents who had actively sought out advice and/or had undertaken property preparation to various extents. Indeed, as for much qualitative interview-based research (Patton 2002; Thomas et al. 2007; Wigfall et al. 2013), recruitment in general required not only forward planning and outreach but also practical and flexible responses to circumstances and significant effort over several months and during several fieldtrips. Interviewees, while older than the average age of the study area populations (see Online Resource 2 for comparison of selected interviewees characteristics with Australian Bureau of Statistics (2011) data), encompassed a diverse range of backgrounds including both men and women, corporate workers, professionals, small business owners, artisans, farmers, public servants, retirees, parents of school age children, and both long- and short-term residents.

From the 65 interviews, four clusters—comprising 18 interviews, on neighboring (or near-neighboring) properties were identified for more detailed qualitative analysis. These clusters were chosen to provide interviewees with characteristics broadly representative of the interviewees as a whole as well as to include properties that were more or less contiguous, often on the same streets and with similar outlooks or neighboring landscapes. Spatial contiguity was important for other analysis in the project, including spatial analysis of property management. Two of these clusters fall within the responsibility of Wamboin RFS Brigade. The two other clusters fall within the responsibility of Blue Mountains RFS Brigades. Any direct quotes presented in this study are from research participants residing within these four clusters. The photo-elicitation exercise was part of a longer (usually at least 2 h) interview in which we used a semi-structured interview schedule to discuss residents' views and actions regarding bushfire risk, amenity, and property management. These interviews also incorporated a risk, amenity, and management mapping exercise as well as a property walk to facilitate in situ exploration of issues arising in the interviews (Evans and Jones 2011; Everett and Barrett 2012).

Our primary aim in using the photos as discussed in this paper was to use photo-elicitation as a means of exploring residents' preferences and assessments of risk in greater depth, and not to generate quantitative preference data akin to that generated in much landscape preference research (for example Ryan 2012; Tyrväinen et al. 2003). Photo-elicitation involves incorporating photos into interviews to tap into 'deeper elements of human consciousness' than those evoked by words alone (Harper 2002, p. 13). More and different types of information are thereby elicited, as photography is never just a matter of reading off the content of the image (Banks 2001). Photo-elicitation can be used simply as a tool to facilitate a more conversational narrative between a researcher and interviewee (Banks 2001; Waitt et al. 2009). Its utility, however, goes beyond this relatively pragmatic role. It also contains the potential to generate a conversation that is open to the interviewee's interpretation of a scene. This allows them to connect experiences and observations and bring them into the dialog. This may cause them to reflect on their own assumptions and beliefs, and alert researchers to their own assumptions about content and meaning, thus prompting further questions and analytical reflection (Banks 2001; Beilin 2005; Brickell 2011; Gill et al. 2009; Pain 2012).

As part of the photo-elicitation exercise we employed a ranking exercise. Reflecting its place as part of a longer interview, our goal of discussing the ranking with interviewees, as well as known difficulties with ranking exercises with more than about five choices, we chose a relatively simple approach to ranking the photos (Alwin and Krosnick 1985; Fabbris 2012; Ritchie et al. 2014). Residents were presented with five alternative images of the way vegetation can appear in the landscape labeled A through E (see images in Figs. 1, 2). The images were photos of vegetated areas taken by the researchers in the actual study areas during scoping visits. There was a set of five images intended to represent the vegetation landscape in Wamboin and a separate set of five images intended to represent vegetation landscapes for the Blue Mountains. Images were selected to show increasing understorey density in each progressive scene with the idea of representing both increasing bushfire risk and the possible consequences of fuel management such as prescribed burning, clearing, or thinning. The ranking exercise not only provided ranking data but also provided a starting point for discussion of the photos and the preferences and reasons behind interviewees' rankings. This interview-based elicitation approach also facilitated exploration of interviewees' certainties and uncertainties in ranking, difficulties in distinguishing between or ranking photos, and discussion where the delineation implied by rankings obscured various relative preferences across different photos.

During the interview, the five images (Figs. 1, 2) were laid out in front of residents in random order and it was explained that the research participants were to rank the photos from their most preferred to least preferred; first according to their esthetic, then recreational, and finally according to bushfire risk mitigation preferences. After each ranking took place, residents were requested to explain the rationale behind their ranking and/or what it was about a particular photo that they liked or disliked. As a result of the initial Wamboin interviews, an additional question was asked in the Blue Mountains to ascertain which photos best corresponded to a landscape that balanced desired risk mitigation and amenity. If residents required clarification of what was meant by esthetic, they were instructed to rank the photos purely in terms of which treescape they would like to look at, for example, when sitting on their veranda or looking out their window. In clarifying recreation we asked them to imagine activities they enjoyed doing, for example, going for a walk or horse ride. In clarifying the preference for bushfire risk mitigation, participants were asked which image made them feel most safe to least safe with reference to bushfire.

For the 63 interviews in which the photo evaluation exercise was conducted, 79 people completed the exercise, as couples often opted to complete the exercise separately acknowledging differing values and perceptions of risk in the landscape. Consistent with the photo-elicitation approach, ranking and associated discussions occurred in different circumstances across the households in which we were conducting the interviews. Such diversity in locations, circumstances, interactions, and practicalities yielded rich interview data, extending discussion as the process unfolded (Bjørnholt and Farstad 2014). This visual approach has some limitations. Choosing photos to encompass a range of possible variables, such as light, vegetation structure, and composition was difficult. Landscape preference studies generally use larger numbers of images than in our study; however, as the photo evaluation was only one part of the interview, we were restricted in the number of images we could use. We did explore with the local RFS brigades whether there were places in their areas that we could use to generate such images but this did not prove possible. We also considered local photo collections that were offered by RFS brigade members. This, however, introduced other biases such as composition style, angle of view, and image aspect ratios. Ultimately, the five photos in each area were chosen from our own photos largely on the basis of being representative of the range of vegetation appearance in the areas balanced with the extent and character of the understorey vegetation and openness.

We analyzed data from the photo ranking exercise both qualitatively and quantitatively. Interview transcripts were

Fig. 1 Blue Mountains photos and preference frequencies (aesthetics and recreation $n = 57$; bushfire $n = 54$)

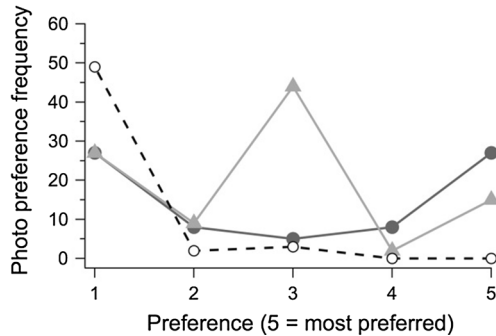
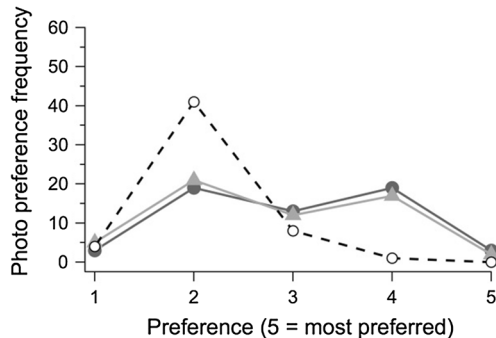
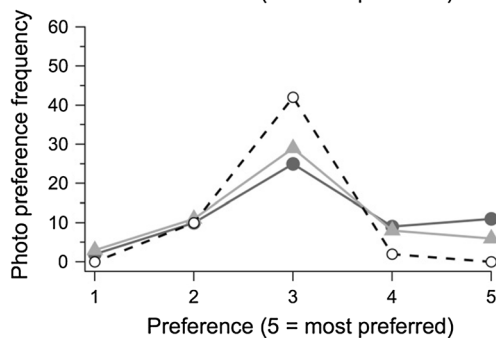
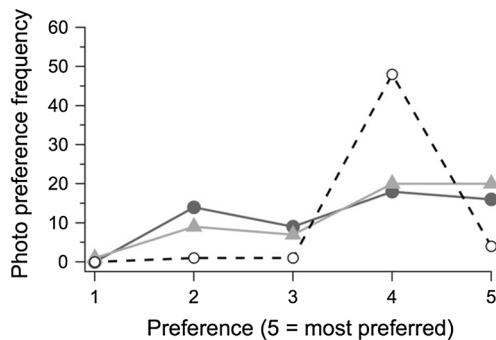
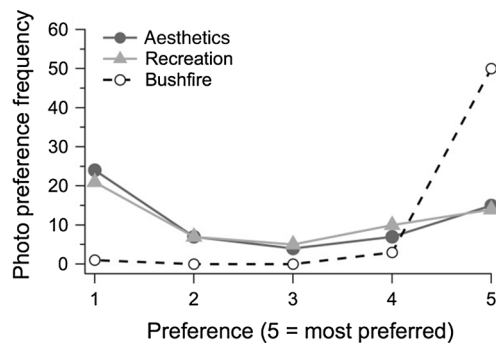
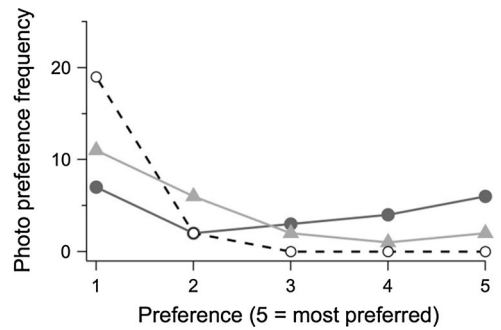
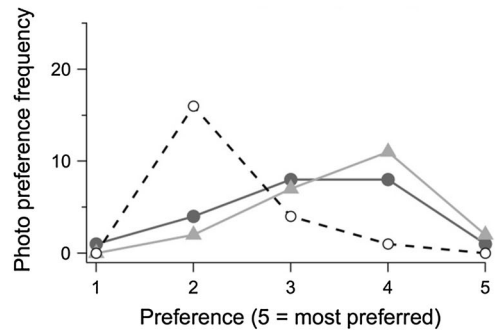
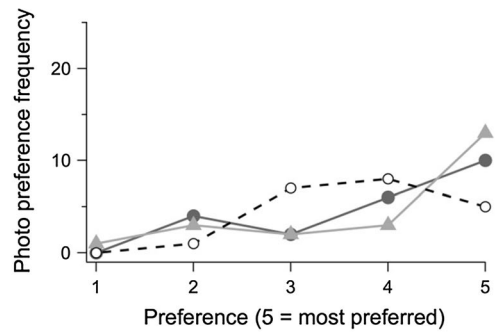
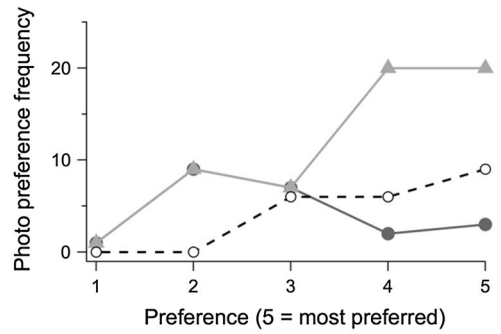
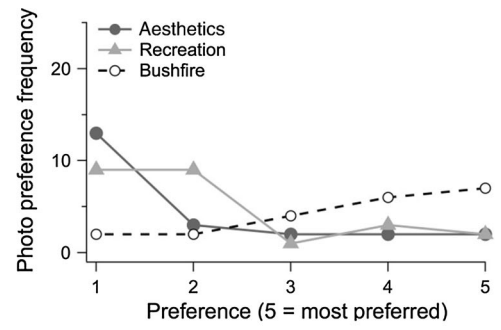


Fig. 2 Wamboin photos and preference frequencies ($n = 21$)



analyzed using the qualitative data analysis software QSR NVivo v.10.0. The transcribed text was then coded in two ways. The first iteration coded parts of the text where a particular image ‘A,’ ‘B,’ ‘C,’ ‘D,’ or ‘E’ was being discussed regardless of what was being said about the image (each letter was represented as a NVivo node). The second round selected text that could be coded according to the reasons and rationale for preference for an image, lack of preference for an image, perceiving an image as safe, perceiving an image as unsafe, for esthetic ranking, for recreational ranking, and for bushfire risk mitigation ranking.

The first four nodes aimed to manage and analyze interview data referring to particular images. Nodes five to seven were used to manage and analyze interview data referring to images as a set, which explain overall preferences. For example, interviewees would sometimes describe the rationale or thinking that lay behind their overall preferences and photo sorting, rather than necessarily talking about a particular image. The NVivo nodes could then be cross-referenced with other coding using the ‘View Coding Stripes’ feature in NVivo. As an example, this could yield an interviewee’s reason for preferring photo C, or reason for perceiving photo E as unsafe, when the same piece of text had been coded to both nodes. A spreadsheet containing all raw data provided an overview of how each participant ranked the photos, and allowed data to be filtered according to preferences.

Results and Analysis

Figures 1 and 2 and Table 1 present the results from the photo evaluation exercise with the relevant photos used as visual prompts for each site (see also Online Resource 3). The most relevant and clearest pattern is that the majority of respondents (91 % in Wamboin, and 88 % in the Blue Mountains sites) agree as to which arrangement of vegetation in the landscape constitutes the biggest fire risk; photo E in both sites. This indicates that residents are able to identify fire risk in the landscape, particularly according to understorey structure in treed landscapes. Other patterns show a tendency for residents to prefer more open landscapes or at least landscapes with an element of openness (for example, photos C and D in Wamboin and photo B and, to a lesser extent C, in the Blue Mountains sites) for both esthetic and recreational purposes. Preferences were also expressed and defined by what residents did not prefer.

Amenity Preferences

For esthetics and recreation the two sets of preferences are significantly correlated across all the photos at the 0.01

Table 1 Mean photo rankings and confidence intervals; 1 = least preferred, five = most preferred; Blue Mountains esthetics and recreation $n = 57$, bushfire $n = 54$; Wamboin esthetics and recreation $n = 22$, bushfire $n = 21$

	Blue Mountains		Wamboin	
	Mean (SD)	95 % CI	Mean (SD)	95 % CI
Esthetics				
Photo A	2.68 (1.71)	[2.23, 3.14]	1.95 (1.40)	[1.24, 2.38]
Photo B	3.63 (1.14)	[3.33, 3.94]	2.86 (1.13)	[2.46, 3.44]
Photo C	3.30 (1.08)	[3.01, 3.59]	4.00 (1.15)	[3.60, 4.59]
Photo D	3.02 (1.08)	[2.73, 3.30]	3.18 (0.96)	[2.70, 3.58]
Photo E	2.40 (1.61)	[1.98, 2.83]	3.00 (1.66)	[2.22, 3.78]
Recreation				
Photo A	2.81 (1.66)	[2.43, 3.34]	2.18 (1.37)	[1.48, 2.61]
Photo B	3.86 (1.13)	[3.68, 4.25]	3.18 (1.05)	[2.85, 3.72]
Photo C	3.05 (0.99)	[2.75, 3.29]	4.09 (1.31)	[3.62, 4.76]
Photo D	2.82 (1.66)	[2.47, 3.05]	3.59 (0.80)	[3.20, 3.94]
Photo E	2.46 (1.70)	[1.91, 2.83]	1.95 (1.29)	[1.31, 2.50]
Bushfire				
Photo A	4.87 (0.58)	[4.71, 5.03]	3.67 (1.32)	[3.07, 4.27]
Photo B	4.02 (0.41)	[3.91, 4.13]	4.14 (0.85)	[3.75, 4.53]
Photo C	2.85 (0.45)	[2.73, 2.98]	3.81 (0.87)	[3.41, 4.21]
Photo D	2.11 (0.54)	[1.96, 2.26]	2.29 (0.56)	[2.03, 2.54]
Photo E	1.15 (0.49)	[1.01, 1.28]	1.10 (0.30)	[0.96, 1.23]

level, except for photo E in Wamboin which is more weakly and significantly correlated at the 0.05 level (Online Resource 4). This is consistent with the interview results, as discussed below, in which esthetics was linked to a preference that one could move in the scene consistent with recreation preferences for either open space to walk through or play in. With respect to mean preference ranking, in both Wamboin and the Blue Mountains the top two preferences are those photos that are relatively open and, in at least three of them, those that contain large, regularly spaced trees, open space, and a low, largely grassy understorey. These are particularly photo B and also photo C in the Blue Mountains and photos C and D in Wamboin. In Wamboin, photo C represents an equivalent scene to photo B in the Blue Mountains in terms of openness and larger tree patterns. While photo C also ranks relatively high as the second esthetic preference in Wamboin (Table 1), the most esthetically preferred second Wamboin photo is photo D, a photo that does have more understorey than photo C, but is still relatively open.

In explaining why certain photos were preferred, interviewees indicated they liked these photos for their visual and physical accessibility. For example, as one interviewee said about the less preferred but also relatively open Blue Mountains photo A, “I can see through, I feel safer in that sort of view. I mean I could walk anywhere.” Quotes

Table 2 Photos themes and quotes regarding residents' more preferred photos

Themes	Key reasons for photos were preferred	Quotes
Visual openness	Ability to see through the trees Openness of the trees Not too open	'Well, because it's got mature trees. And it's got some scope for looking through the trees. And it's got a small amount of understorey. So you could see where you were walking and you wouldn't have to bash your way through...it felt like it had a balance that I liked.' (W C) 'Because the undergrowth's gone, you actually see further into it. And you've actually got more of that vista, I guess, because you can see more.' (BM B)
Accessibility	Relatively easy to walk through Features of interest/engagement	'the combination of natural bush plus some cleared area...not a jungle...you could walk through it quite easily.' (BM B) 'you see lots of birds in that environment...easier to see them...easier to walk around into.' (W C)
Texture	Not too smooth or uniform Not too manicured	'Yeah, stark and sort of uninviting (BM A). At least that's sort of got the tree ferns, the grass is a little longer.' (BM B) 'I like a little bit of understorey and I like the older trees in it.' (W C)
Habitat or perceived naturalness	Environmental values/interests Conformity to a valued image of indigenous nature	'This I like because it looks fairly natural, but still it has the tree fern and the ferns and these fish ferns or birds' nest ferns they are.' (BM B) 'That's a sort of birdie environment that is certainly, and this one which I suppose draws me to them a bit more.' (W C)
Interest	Promise of something interesting Everyday engagement is straightforward	'I'd probably be drawn to maybe something more easy to interact with.' (BM B) 'That's like something that's developing and it would be nice to see how that develops over time.' (W C)
Appearance and esthetics	Tree form, patterns, light and shading A pleasant place to be	'This just looks like a nice gentle, sunny, aesthetically pleasing place to be.' (BM B) 'Yeah, I quite like that because it's got the, I don't know it's got this nice shapes in the trees, different.' (W C)
Perceived fire safety	Fuel loads are not high Access for fire-fighting is possible	'That's a bit too clear for me from an aesthetic point of view but from a fire point of view, good.' (BM B) 'And if you're going to fight a fire, you've got to be able to access it.' (W C)

BM, Blue Mountains, W Wamboin; letter indicates photo

reflecting these views are outlined in Table 2. However, Blue Mountains photo B was most preferred overall partly for its more natural and less managed appearance—in the words of one interviewee, it has “the best of both worlds.” Interviewees saw it as containing a balance between a natural appearance, as represented by the remaining understorey and the less mown appearance relative to the more obviously managed photo A, and accessibility and openness that appealed to them visually and for access. One interviewee noted, for Blue Mountains photo B in contrast to photos D and E “they're not hidden, things are starting to get very hidden there.” Some interviewees also made positive comments about the fact that Blue Mountains photo C appears to have open ground discernible beyond the foreground vegetation. Some similar comments were made regarding Wamboin photo B. This theme of visibility and an ability to perceive and locate oneself in a broader setting was also evident in how people talked about Wamboin photos C and D. One interviewee said of photo C, “you could see where you were walking and you wouldn't have to bash your way through...it felt like it had

a balance that I liked.” Others talked about liking the shape of the older trees in photo C and also about being able to sit and have a picnic. For photo D, relatively open but with more shrubs, interviewees continued to like the ability to see through the vegetation. Despite the openness, these photos hold interest for the interviewees and contain potential for finding and enjoying the things that they value, such as the interviewee who valued Wamboin photo C for its potential for bird watching (Table 2).

The significance of elements of interest in the photos was also evident in the comparisons that interviewees made between Blue Mountains photos A and B and, to a lesser extent between A and E. Photo B, while still open and accessible, contained more elements of interest relative to Blue Mountains photo A. Photo A was ranked last esthetically and recreationally by a number of interviewees (Fig. 1). Interviewees who did not rank photo A highly tended to make comments such as “I find that a bit too clipped and park like for me” or noted that it was too “manicured,” “too stark,” or “too cleared” (Table 3). Further, as Fig. 1 shows, the frequency distribution of

esthetics and recreation preferences for Blue Mountains photos A (and to some extent for E) tend to the extremes, indicating that there is division among interviewees between those who prefer relatively open scenes and those who prefer denser vegetation. For example, one interviewee noted that relative to photo E, photo A lacked the interest he was looking for when out bushwalking. To a lesser extent there is a similar distribution of preferences for Wamboin photo E (Fig. 2), where preferences tended to be distributed to either end of the scale, although there is no corresponding such distribution for other Wamboin photos. To some extent these views regarding preferences were qualified where alternative users other than the interviewee themselves were envisaged. For example, one interviewee who ranked Blue Mountains photo B as their first preference also noted that Blue Mountains photo A would be preferable for a family picnic with children around. More generally, interviewees who ranked photo A as their first preference also noted the value of photo A for family-oriented activities.

The photos with more understorey, such as Blue Mountains photos D and E were generally less preferred on esthetic and recreational grounds. Speaking to a theme of the ability to have ‘immersive contact’ with native vegetation, one interviewee said of Blue Mountains photo E, “once it’s like this it’s much harder to interact with.” Interaction of a more vigorous nature is possible in such

vegetation, and one interviewee said Blue Mountains photo D would be their choice if they wanted an adventure in the bush. However, people are generally not looking for such adventure in their everyday life on their properties and therefore tend to prefer the scenes that are easier to access. Notwithstanding this, as noted above, there is some preference among interviewees for the photos with more understorey, such as Wamboin photos E and Blue Mountains photos D and E. For example, in Wamboin, this was largely due to the greenness of the understorey which appealed to some interviewees—“I don’t mind the understorey here, looks quite lush.” Similarly, in the Blue Mountains, interviewees again either liked the healthy appearance of the dense understorey of photo E or were able to picture themselves still able to move through photos D and E, for example on a bushwalking track. In such cases, esthetic and recreational preferences were not necessarily associated with an absence of awareness of the inherent fire risks.

Esthetic and recreational preference tended to decline with increasing understorey (Table 1, Figs. 1 and 2). Photo A in Wamboin differs, however, in being the least preferred esthetically due to its lack of understorey, the presence of leaf litter, and composition of relatively dense young trees, which people did not find attractive. Apart from Wamboin photo A, and notwithstanding some of the positive comments about the understory above, photo E also was ranked low in esthetic and recreational preference.

Table 3 Photos themes and quotes regarding residents’ less preferred photos

Themes	Key reasons photos were less preferred	Quotes
Lacks visual openness	Inability to see through trees	‘Visually looking through it, you won’t see anything or be able to move through it once it gets up to its full height.’ (BM E)
Inaccessibility	Lacking ease of movement; need to look out for danger Difficult for accessing in a fire	‘Not so much E. It’s just too full on. Yeah hard for us to do what we want to do which is walk around and not have to keep watching out for snakes and things as we walk. Just to be able to be able to get the bigger picture rather than having to concentrate where you’re actually stepping.’ (W E) ‘That one’s a bit more hard to transverse, probably, and probably harder to fight a fire in.’ (BM E)
Texture	Too uniform, stark, or boring Lacking understorey or too much understorey Lack of species richness, diversity, and complexity	‘Had too little understorey. ... That’s right because it shows to me there’s nothing interesting that’s happening at the near level. The trees are interesting; particularly here I think the trees are interesting. But there’s not going to be any small flowers. There’s not going to be any creepers. There’s not going to be anything. [Wamboin A] And that one’s [Wamboin E] way too much. ... Photo E way too much. I can’t imagine walking through that.’ (W A & E) ‘I find that a bit too clipped and park like for me.’ (BM A)
Habitat and perceived naturalness	Hazardous wildlife habitat e.g., for snakes and leeches Nature overwhelming, inhospitable, or appears damaged	‘E looks inhospitable because I couldn’t walk through. It would be full of snakes and other goodies.’ (W E) ‘I wouldn’t go near it because I’d be terrified of snakes or leeches or something like that.’ (BM E) ‘I rank this one the least because, although it’s very natural and obviously I like things with natural, they’re a bit forbidding.’ (BM E)

BM Blue Mountains, W Wamboin; letter indicates photo

Table 4 Resident perspectives on bushfire risk mentioned during photo evaluation exercise

Themes	Key reasons photo were considered safe or unsafe (relative to other photos)	Quotes
Safe(r) with respect to bushfires	Low fuel loads and/or structure: Minimal groundcover and understorey, sparser tree spacing, open canopy	‘Cleared, no undergrowth, easy to, you could get a vehicle into there. This one similar, you’ve got a cleared area with denser scrub at the back.’ (BM A and B)
	Accessible for fire-fighting purposes	‘There’s no understorey, and not so much canopy either.’ (W A)
	Area exhibits signs of already having been burnt	‘Seems a lot of leaf vegetation on the ground, but pretty low, not likely to catch alight those ones... that’s already been burnt [W A]... Still C [is the safest].... I think probably with these being a bit sparser, the trees [W C]’ ‘And if you’re going to fight a fire, you’ve got to be able to access it.’ (W B and C)
Unsafe with respect to bushfires	High fuel loads and/or structure, particularly in terms of understorey vegetation growth	‘When it gets dry that nice green stuff is going to be a fire risk... I thought, “Fire risk,” when I saw E; not because it’s fire risk now, but it will be when it becomes dry.’ (W E)
	Potential future vegetation growth a hazard	‘This one’s just the undergrowth. Fuel loading on those is pretty high.’ (Blue Mountains Photo E)

BM Blue Mountains, W Wamboin; letter indicates photo

The reasons for disliking these photos are generally the reverse of the reasons for liking the more open images above. These reasons, summarized and illustrated in Table 3, are lack of visual and physical accessibility. There was furthermore a perception of uniformity, a lack of things of interest, as well as perceptions of danger, such as snakes and other creatures. One interviewee went as far as to describe Blue Mountains photo E as “forbidding” and another labeled Wamboin photo E as “inhospitable.”

Bushfire Risk Mitigation Preferences

In Wamboin the first preferences for bushfire risk mitigation (i.e., scenes in which people feel safest) are the relatively (but variably) open scenes of photo A, B, and C. The least preferred image is photo E, the scene with the most understorey. The two interviewees who ranked Wamboin photo A as their least preferred photo on the basis of bushfire risk, did so based on what they perceived as large amounts of flammable leaf litter. In the Blue Mountains almost all interviewees ranked the open forest photos A and B as their preference for bushfire risk mitigation and photo E, the photo with the most understorey, was almost unanimously ranked as the least preferred. Table 4 summarizes these preferences. In general, people ranked their preferred images on the basis of relatively low fuel loads due to limited understorey and groundcover, as well as fairly open tree spacing. Such photos were also perceived as accessible for fire-fighting. In the case of Wamboin photo A, lower fuel loads were attributed to the evidence of a relatively recent burn. Conversely, scenes perceived as relatively high risk were

assessed as such due to perceived high fuel loads in the understorey.

Preferences for Balancing Risk and Amenity

In the Blue Mountains, interviewees were asked which scene represented their overall preference with respect to balancing risk and amenity on their own property. Photo B was preferred by the largest proportion of interviewees (40 %) and 77 % selected photos A or B as representing risk/amenity management outcomes they would be satisfied with. Ten interviewees were unable to make a definitive preference choice. Five of these were wavering between photos B and C, both photos with open spaces and relatively low fuel loads. This indicates the extent to which this is a potentially difficult question for interviewees. It asked them to weigh up, and possibly engage in compromises across, a range of values, risk perceptions, and management goals for their property. It also tests their willingness to put resources such as time and money into achieving certain outcomes relative to other resource uses. It suggests the value of discussing goals and options between fire agencies and residents.

Discussion

This study provides new evidence regarding residents’ landscape preferences in fire-prone Australian environments and into associated relationships between residents’ sense of amenity and bushfire risk mitigation through vegetative fuel load management. It suggests that findings

from the USA relating to these issues are relevant to Australia and more generally applicable. These results also suggest the ongoing value of existing frameworks in landscape research and their role in interpreting amenity and bushfire risk preferences. The study provides insights that will help bushfire managers understand and engage with residents' landscape values and property management goals.

Ranking results and interview data together show that, for amenity and bushfire risk mitigation, interviewees tended to prefer relatively open scenes composed of relatively large trees with limited understorey or which could be seen through to some extent. Rather than manicured uniformity, there was a preference for scenes that had small amounts of sparse understorey or some other manifestation of rougher texture such as unmown grass. Such scenes conform to ideals of unmanaged 'nature' even where they may be the result of management interventions such as understorey removal or suppression, mowing or slashing, or burning. Similarly, with some qualification as discussed below, interviewees tended to have lower preferences for scenes that had relatively large amounts of understorey and/or could not easily be seen through. Such results are consistent with research in the USA that has found similar preferences for open vegetation with larger trees retained and understorey controlled but not entirely absent (for example, Ryan 2012). It also suggests that, as in the USA and with appropriate engagement (McCaffrey et al. 2011), Australian WUI residents are likely to be open to fuel reduction activities that thin or remove vegetation to reduce bushfire risk, and that such vegetation management is not necessarily incompatible with amenity. In fact, where people are able to separate esthetic, recreational and risk in expressing their preferences, our results show that the amenity gained from landscapes surrounding homes is generally consistent with management of native vegetation to mitigate bushfire hazards.

Despite these overall results, there was some evidence that esthetic preferences were somewhat divided between interviewees who preferred open vegetation and those who preferred vegetation with a denser understorey and talked positively of walking through or viewing such vegetation. As suggested by Nelson et al. (2005), this observation is potentially significant as it alerts us to the existence of a parallel set of preferences that relate to a different way of perceiving and valuing naturalness and nature that WUI residents seek contact with. Our results did not indicate any particular objection to vegetative fuel reduction among such interviewees but it is possible that such preferences could be allied with opposition by residents to fuel reduction on the grounds that it causes environmental harm (Whittaker and Mercer 2004). This highlights the significance of resident perceptions of naturalness and

suggests opportunities for further research to incorporate investigation into residents' understandings of the environmental value of vegetation and of the dynamics and consequences of apparent environmental stasis or change.

As noted for both the USA (McCaffrey et al. 2011) and Australia (Eriksen and Gill 2010) there has been an unjustified, or at least simplistic, tendency to assume that living close to natural vegetation and undertaking relatively little hazard reduction, means that residents do not accurately perceive bushfire risk and suffer from "bush blindness" (for example see Anonymous 2014). The results of this study suggest that, for our study areas at least, such blindness does not exist to a great extent. Ranking data and interviews showed that scenes with relatively high levels of fuel, particularly understorey and ladder fuels, were less preferred on esthetic, recreational, and bushfire safety grounds. Conversely, the data sources showed that scenes with relatively low levels of fuel, particularly understorey and ladder fuels, were preferred on esthetic, recreational, and bushfire safety grounds. Perceptions of bushfire risk were common across all study areas and for the large majority of interviewees, almost unanimously so in the Blue Mountains. Given the timing of the research, this is possibly in part an artifact of the scale and continuing impact of the 2009 Victorian bushfires. However, it is also consistent with findings that WUI residents often are bushfire aware but are weighing up a range of values and goals, of which bushfire risk reduction is but one, as they manage their properties and juggle other demands.

With respect to landscape preference frameworks, the results demonstrate the utility of the key elements of Kaplan and Kaplan (1989) framework, Appleton's (1975) prospect-refuge theory, and with the broader findings about landscape preferences. That is, interviewees prefer relatively open scenes that are neither wholly open such as open farmland, nor 'blocked' by understorey. In Appleton's terms, interviewees prefer scenes that offer prospect—both seen and partially hidden—and a certain level of refuge. The Kaplan's framework of complexity, coherence, legibility, and mystery can be used to interpret our results and we have summarized how ranking and interview data relate to these framework components in Table 5. Overall, the most highly preferred photos, photo B in the Blue Mountains and photo C in Wamboin could be characterized as having moderate complexity, moderate coherence, a relatively high level of legibility, and a low to moderate level of mystery. These concepts have proven useful in urban park design in the creation of spaces that meet people's need for privacy, enjoyment, and safety (Ryan 2006). Further developing and translating this framework, its components, and its association with vegetation needs and preferences may prove useful in producing tools for bushfire managers in structuring

Table 5 Interviewee preferences and the Kaplans' (1989) framework

Framework component	Evidence from preference ranking and interviews
Complexity	<p>Preferences for scenes that had some complexity as represented by interesting larger trees and some rougher grass and sparse understorey</p> <p>Less preference for undifferentiated or substantial understorey</p> <p>Negatively comments on scenes that were simple in composition</p>
Coherence	<p>Preferences for scenes in which the trees exhibited interesting form and spacing but overall had enough similarity to provide coherent patterns and some sense of order</p> <p>Perceived excessive order reduced preference ranking</p>
Legibility	<p>Preferences for scenes or scene characteristics that would allow them to easily move around, see where they were going, retain a sense of location, and undertake management</p> <p>Preferences for scenes or scene characteristics that facilitated straightforward everyday interaction</p> <p>Less preference for scenes where it would be difficult to spot hazards</p>
Mystery	<p>Preferences for scenes in which all was not revealed at first glance</p> <p>Preferences for scenes that offered the potential to find, observe or do things they were interested in</p>

community engagement material and processes. Nelson et al. (2005, p. 322) emphasize that for homeowners, house, garden, and property layout, design and management involve an “expression of themselves, their preferences, uses and understanding of ecological systems.” Local RFS brigades undertake significant local community engagement work and much of this involves talking and providing advice to residents about these issues and activities. This will always be in variable and sometimes challenging social settings. Agency engagement with residents should focus on a dialog about what residents desire from the land around and in the vicinity of their houses. Our results also suggest an approach for equipping these brigades and other managers with engagement frameworks and tools that can assist in identifying and exploring landowners' preferences and desires, and how these can be implemented to best accommodate amenity and bushfire risk reduction. This study suggests that amenity contingently characterized in terms such as access, interest, order, balance of elements, manageability, and feeling safe is a valuable place to start. This opens up a range of potential landscape elements and preferences that can be explored by residents and agencies in developing hazard mitigation and management plans for properties in amenity-rich bushfire-prone landscapes.

Finally, while this study is valuable for generating insights into amenity and risk preferences and perceptions in Australian bushfire-prone environments, the study methodology illustrates both strengths and limitations of the qualitative approach used. The use of semi-structured interviews with photo-elicitation and ranking, and a property walk has enabled us to both identify and assess preferences and explore the thinking and reasons underlying them. The insights from this relatively in-depth approach are valuable as well as being consistent with research elsewhere and with landscape preference frameworks.

Such consistency and insights suggest the value of qualitative research for landscape preference research more generally. The study does, however, have a number of limitations. First, is the relatively small sample size, in part an inevitable trade-off as part of qualitative research, the logic of which emphasizes recruiting information-rich cases and, often, seeking variation within them (Patton 2002). While our interviewees were recruited using diverse means and encompass a range of types of people, their overall demographic representativeness of the study area's population is variable. Second, although using a small number of photos made sense in the context of a long interview that had various goals, most landscape preference research relies upon larger numbers of photos, often digitally manipulated. These limitations suggest the value of larger-scale survey-based quantitative research that builds upon and further tests the outcomes of this study.

Conclusion

The growing number of Australians living in bushfire-prone landscapes poses significant challenges for mitigating and managing the threat of bushfire. Managers face the challenge of dealing with diverse populations who are often seeking contact with nature as well as home and garden spaces that reflect their values and property management goals. While this can create a challenging environment for bushfire risk reduction, particularly when working with the assumption that residents are unlikely to adequately perceive or act on risk reduction guidelines, this research shows that there is room to meet amenity and bushfire safety goals. Moreover, it shows that findings from the USA in this regard are applicable elsewhere. While not all residents will subscribe to the preferences found in this

study, this research does provide concepts that can be used to identify and describe what WUI residents desire from their “natural” surroundings. Such tools can help managers engage with residents, gain insight into their notions of nature and naturalness at the WUI, and to plan landscapes that incorporate both amenity and risk reduction needs.

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