

Values of the public at risk of wildfire and its management

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Abstract. Wildfire management agencies increasingly seek to understand what the public values and expects to be protected from wildfire and its management. Recent conceptual development demonstrates the utility of considering values at three levels of abstraction: localised valued entities such as people, places and objects; valued attributes of communities and landscapes; and core values, or ideals that guide in life. We used a large-scale survey ($n = 1105$) in Victoria, Australia, to test and extend this framework. The results confirm the usefulness of the conceptual framework and demonstrate that values that members of the public consider at risk of wildfire are much more diverse than those typically considered in wildfire risk management. Relationships between values at different levels of abstraction are meaningful and reveal the multiple ways that objects, places and people become valued. The research suggests ways to understand and practically incorporate values of the public in wildfire management.

Additional keywords: assets, core values, valued attributes, valued entities.

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Introduction

Over more than 30 years, environmental social scientists have called for greater consideration of values of the public and local communities in environmental planning (e.g. Brown 1984; O'Brien 2003; Tadaki *et al.* 2017). At the same time, significant shifts in policy have led to a broader range of values – defined broadly as what is important to people and why – being considered in environmental management. For example, whereas forest policies of the past focused on economic efficiency, greater attention is now routinely given to ecological outcomes and social acceptability (Bengston 1994). Ecosystem management now includes greater consideration of cultural values (Chan *et al.* 2016; Kenter 2016). This shift has also emerged in wildfire management, where new approaches to risk-based assessment and community participation in decision-making are creating greater impetus to understand and incorporate values of the public in risk management (Department of Environment, Land, Water and Planning 2015; Ingalsbee 2017).

Social research has an important role in understanding values at risk of wildfire. To date, such research has given greatest attention to understanding public concern for values of natural landscapes. For example, Loomis and Gonzalescaban (1994) assessed trade-offs between fire control and owl habitat protection, while Burtz and Bright (2014) showed that a basic belief in the importance of natural processes strongly predicted acceptability of prescribed burning. Some researchers have studied place-based values of natural environments (e.g. Morehouse *et al.* 2010). Others have studied public concern for impacts of fire on landscape values, for example useable timber and water supply (e.g. Shindler *et al.* 2009). Far less attention has been given to qualities of settled areas and communities that are

important to people and can be affected by fire. This emphasis can perhaps be explained by historical roles forest managers have played in mitigating risks of wildfire through manipulating vegetation: perhaps values that are less familiar to managers are less readily considered in practical management. Alternatively, it might relate to a broader association between wildfire and ‘wild’ rather than settled land. Regardless of the reason, failure to consider a comprehensive breadth of values that can be affected by wildfire could limit understanding of the difficult choices that individuals and institutions make in planning for such disasters.

Land and fire management agencies are likely to experience significant advantages from understanding values of the public and incorporating these in wildfire planning. Conflict over wildfire management may be driven by mismatches between values of agencies and the public, or by strong differences in values within a community (Burtz and Bright 2014; Rawluk *et al.* 2017). For example, conflict over the use of planned burning as a tool to reduce fuel loads and bushfire risk can be understood as tension between concern for protecting human lives and protecting natural ecosystems (e.g. Loomis and Gonzalescaban 1994). By understanding the values of local communities and the broader public, fire management agencies can better align their objectives with the values of these people, and more transparently account for how their decisions do and do not incorporate these values. In practical terms, this might involve using knowledge of values of the public to: structure and prioritise management objectives; structure selection of indicators used to monitor wildfire management; inform the balance of objectives underpinning risk management strategies and scenarios; guide design of participatory strategies and community

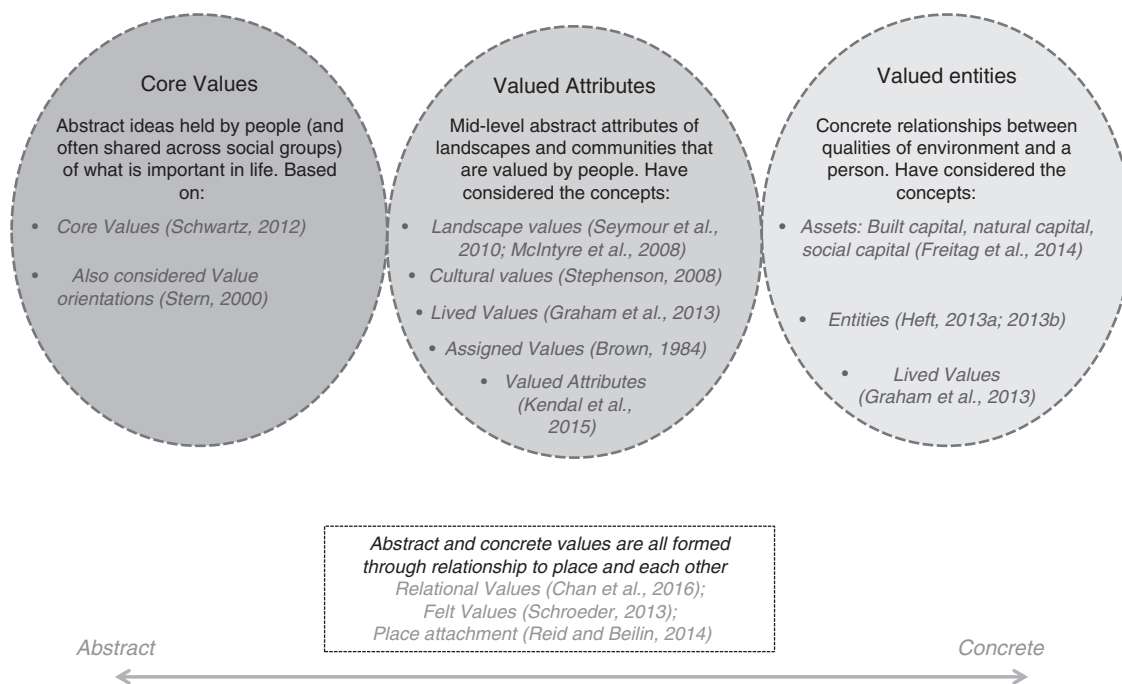


Fig. 1. Visual representation of conceptual framework. With permission from Rawluk *et al.* (2017).

engagement; and shape the language and concepts used to report on wildfire planning decisions (Williams *et al.* 2017).

Understanding and incorporating a comprehensive range of values affected by wildfire is complicated by disciplinary and professional differences in the ways that values are understood. Wildfire planning often emphasises mappable assets in the landscape, an approach that has been criticised because it fails to recognise the meaning of these assets to people, perhaps better understood through higher-order categories and processes of place and relationship (Beilin and Reid 2015). Research within natural resource management has often considered values as broader attributes of environments that are important to people, for example scenic beauty or ecological quality (Bengston 1994; McIntyre *et al.* 2008). Related approaches have been applied to wildfire management (e.g. Shindler *et al.* 2009; Morehouse *et al.* 2010). Other research has utilised economic conceptions of value, focusing on willingness to pay for fire prevention that protects fauna (e.g. Loomis and Gonzalescaban 1994). Psychological approaches to values emphasise cross-situational principles or ideals that are important in understanding environmental conflict (Ford *et al.* 2009) but have rarely been incorporated in exploring values relevant to wildfire management. These different perspectives on values can create additional challenges for wildfire professionals seeking to better understand the values of the communities they serve, and to identify appropriate strategies for using this knowledge in decision-making.

Recent research bridges these different approaches by conceptualising values at three levels of abstraction (Rawluk *et al.* 2017, summarised in Fig. 1). At the most concrete level, valued entities are largely mappable places and objects that people seek to protect from harm, such as natural places, homes and workplaces. Valued attributes describe the general qualities of

communities and landscape that are important (for example human wellbeing or livelihoods). Core values are more abstract ideals in life such as security or benevolence. These principles are positioned as underpinning and shaping less abstract values. Importantly, the framework highlights the connections between values at these different levels, which help reveal the relationships through which entities become valued.

The resulting conceptual framework creates coherence across different conceptualisations of value in ways that usefully inform wildfire planning practice. Planning practitioners may focus on tangible valued entities because entities are central to spatially explicit or asset-based management, or because planners may consider abstract core values too contested and uncertain to manage (Thacher and Rein 2004). The bridging of more tangible and abstract forms of value suggests new approaches for incorporating values in decision-making. For example, asset-based planning might be structured to ensure underpinning valued attributes and core values are also protected (Williams *et al.* 2017).

Qualitative document analysis and interviews have already provided preliminary support for this framework, and facilitated description of values at each level that might be affected by wildfire and its management (Rawluk *et al.* 2017). The present paper builds on this work by using quantitative approaches to further develop the framework in two directions. First, the earlier, qualitative research (Rawluk *et al.* 2017) provided a detailed and comprehensive understanding of values that can be affected by wildfire and its management. It is noteworthy that the values identified in their work extend well beyond elements and attributes of natural landscapes, identifying the importance to the public of tangible elements of settled areas and valued attributes of these elements. However, to make this knowledge

useful for practical strategic planning, wildfire planners need guidance on a more concise set of values that can efficiently represent the concerns of diverse communities. We present research designed to quantitatively examine the nature and structure of values at risk and so identify a small yet comprehensive set of values that can be affected by wildfire and its management. The resulting generalised set of values can be a useful starting point for wildfire managers as they engage with communities to understand the detail of local perspectives, anticipate potential value conflict and structure conversations about potential value trade-offs. Such sets of values can also guide other aspects of wildfire decision-making through informing the choice of objectives or criteria used to guide risk analysis, strategy development and other elements of decision-making (Ford *et al.* 2017).

Second, the conceptual framework assumes particular relationships between values, particularly across levels of abstraction. Valued attributes are understood to describe the relationships or outcomes through which specific entities become valued, while the principles inherent in core values are understood to motivate the valuing of particular attributes of landscape and community. To date, these predicted relationships have only been partially tested. Kendal *et al.* (2015) examined links between core values and valued attributes in the context of public land. Anderson *et al.* (in press) explored how core values were related to valued attributes of forests. But these studies examined only two levels of values (omitting valued entities that are critical for wildfire planning) and a narrow set of values (only those relevant to natural landscapes rather than settled landscapes affected by wildfire). Building on this, we now test the relationships of a broader range of values in ways that can contribute to both theoretical development and practical application in wildfire planning. The resulting insights into ‘pathways of valuing’ can assist agencies to protect not only the assets or entities of concern to the public, but the relationships and outcomes that give these meaning.

The research was conducted in the context of the strategic wildfire risk planning in the state of Victoria, Australia. The State government plays a lead role in planning for wildfire risk through the Department of Environment, Land, Water and Planning (DELWP), working collaboratively with local government and emergency management organisations to plan for cross-tenure management of wildfire risk (DELWP 2015). Broad policy objectives of the Department emphasise the protection of human life above all else, while recognising a range of other human welfare-focused factors (for example, properties and infrastructure) and balancing these with protection of ecological resilience (Department of Sustainability and Environment 2012). These values form the basis of strategic wildfire planning through the Code of Practice for Bushfire Management on Public Land (Department of Sustainability and Environment 2012). Although the code mentions several additional objectives, complexity and data constraints mean that in practice, properties, infrastructure and ecosystem resilience are the primary values considered in bushfire risk planning. During the period the research was undertaken, DELWP was undergoing important changes in policy directions, encouraging greater attention to understanding values of the public, and facilitating a greater role for local communities in decision-making (DELWP

2015). This shift appears related to broader institutional changes in the framing of fire management from a problem of controlling fire (emergency risk management) to one of living with fire (a sustainability framing) (Bosomworth 2015), with the latter framing giving greater emphasis to community engagement about value choices and trade-offs given the inevitability of fire. It also reflects increasing emphasis on ‘shared responsibility’ for risk management between community and fire agencies, a notion that some attribute to attempts to engender more realistic expectations among people living in fire-prone landscapes (Bosomworth *et al.* 2017).

In this context, we aimed to:

- (1) Examine the nature and structure of valued entities, valued attributes and core values that can be affected by wildfire and its management; and
- (2) Identify the relationships between values at three levels of abstraction.

For wildfire managers, this research can assist with identifying a concise yet comprehensive list of values that can inform both community engagement and decision-making, and illuminate the pathways of valuing that underpin the priorities of the public for wildfire protection.

Method

A survey was conducted in Victoria, Australia. The survey built on earlier qualitative research (Rawluk *et al.* 2017) such that the two studies together can be considered a mixed-methods approach to exploring these aims (Creswell and Piano Clark 2007).

Population and sampling

The population of interest was adult residents of fire-prone regions in Victoria. With the focus on understanding relationships between variables, the sampling strategy was designed to maximise diversity of participants. Participants were therefore selected from two purposefully chosen, contrasting fire-prone regions of Victoria (peri-urban areas east of Melbourne, and rural areas of north-east Victoria and west Gippsland). These areas were selected because they cover many areas of high wildfire risk, incorporate diverse experiences of fire (significant to minimal), and both rural and peri-urban communities. Regional boundaries for the survey were practically determined by a combination of local government areas and postcodes associated with those regions.

Participants were recruited through two approaches. A private company was engaged to recruit people from existing paid online panels (865 valid responses, 563 from the peri-urban region and 302 from the rural region). This approach ensured the inclusion of individuals from across the two regions who had no specific interest in wildfire. Participants were also recruited through stakeholder groups with a wide range of potential interests in wildfire, including organisations with interests in farming, environment, tourism, winemaking, apiary, timber, mining, recreation and emergency management, as well as sporting, service and other community groups. This second approach ensured that a wide range of views was included in the survey, even though some of these views may be held by small numbers of people. Contact people for these groups were

asked to forward the survey link to their members (240 valid responses, 108 from the peri-urban region and 132 from the rural region). It should be noted that preliminary analysis indicated variations in values across the sample were not related to the region from which participants were drawn, and so these cohorts are combined in further analyses. In total, 1105 valid responses were received (54% female, 33% of all respondents had education at Bachelor degree or higher). Approximately 42% of participants had no direct experience of fire in the landscape, 27% had experienced planned burning in some form, and 30% had some direct experience of wildfires.

Questionnaire design

A questionnaire was developed to measure values at the three levels of abstraction identified within the conceptual framework. Decisions about which values to include and how to measure these were informed by outcomes of the qualitative research, described in detail in [Rawluk *et al.* \(2017\)](#). Given the aim to explore relationships between valued entities and their potential attributes, further consideration was given to conceptualising relevant entities. For example, natural and experiential qualities of landscape were conceptualised as attributes of natural landscapes, whereas human health and human relationships were conceptualised as attributes of people, and livelihoods were considered attributes of workplaces. Priorities for protection of valued entities were measured using 30 items covering 9 themes identified in qualitative research (people, property, natural places, farms, business, domestic pets, wildlife, infrastructure and community sites) ([Rawluk *et al.* 2017](#)). Importance of valued attributes was measured using 32 items targeting 8 categories identified in the qualitative research (human life and wellbeing, natural, experiential and productive qualities of landscapes, animal welfare, community support, government support and access to infrastructure). Items for measuring valued attributes of natural environments (natural, productive and experiential) were adapted from [Kendal *et al.* \(2015\)](#) and [Ford *et al.* \(2017\)](#). Other items were developed from previously collected qualitative data ([Rawluk *et al.* 2017](#)), wherever possible using language and concepts of research participants and submissions.

Five core values were selected for measurement. These were chosen based on the core values expressed by participants in the qualitative research ([Rawluk *et al.* 2017](#)). Interpretation of those values drew significantly on [Schwartz's \(2012\)](#) circular continuum of 19 values, as well as environmental research that separates biospheric and social altruistic forms of universalism ([Stern and Dietz 1994](#)). Three of the expressed core values were from the self-transcendent sector of Schwartz's model: universalism – biospheric, universalism – altruism, benevolence. Note that although research on environmental values typically also includes egoistic values from the self-enhancement sector Schwartz's model (e.g. [de Groot and Steg 2008](#)), the qualitative research on which the questionnaire was based did not support such inclusion in the current study. Two other core values were from opposing sectors of the conservation–openness to change dimension of Schwartz's continuum: security and self-direction. Core values were measured using 18 items adapted from [Schwartz *et al.* \(2012\)](#), with a minimum of three items for each value.

Participants also provided information about age, gender, dependents and past experience with wildfire. Participants were contacted by email and completed the survey online.

Analysis

A total of 1257 responses were initially received, but the quality of some responses was unclear, a common occurrence when using a paid panel ([Menictas *et al.* 2011](#)). A total of 142 participants who completed the survey in less than 7 min (almost all recruited through the paid online panel) were removed from the sample. Responses were also assessed to identify flatlining in responses (where all values were rated at same level, reflecting unconsidered responses). This resulted in removal of a further 10 responses (again from paid online panel participants), resulting in the final 1105 responses.

The structure of values at each level of abstraction was analysed using principal axis factoring to extract factors and rotation using varimax with Kaiser normalisation. The method was applied to simplify responses to a large set of questions about values into a smaller set of underpinning value categories. Factors scores were then calculated for each value, based on item loadings on each factor. The relationships between values at different levels of abstraction were examined using structural equation modelling (SEM). Because of the large number of variables in the model, factors scores were used to build a structural model only. Assumptions of normality, linearity and multicollinearity were tested to ensure the data were appropriate ([Tabachnick and Fidell 2007](#)).

Results

Valued entities

Six factors were extracted based on a scree test. The factors were interpretable with the exception of loadings of two items about gardens (*protecting private gardens* and *protecting public gardens and reserves, and their facilities such as walking paths and picnic tables*), which loaded on a factor otherwise related to workplaces and education. These were removed from further analysis, with the final solution explaining 64% of variance. The valued entity factors ([Table 1](#)) were interpreted as representing:

- (1) People, homes and health facilities: people including self, family members and community, their homes and health facilities;
- (2) Natural places and wildlife: specific natural environments; flora and fauna, including rare or threatened species;
- (3) Places of work and education: workplaces including farms and businesses; tools and equipment for work; schools and other places of education; welfare and support services;
- (4) Infrastructure: road access, water facilities, communication systems and electricity supply;
- (5) Heritage objects: family heirlooms; documents and records; old buildings and historic sites;
- (6) Domestic animals: farm livestock, domestic pets such as dogs and horses and their feed and water.

This final factor, domestic animals, is clearly distinguished (consistent with qualitative analysis, [Rawluk *et al.* 2017](#)), but items also cross-loaded with factor 2, suggesting animals are associated with natural environments to some extent.

Table 1. Factor loadings for principal factors extraction and varimax rotation on valued entity items (only loadings over 0.35 are shown, highest loadings for each item in bold)

Factor labels: F1, people, homes and health facilities; F2, natural places and wildlife; F3, places of work and education; F4, infrastructure; F5, heritage objects; F6, domestic animals

Item	F1	F2	F3	F4	F5	F6
Protecting neighbours who are vulnerable or need assistance	0.63					
Protecting members of my immediate family (partner, children, parents, grandchildren)	0.60					
Protecting myself	0.55					
Protecting the homes that I and others live in	0.40				0.37	
Protecting members of the local community	0.72					
Protecting hospitals and other health facilities	0.56			0.39		
Protecting people in general	0.76					
Protecting my friends	0.68					
Protecting nearby natural environments		0.83				
Protecting natural places that are special to me		0.74				
Protecting wildlife (plants, birds and animals)		0.84				
Protecting plant and animal species that are rare or threatened		0.84				
Protecting places of education such as schools, kindergartens and community education centres	0.38		0.52			
Protecting farms, including sheds, fences and machinery			0.52			0.36
Protecting the tools and equipment for my work			0.65			
Protecting local businesses			0.64			
Protecting my workplace(s)			0.73			
Protecting government welfare and support services			0.53	0.35		
Protecting water supply facilities, such as pumps	0.38			0.52		
Protecting systems for communication, such as mobile phones				0.52		
Protecting road access	0.33			0.40		
Protecting the electricity supply			0.35	0.66		
Protecting old buildings and historic sites		0.42			0.48	
Protecting documents and records				0.35	0.65	
Protecting family heirlooms and photographs					0.73	
Protecting the water and feed for livestock		0.35		0.40		0.60
Protecting the livestock on farms		0.43				0.56
Protecting companion animals such as dogs and horses		0.41				0.49

Qualitative analysis suggested that homes are a distinct category (Rawluk *et al.* 2017), but in the present analysis, homes load on the same factor as people.

Valued attributes

Six factors were extracted, accounting for 62% of the variance. Two items about community had multiple cross-loadings that made interpretation difficult (*the emotional support provided by community*, and *the familiar rhythms of community life*). It is possible the language in these statements, particularly the term 'community' was unclear for members of the public. These items were removed from further analysis, with the variance explained unchanged in the final solution. The valued attribute factors (Table 2) were interpreted as:

- (1) Natural and experiential qualities of landscape: the life support function of ecosystems for all living beings, and the opportunities nature provides for positive experiences such as sense of peace and beauty;
- (2) Livelihoods and production: jobs and livelihoods, the local economy and business and the productive capacity of the landscape;

- (3) Human health and relationships: human physical and mental health, welfare and wellbeing; the affectionate and supportive relationships people have with one another;
- (4) Personal history and identity: the sense of identity associated with a home, and the personal memories held in possessions such as photos and other sentimental items;
- (5) Sense of normality: the ability to go about normal daily life with a sense of security;
- (6) Animal welfare: the welfare and wellbeing of farm animals and pets.

This structure was broadly in line with expectations based on qualitative research but combines experiential and natural attributes of environments. Similarly, health and human relationships combined into a single factor as did livelihood and productivity. The animal welfare factor is less distinct than the others, with some cross-loadings with natural attributes, but is consistent with interview findings that included this attribute.

Core values

Five factors were extracted. Initial analysis showed that two statements (*valuing the lives of all human beings* and *going out*

Table 2. Factor loadings for principal factors extraction and varimax rotation on valued attribute item (only loadings greater than 0.35 are shown, highest loading for each item in bold)

Factor labels: F1, natural and experiential qualities of landscape; F2, livelihoods and production; F3, health and relationships; F4, personal history and identity; F5, sense of normality; F6, animal welfare

Items	F1	F2	F3	F4	F5	F6
Ecosystems that support all life by helping to produce and renew air, soil and water	0.74					
The sense of peace and tranquillity that natural areas give to me and others	0.77					
The enjoyment one gets from experiencing natural sights, sounds and smells	0.73				0.36	
The way being in the natural environment helps me feel better physically and mentally	0.75					
Areas of native vegetation that provide habitat for plants, birds and animals	0.87					
The sense of awe and respect that nature inspires	0.78					
The lives of wildlife, native birds and animals	0.82					
Habitat for rare or threatened plants, birds and animals	0.85					
Large old trees and logs that provide homes for wildlife	0.78					
The welfare of companion animals	0.44					0.35
The welfare of farm animals	0.53	0.42				0.41
Local businesses and economic activity		0.54	0.41			
The income provided by farming activities		0.72				
Foods that are grown in the region	0.36	0.54				
Forest and wood products, such as building timber and furniture		0.56				
The jobs provided by local employers		0.58	0.37			
The economic and other benefits from vineyards and other horticultural plantings		0.64		0.38		
The welfare of people in general		0.35	0.68			
The physical health of people		0.37	0.60			
The mental health of people in my community		0.48	0.56			
The relationships I have with members of my family			0.52			
Children's wellbeing and sense of security			0.65			
Friendships with people			0.57	0.37		
The memories that are associated with a home				0.66		
Being able to trace my own history in possessions such as books and photographs				0.63		
The wellbeing that comes from having routine and structure in my everyday life		0.36		0.46		
Enjoying the objects of sentimental value that I and other people keep in our homes				0.78		
Feeling connected through schools, sporting clubs and other local groups			0.42	0.51		
The sense of security that allows me to function in everyday life		0.35	0.38		0.47	
The ability to go about daily life as normal				0.35	0.57	

of my way to be a dependable and trustworthy friend) had cross-loadings that made interpretation difficult. After removing these items from analysis, the five-factor solution explained 68% of the variance (Table 3). The structure was consistent with anticipated categories based on Schwartz *et al.* (2012) and Rawluk *et al.* (2017):

- (1) Universalism biospheric: concern for the welfare of the natural environment;
- (2) Security: stability and security of society;
- (3) Benevolence: concern for family, friends and close neighbours;
- (4) Self-direction: independent thought and action; and
- (5) Universalism social-altruistic: concern for welfare of whole community, society and the world.

The fifth factor is less distinct than the others, with the two main items in this factor also loading on universalism biospheric to some extent. The cross-loading is consistent with literature that suggests universalism is a single concept, but the identification of a distinct fifth factor fits with past research in

environmental contexts (de Groot and Steg 2008; Rawluk *et al.* 2017).

Relationships between valued entities, valued attributes and core values

SEM was used to test whether theorised relationships among core values, valued attributes and valued entities were consistent with the survey data collected. Our use of SEM was in part exploratory, as although we had a good theoretical basis for understanding the general relationship between core values, valued attributes and valued entities (Rawluk *et al.* 2017), there was less basis for predicting which core values were related to particular valued attributes, and which valued attributes were related to particular valued entities. Although it is desirable to combine structural and measurement models in SEM, the number of variables made it infeasible in this study, and only a structural model was built. Factor scores from the exploratory factor analyses presented in the previous sections were used as inputs to the SEM, and are considered to accurately represent the factors. Correlations were significant between variables,

Table 3. Factor loadings for principal factors extraction and varimax rotation on core value items (only loadings greater than 0.35 are shown, highest loading for each item in bold)

Factor labels: F1, universalism biospheric; F2, security; F3, benevolence; F4, self-direction; F5, universalism altruistic

Items	F1	F2	F3	F4	F5
Respecting nature and living in harmony with other species	0.83				
Having unity between people and nature	0.81				
Protecting the natural environment from destruction or pollution	0.82				
Working against threats to nature	0.73				
Ensuring our government protects us against all threats		0.66			
My personal security		0.69			
Living in secure surroundings		0.69			
Avoiding anything that may endanger my safety		0.74			
Being there to help people who rely on me			0.57	0.39	
Helping the people who are dear to me			0.81		
Being responsive to the needs of family and friends		0.37	0.65		
Freedom to choose what to do		0.41		0.62	
Doing everything on my own initiative		0.35		0.59	
Making my own decisions about life				0.77	
Protecting society's weak and vulnerable members	0.42				0.54
Ensuring that every person in the world has equal opportunities in life	0.43	0.35			0.56

suggesting good relationships between values at different levels of abstraction (Table 4).

An initial structural model was built with specification of paths informed by previous quantitative research. For example, significant relationships between biospheric – universalism and natural, experiential and production valued attributes had been observed previously in regression analyses and so were included in the initial model (Kendal *et al.* 2015). Where no previous measures were available, qualitative data were used to identify likely relationships; for example, descriptions of social universalism suggested links with broadly people-focused valued attributes: health and relationships; economy and livelihood; and sense of normality (Rawluk *et al.* 2017). The benevolence core value was expected to also be associated with these attributes, and to be linked to personal identity, which is usually spoken about with reference to families (Rawluk *et al.* 2017).

The initial model was run using the AMOS module of *IBM Statistics SPSS 21*. Although SEM should be theory-driven, it is appropriate to make limited exploratory revisions (Hair *et al.* 2006). Two paths were removed as they were not significant: from biospheric – universalism to economy and livelihood; and from benevolence to economy and livelihood. Examination of residuals and modification indices in AMOS led to identification of paths that, if added, would most improve the model fit. Four such paths between values at different levels of abstraction were added: from benevolence to natural and experiential attributes; from natural and experiential attributes to people and homes; from benevolence direct to people and homes; and from security direct to infrastructure. The final model is shown in Fig. 2. The refined model has a comparative fit index (CFI) of 0.91 and an normed fit index (NFI) of 0.90, which are indicative of good fit (0.90 or above) in a complex model with large sample size (Hair *et al.* 2006). Root mean square error of approximation (RMSEA) of 0.080 is slightly above what would be considered a good fit for a model of this complexity (0.070 or below).

Overall, the data provide some support for the theorised value structure.

The model suggests that the importance participants give to protection of natural places is primarily related to natural and experiential attributes of landscapes, which in turn is underpinned by core values of universalism – biospheric and, to a lesser extent, benevolence.

Protection of domestic animals is related to multiple attributes: livelihood and production, sense of normality, and especially animal welfare. All core values underpin one or more of these attributes, no doubt reflecting the fact that domestic animals incorporate both livestock and family pets, and that wildlife may also be considered in importance given to the attribute of animal welfare. However, the strongest pathway associated with protection of domestic animals is through animal welfare to security and universalism – biocentric.

People and homes are associated primarily with attributes of human health and relationships, which in turn are primarily underpinned by core values of universalism – altruistic and benevolence. There are also minor pathways from people and homes to natural and experiential attributes and sense of normality, which then connect with all core values. There is also a direct pathway between people and homes and the core value of benevolence, suggesting that benevolence inherently involves protection of lives.

The priority given to protection of heritage objects is most closely related to attributes of personal history and identity, and through this primarily to security, with weaker pathways to the attribute of sense of normality and to other core values. Protection of places of work and education is also related to multiple attributes but especially livelihoods and production. This attribute is in turn underpinned primarily by the core value of security, with weaker associations with universalism – altruistic and self-direction. Infrastructure is linked to importance placed on the valued attribute of livelihood and production and directly

Table 4. Pearson correlations among factor scores for all core value, valued attribute and valued entity factors
 **, Correlation is significant at the 0.01 level (2-tailed); *, correlation is significant at the 0.05 level (2-tailed)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
(1) Core value: universal – biospheric																
(2) Core value: security	0.02															
(3) Core value: benevolence	0.03	0.09**														
(4) Core value: self-direction	0.03	0.12**	0.06*													
(5) Core value: universal – altruistic	0.12**	0.07*	0.06*	0.02												
(6) Valued attribute: natural and experiential	0.81**	0.02	0.12**	0.08**	0.11**											
(7) Valued attribute: livelihood and production	0.02	0.39**	0.09**	0.19**	0.25**	0.02										
(8) Valued attribute: health and human relationships	0.09**	0.25**	0.48**	0.11**	0.44**	0.03	0.14**									
(9) Valued attribute: personal history	-0.01	0.39**	0.11**	0.15**	0.10**	0.00	0.10**	0.07*								
(10) Valued attribute: normal life	-0.08**	0.38**	0.15**	0.35**	-0.11**	0.02	0.06*	0.04	0.09**							
(11) Valued attribute: animal welfare	0.07*	0.16**	0.04	-0.05	-0.05	0.04	0.05	-0.02	0.02	-0.05						
(12) Valued entity: people and homes	0.12**	0.27**	0.51**	0.12**	0.28**	0.15**	0.16**	0.69**	0.14**	0.15**	0.07*					
(13) Valued entity: natural places	0.70**	0.04	0.05	0.06	0.12**	0.83**	0.04	-0.02	0.05	-0.04	0.12**	0.02				
(14) Valued entity: places of work	-0.01	0.27**	0.05	0.11**	0.26**	-0.06*	0.50**	0.26**	0.29**	-0.02	-0.11**	0.04	0.02			
(15) Valued entity: infrastructure	0.02	0.31**	0.07*	0.19**	0.06	0.05	0.29**	0.16**	0.09**	0.18**	-0.04	0.07*	0.01	0.14**		
(16) Valued entity: heritage objects	-0.02	0.35**	0.07*	0.14**	0.00	0.00	0.04	-0.00	0.66**	0.18**	0.02	0.02	0.10**	0.06*		
(17) Valued entity: domestic animals	0.07*	0.24**	0.06*	0.09**	0.05	0.11**	0.42**	-0.03	0.05	0.17**	0.44**	0.05	0.07*	0.04	0.07*	0.00

to the core value of security. There is also a weaker pathway from infrastructure and the valued attribute of sense of normality.

Discussion

Structure of values at each level of abstraction

The six valued entity categories identified through this study confirm that members of the public value a broader range of entities than are usually targeted in wildfire risk planning, where focus is typically on homes and infrastructure (Beilin and Reid 2015). This finding extends work of Rawluk *et al.* (2017) to suggest a more concise set of categories of valued entities of the public. As these categories reflect ways that the public think about what is important in relation to wildfire, management tools based on these entity categories may be more effective for ensuring values of the public are comprehensively considered in wildfire, and in communicating with members of the public about wildfire risk management. At the same time, the findings present challenges for wildfire managers who seek to incorporate this broader range of valued entities in planning. Some entities, such as domestic animals and heritage objects, are less easily mapped, and so will be difficult to incorporate in spatially explicit planning processes. Other tactics may be needed to incorporate these values in strategic planning.

This study found that multiple natural and experiential attributes of landscapes loaded on a single factor, whereas attributes of people and communities figured in several distinct factors. The first part of this finding is not easily reconciled with past research that highlights multiple ecological, social and economic qualities of natural environment valued by members of the public (e.g. Bengston and Xu 1995; McIntyre *et al.* 2008; Kendal *et al.* 2015; Ford *et al.* 2017). It also differs from the qualitative research informing the current study, in which natural and experiential attributes of landscapes were categorised separately (Rawluk *et al.* 2017). A possible explanation is that rating the importance of valued attributes in the context of wildfire – which makes no distinction between natural and settled landscapes – may have the effect of making human impacts more salient and impacts on natural environment less so. This explanation has broader implications because it implies that valued attributes may be applied differently across different issues, with context drawing attention to some attributes and not others. First, great care is needed in generalising descriptive values identified through research in one context, to decisions made in regard to different environments or issues. Although values are considered to be quite stable (Ford *et al.* 2009), the relative salience of values may change depending on the situational context in which the values are evoked. Second, whereas practices such as prescribed burning are undertaken primarily in natural landscapes, the impacts of such practices, and the wildfires they influence, extend far beyond the natural landscape. Both researchers and practitioners should therefore consider the full breadth of valued attributes potentially affected, as have been identified in the present study.

The remaining, more human-centred, valued attributes identified in the current study are closely related to concepts of human need. For example, the concept of ‘personal history and identity’ resonates with concepts of both belongingness and

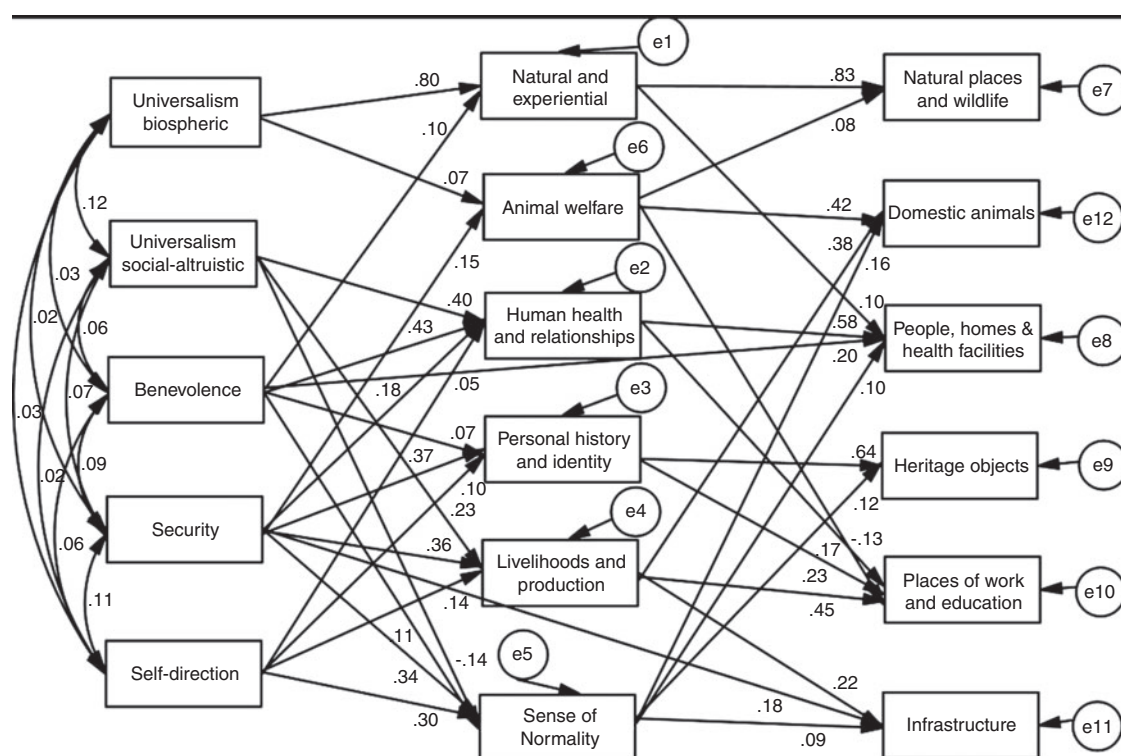


Fig. 2. Structural model of the value structure of members of the Victorian public in relation to bushfire, including exploratory revisions ($n = 1105$; all paths are significant at the 0.05 level; standardised regression coefficients are shown; 'e' indicates error).

self-actualisation, drawn from Maslow's (1943) hierarchy of human needs and used by Graham *et al.* (2013) to describe the 'lived values' at risk of sea-level rise. This finding is helpful in confirming the relevance of human needs-oriented approach in strategic risk planning (Jones *et al.* 2015).

The structure of core values is in line with expectations, reflecting the five factors selected from Schwartz's (2012) framework. Two aspects of this are worth noting. First, egoistic values (for example resources, influence and achievement) were not included – a decision made based on their infrequent appearance in qualitative research that informed this decision (Rawluk *et al.* 2017). We acknowledge however, that it is possible that participants in these face-to-face interviews were reluctant to express egoistic values that are more readily expressed through anonymous surveys. Given this, we suggest that egoistic values are not excluded from policy and planning on this basis of the present study alone. Research using other methods may provide further insight into these in the future.

A second interesting aspect of the structure of core values is the prevalence of security and self-direction values. These two values are drawn from the conservation–openness to change dimension of Schwartz's (2012) model, and have rarely been included in research on environmental evaluation and behaviour (which has typically focused on values from the self-enhancement–self transcendent dimension, including egoism, altruism and biospheric values). However, recent studies have also highlighted related values. For example, Demski *et al.* (2015) explored values in the context of energy system transition through workshop-based discussion. Their analysis of key

themes includes 'stability and security' and 'autonomy and power' (Demski *et al.* 2015, p. 64). Although the authors did not link these themes to Schwartz's framework, the similarities are clear. The relevance of conservation–openness to change values across several studies demonstrates the utility of mixed-methods approaches for value analysis, and suggests further consideration should be given to their inclusion in studies of environmental concern.

Relationships between values at different levels of abstraction

The analysis of relationships between core values, valued attributes and valued entities provides support for our overall contention that priority given to protection of valued entities is underpinned by importance of valued attributes, which in turn is shaped by core values. Some pathways explain a great deal of the variance in priority given to a valued entity (for example, natural places), whereas other pathways account for a smaller proportion of variance (for example, infrastructure). Where explanation of variance is low, factors other than the values measured may be influencing the priority given to particular entities. For example, priorities for protection of entities may also relate to place dependence or to how people use the landscape. Nevertheless, the overall support for the model lends further weight to a growing body of work suggesting that values can be understood at multiple levels of abstraction, and that core values underpin the value placed on more specific attributes and entities (Kendal *et al.* 2015; Rawluk *et al.* 2017).

This finding contributes to theory of environmental values by emphasising the relational nature of values and valuing. Recent scholarship has posited the concept of ‘relational values’, notions of appropriate or desired relationships between people and nature, often understood to be expressed primarily in the everyday relationships between people and place (Tadaki *et al.* 2017). Our model demonstrates complex relations of valuing nature as well as objects, places and people, showing how psychological conceptions of value (such as those reflected in core values and valued attributes) play a role in shaping or explaining these relationships. The research presented here offers a conceptual framework and methodology for revealing the relationships of value and valuing. Although the present study examines such values as applied to priorities for entities for protection from wildfire, the approach is applicable to other issues of risk and natural resource management.

For wildfire management, evidence of the links between values at different levels can be of practical use. These relationships reveal the role of more abstract core values and valued attributes in understanding why members of a community do or do not prioritise ‘assets’ such as homes or infrastructure for protection. In discussing the results with wildfire management professionals, some have reported how these findings ‘brought assets to life’; one fire planner described how they felt they now understood *why* assets matter. Understanding their relationships to valued attributes can help inform the selection of assets for protection, and can identify where other non-asset-based ways of protecting valued attributes are needed.

The model supported by this analysis suggests that valued entities can be prioritised for many reasons. Although primary pathways of association are fairly obvious and can be identified easily, no entity is associated with only one valued attribute. Similar complex relationships between valued attributes and core values have previously been observed using survey methods by Kendal *et al.* (2015) and Anderson *et al.* (in press). Our study is the first to use quantitative methods to demonstrate that this complexity extends to the valuing of entities. For wildfire managers, this finding may be helpful for structuring and prioritising entities for protection. For example, places of work and education can be valued for contributions to human health and relationships, livelihood and production, animal welfare and personal history and identity. Such links to multiple attributes serve to amplify the importance of particular entities; careful planning consideration should be given to protecting assets in ways that sustain these multiple benefits.

Implications for strategic wildfire risk planning and management

The findings can support the explicit incorporation of values of the public in strategic wildfire risk planning, contributing to greater accountability in decision-making. An understanding of values and pathways of valuing can support community engagement and participatory processes, for example by framing conversations about value trade-offs and priorities (O’Brien 2003). Aligning management objectives with values of the public can help members of the public see how their expectations are being considered (Ives and Kendal 2014). The structuring of values illustrated in the present work can also enhance the transparency of decision-making. In recent years, wildfire

risk assessment in Victoria has been dominated by the use of spatially explicit risk modelling tools. Neale (2016) analysed decision-making in this context and demonstrated that not all (valued) entities were included in the decision process, as some were not considered compatible with the methods used, but the inclusion or exclusion of these entities was not consistently made evident. The incorporation (or not) of values may be similarly obscured in many of the more discursive approaches wildfire managers use to make decisions (Williams *et al.* 2017). The set of values identified in the present study can be used to structure objectives, risk assessment and monitoring in ways that ensure a broader range of values are explicitly considered and reported on in decision-making.

Although the findings can be useful to wildfire planners and managers internationally, the insights this study provides about the range of values relevant to wildfire planning cannot replace local intelligence and participatory processes required to support strategic wildfire planning for specific places and social contexts. A key goal of the study was to understand the range of values relevant to members of the Victorian public in general. This was analysed within a particular political and historical context, and questions were posed specifically in relation to wildfire management. Although the range of values identified are likely to be shared by many populations globally, the findings should not be taken to represent the values of any specific local community. It is worth noting that the values identified at the broad scale of the public do not include values important to many subgroups and that figure strongly in government policy, for example Indigenous cultural heritage. In addition, the research was not designed to describe the relative importance of these values to any population, nor was it designed to capture factors other than values that are important to public concerns and expectations regarding wildfire management. As such, the insights to values presented here are best considered a starting point for understanding and incorporating values in wildfire management. Local social analysis and engagement strategies remain vital to understanding and incorporating the values of the public in wildfire decision-making.

Conclusion

This research has contributed new knowledge by quantitatively testing a conceptual framework for describing values that can be affected by wildfire at three levels of abstraction. An important outcome is the concise yet comprehensive set of valued entities identified through this work. These point to a broader range of objects and places than are typically considered in spatially explicit or asset-based risk management. A second key outcome is demonstration of how priority given to protection of these valued entities is grounded in more abstract values typically utilised within social sciences, including valued attributes and core values. The links between valued attributes and valued entities are particularly useful for planning purposes: they can illuminate the reasons why certain places or objects are valued, or categories of valued attributes can be used to structure decision-making to ensure entities targeted for protection are those that meet important values and needs. Together, these findings provide an excellent starting point for defining sets of objectives to frame risk analysis under international risk management

standards such as ISO 31000 or other forms of consequences analysis in structured decision-making (Thompson and Calkin 2011), to anticipate public response to strategic plans before release, and to inform value-based communication to assist government agencies in explaining to communities the basis for their decisions (Ives and Kendal 2014).

Conflict of interest

The authors declare no conflicts of interest.

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