Understanding the acceptability of fuel management strategies used to reduce wildfire risk in Australia

by

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Candidate's Declaration

This thesis is a Thesis by Compilation, as set out in ANU's *Higher degree by research - thesis by compilation and thesis by creative works procedure*, and is presented as a compilation of four journal articles and one technical report, detailed below. I am the primary author on all papers, and the level of contribution by me and my co-author, Associate Professor Jacki Schirmer, is acknowledged below and in Box 1-1 in the introduction. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of the authors' knowledge, it contains no material previously published or written by another person, except where due reference is made in the text.

Chapter 1	Introduction: I wrote this chapter, with review from my supervisory panel.
Chapter 2	Methods: I wrote this chapter, with review from my supervisory panel.
Chapter 3	**Mylek M, Schirmer J. (2012) Reducing bushfire risk: public perceptions about fuel management strategies in the ACT and surrounds. Technical report 221, Cooperative Research Centre for Forestry** I conducted the research, gathered and analysed the data, and wrote this technical report, with guidance and review from my co-author.
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Abstract

Wildfires commonly cause social, economic and environmental impacts in Australia; however, fuel management to reduce wildfire risk often attracts controversy. This thesis examines acceptability of managing fuel in Australia, the extent to which *what* people think and *how* they structure their thoughts about fuel management predicts acceptability, and what this means for communication about fuel management.

Acceptability of three fuel management strategies (prescribed burning, mechanical thinning and livestock grazing) was explored through 24 qualitative interviews and a survey of 488 residents living in and around the Australian Capital Territory; and an Australia-wide survey of 4390 residents.

My first question asked *how acceptable is the use of different fuel management strategies in Australia?* With little published on acceptability of fuel management in Australia, this was an essential precursor to exploring factors predicting acceptability. While my findings show 66% or more support use of all three strategies, most did not think complexly about fuel management. These views are therefore susceptible to change and may lack long-term stability.

My second question asked *to what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?* Consistent with studies in other regions, acceptability was higher for people who trusted those managing fuel, who had high self-rated knowledge about fuel management, and who felt fuel management had more positive than negative impacts. Past experiences of wildfire, perceptions of wildfire risk, length of time since experiencing a wildfire, and socio-demographic factors were not strong predictors.

I drew on Integrative Complexity Theory and other information processing theories to examine my third question: *how is acceptability influenced by the way people structure their thinking about fuel management?* Lower integrative complexity (IC) predicted more extreme attitudes (whether for or against fuel management), while higher IC predicted more moderate, stable attitudes, which is ideal in planning and implementing long-term strategies like fuel management. People had higher IC for prescribed burning than grazing or mechanical thinning, likely reflecting higher familiarity with this common practice, and greater exposure to complex information about its use. To better understand the distribution of IC, I developed a modified scoring method that I argue is likely to better reflect true complexity of thinking, and shows that IC about fuel management is often low.

My fourth question asked *what are the implications of better understanding acceptability for communication*? My findings suggest a need to rethink communication objectives: long-term support for fuel management may be better achieved by increasing IC about fuel management, than by seeking support using simple messaging, as more complex thinking is associated with more stable attitudes. The key area to address in Australia to achieve long-term stable support is

communicating about benefits and costs of fuel management. This differs to the common focus on communicating about wildfire risk to build support for fuel management. My findings suggest that in Australia awareness of risk is high irrespective of personal experiences with wildfire. Communication about risk is unlikely to successfully build IC or support for fuel management, while building understanding about actions intended to address risks can. Ideally, communication should be targeted to match current levels of IC to support more effective information processing, and to open avenues for gradually increasing IC. Further research is needed to test these recommendations, particularly whether designing communication that targets both *what* and *how* people think is effective in building more stable, long-term support for fuel management based on a more complex understanding of the issues.

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List of acronyms and abbreviations

ABS: Australian Bureau of Statistics

ACT: Australian Capital Territory

EFA: Exploratory Factor Analysis

ELM: Elaboration Likelihood Model

HSM: Heuristic-Systematic Model

IC: Integrative complexity

LG: Livestock grazing

ICT: Integrative Complexity Theory

MT: Mechanical thinning

NSW: New South Wales

PB: Prescribed burning

RWS: Regional Wellbeing Survey

SPSS: Statistical Package for Social Sciences

Glossary and Terms

Acceptability: In this thesis acceptability is used to mean ‘socially acceptable’. Considering something to be socially okay, or within the realm of what is appropriate, or something that is tolerable, or superior or sufficiently similar when compared to imagined alternatives.

Attitude: A set of emotions, beliefs, and behaviours toward a particular object, person, thing, or event.

Bushfire: An Australian term to mean an uncontrolled fire in the landscape. This term is used instead of wildfire in some chapters.

Controlled burning: A common term used instead of prescribed burning, to mean the planned application of fire under specified environmental/weather conditions to meet particular management objectives. The term controlled burning is used in place of prescribed burning in some chapters.

Differentiation: Acknowledgement of different arguments to complex and controversial issues. See Integrative Complexity Theory.

Fuel: materials that burn in a wildfire, such as grass, leaf litter, twigs, bark, undergrowth, shrubs, trees and other vegetation.

Fuel management strategies: Strategies that are argued to reduce wildfire risk or severity by reducing (or modifying) the amount of flammable material available to burn in a wildfire

Integration: Understanding that different arguments to an issue have complex connections, with trade-offs between them. See Integrative Complexity Theory.

Integrative Complexity Theory (ICT): ICT explores the structure of thought (how people think) about complex and controversial topics. It incorporates how a person differentiates opposing arguments about an issue (differentiation) and their understanding about complex connections between those arguments (integration).

Integrative complexity (IC): The complexity with which someone thinks. See Integrative Complexity Theory.

Livestock grazing: the use of livestock to reduce or change the structure of edible fuel levels.

Mechanical thinning: the removal or structural alteration of trees or understorey to reduce the amount of combustible fuels.

Prescribed burning: the planned application of fire under specified environmental/weather conditions to meet particular management objectives.

Social acceptability: See acceptability. An aggregate of the comparative positive and negative judgements about something.

Social trust: a person's willingness to rely on those responsible for decision making

Support: Similar to acceptability, however often used to mean a more active type of acceptability, more than 'socially okay' or 'tolerable'.

Vegetation thinning: See mechanical thinning. The term 'vegetation thinning' is used in place of mechanical thinning in some chapters.

Wildfire: See bushfire.

Wildland fire: See bushfire. This term is used instead of wildfire in some chapters.

1 Introduction

Major wildfire events are a common occurrence in Australia, often resulting in significant social, economic and environmental impacts, and receiving widespread and often graphic coverage by the media (Gill 2008; Stephenson et al. 2013). One way of preparing for and reducing the impacts of wildfires is through the use of fuel management strategies, such as prescribed burning, mechanical thinning and livestock grazing. Fuel management strategies are argued to reduce wildfire risk or severity by reducing (or modifying) the amount of flammable material available to burn in a wildfire (Gill 2008; Schwilk et al. 2009; Davies et al. 2010; Penman et al. 2011; McCaw 2013; Ximenes et al. 2017), including fuels such as grass, leaf litter, twigs, bark, undergrowth, shrubs, trees and other vegetation (Hollis et al. 2015). These strategies are also used, to differing degrees and in specific contexts, to meet ecological, social and cultural needs (Lewis 1989; Attiwill 1994; McKemey et al. 2019).

Since 1939, most inquiries into significant wildfire events in Australia have identified a common theme: the importance of wildfire risk reduction, particularly fuel management, and of landscape-scale prescribed burning in reducing wildfire risk (Kanowski et al. 2005). For example, the 2009 Victorian Bushfires Royal Commission states (Parliament of Victoria, 2010, page 15, ***bolded emphasis added to the original***):

> *"The Commission recognises that prescribed burning is risky, resource intensive, available only in limited time frames, and can temporarily have adverse effects on local communities (for example, reduced air quality). Nonetheless, it considers that the amount of prescribed burning occurring in Victoria is inadequate. It is concerned that the State has maintained a minimalist approach to prescribed burning* ***despite recent official or independent reports and inquiries, all of which have recommended increasing the prescribed-burning program.*** *The State has allowed the forests to continue accumulating excessive fuel loads, adding to the likelihood of more intense bushfires and thereby placing firefighters and communities at greater risk".*

Despite regular findings of a need for greater investment in fuel management to reduce wildfire risk, fuel management strategies remain a complex and controversial land management issue in Australia and around the world. Multiple studies have identified that conflicting views are often held about the appropriateness of different fuel management strategies, and about what the overall objectives of fuel management should be (Manfredo et al. 1990; Brunson and Shindler 2004; Brunson and Evans 2005; Carroll and Bright 2010; Altangerel and Kull 2013). Many things contribute to the debate over the use of fuel management to reduce wildfire risk, including whether managing fuels can meet expectations of wildfire protection, the trade-offs associated with doing so (the real and perceived benefits and costs), the complexity of managing fuels with multiple objectives and the disagreement about the level of wildfire risk that people should accept (Whittaker and Mercer 2004; McCaffrey et al. 2008; Burrows and McCaw 2013).

Many argue that successful implementation of fuel management strategies requires a level of public support for these strategies, and that wildfire managers need to understand the social acceptability of their actions within multiple contexts (Arno and Brown 1989; Shindler et al. 2002; Brunson and Shindler 2004; Dombeck at al. 2004; Brunson et al. 2006; Lijeblad et al. 2009). However, the level and type of public acceptance necessary to sustain long-term implementation of fuel management is not well defined in the literature, with an implicit but usually unexplored assumption that higher social acceptability is typically better.

Brunson (1996) describes acceptability as the result of comparing something to the imagined alternatives, where it is acceptable only if it is considered to be better or adequately similar to those alternatives, and suggests that acceptability is only obvious when it is reflected in behaviours that indicate its absence (in other words negative comments or actions reflecting unacceptability) (Brunson 1996; Brunson and Shindler 2004). *Social* acceptability is an aggregate of 'acceptability' (Brunson 1996), and although it might be obvious in its absence, it can also be measured in the positive (presence).

Negative public attitudes can postpone, modify, or prevent implementation of management strategies (Shindler et al. 2002; Brunson and Evans 2005). Understanding acceptability of fuel management can help wildfire managers identify whether their planned strategies will be supported by the public, and when they may need to consider a different approach to address the concerns of the public (Winter et al. 2002). This is an important step in successfully implementing wildfire risk management activities in ways that acknowledge social values, meet public expectations and consider alternative approaches (McCaffrey et al. 2008; Carroll and Bright 2010; Toman et al. 2011; McCaffrey et al. 2013; Toman et al. 2014). Understanding acceptability can also inform the design of communication strategies that effectively reach different people and improve understanding of fuel management (Cortner et al. 1984; Bright and Manfredo 1997; Bell and Oliveras 2006; McCaffrey et al. 2008), with some studies suggesting that the level and quality of information dissemination and public outreach is an important factor in predicting acceptability of fuel management (Manfredo et al. 1990; Shindler and Toman 2003).

Better understanding the social acceptability of fuel management, and identifying how to use this understanding to respond to concerns and inform communication about fuel management, requires going beyond understanding how acceptable fuel management is, or even who finds it more or less acceptable. Ideally, it requires understanding the different factors associated with acceptability of fuel management, and the processes by which people form and change their views about fuel management (Brunson and Schindler 2004; Carroll and Bright 2009). Understanding the reasons why a strategy is or is not supported provides wildfire managers with important insights into what they are doing right, possible alternatives, what needs work in terms of their relationships with the public (Lijeblad et al. 2009), and what types of information they need to include when communicating about their actions (Vogt et al. 2005).

Several studies examining acceptability of various fuel management strategies and how to address public concerns about fuel management have been undertaken in North America (e.g. Shindler and Toman 2003; Winter et al. 2004; Brunson and Evans 2005; McCaffrey et al. 2008; Carroll and Bright 2010; McCaffrey et al. 2013; McCaffrey 2015). Many of these studies have focused on identifying existing levels of acceptance of fuel management and general perceptions about the use of fuel management strategies (e.g. Bell and Oliveras 2006; Blanchard and Ryan 2007), the types of people holding different views about fuel management (e.g. Manfredo et al. 1990; Bright and Manfredo 1997; McCaffrey et al. 2008), and the various factors influencing acceptability (e.g. Siegrist and Cvetkovich 2000; Winter et al. 2002; Brunson and Schindler 2004; Vogt et al. 2005; Blanchard and Ryan 2007; Lijeblad et al. 2009; McCaffrey et al. 2013).

These studies have generated important insights into differing views about fuel management and, to some extent, how these insights can be drawn on to improve communication about fuel management (reviewed subsequently in Chapters 4.7, 5.7 and 6.4). However, little is known about whether these findings are applicable to regions outside North America. Regions with different levels of exposure to, familiarity with, and media coverage of wildfires and fuel management activities may differ in their levels of social acceptance of different wildfire risk mitigation activities. Australia is likely to represent one extreme of exposure to and familiarity with wildfire: being one of the most wildfire-prone continents in the world, Australians generally have high awareness of wildfire risk and some acceptance of wildfire as a ‘typical’ part of life and the landscape (Bell and Oliveras 2006). With Intergovernmental Panel on Climate Change predictions of growing wildfire risk in many countries due to climate change (Hoegh-Guldberg et al. 2018), understanding acceptability of fuel management in a country where wildfire is already common may provide insight to likely shifts in acceptability that will occur in other countries in the future as they are exposed to wildfire at increasing frequency, or implement large scale fuel reduction strategies. Understanding similarities and differences between regions can further contribute to theories of acceptability of fuel management that have to date been largely developed in North America and based on studies in that region.

While some studies explore acceptability of more than one fuel management strategy (usually prescribed burning and mechanical thinning), few have explicitly compared the acceptability of different fuel management strategies to identify where, when and why one strategy is considered more acceptable than another. Exceptions include a small number of studies that have compared acceptability of different strategies to better understand when they are considered more or less acceptable, with a particular focus on understanding whether their use in different landscapes predicts acceptability (Winter et al. 2002; Brunson and Shindler 2004; McCaffrey et al. 2008; Paveglio et al.

2010). There is an increasing need for this type of understanding, particularly with growing calls to use a wide range of fuel reduction strategies to overcome the limitations of relying on a single method such as prescribed burning that cannot be implemented in all situations (Matthews et al. 2012; Ximenes et al. 2017).

Some studies have suggested that personally experiencing a major wildfire triggers heightened interest in reducing wildfire risk, including fuel management to reduce that risk (Gill 2008; Lapsley 2015; Brown 2017). However, it is also suggested by some wildfire managers that this interest reduces over time, ultimately resulting in lowered public support for fuel management. If length of time since experiencing wildfire does influence acceptability of fuel management, there are important implications for the long term nature of fuel management policy and program implementation. However, despite being proposed as a potential factor influencing support for fuel management, no empirical studies have examined whether support varies with time since personally experiencing a wildfire.

A small number of studies have begun to explore the way in which people think about fuel management, and how this is associated with their level of acceptance of fuel management. This constitutes an important shift as it focuses on how people think rather than what they think. One theory in this area is Integrative Complexity Theory. This theory examines how complexly people think about a topic and the extent to which they can integrate different arguments for and against a particular position, and has been found to predict the strength of attitudes about those topics in multiple studies of controversial issues (de Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000, Carroll and Bright 2009; Czaja et al. 2016).

There is a growing body of literature examining acceptability of fuel management, generating new insight into different aspects of acceptability. However, there are some important gaps in this literature. Most studies have been conducted in North America, with few comparing relative acceptability of different fuel management strategies, and few examining the level of social acceptance needed to sustain long term implementation of fuel management strategies. One of the more significant gaps identified when examining the findings of existing studies is a lack of studies that combine understanding of *what* people think about fuel management with *how* they think about it. While some studies argue that understanding complexity of thinking, or attitude formation processes more generally, can assist in design of communication (Schroder et al. 1967; Petty and Cacioppo 1984; Hunsberger et al. 1992; Bright and Barro 2000; Carroll and Bright 2009; Czaja et al. 2016), there is little literature exploring how to combine an understanding of what attitudes are held, at what levels, and how they are formed to assist in informing communication.

I initially identified that I wanted to examine both what people think about different fuel management strategies and how they think about them. However, the breadth and depth of possible theories, topics and fuel management strategies that could be examined within this overall scope was greater than can be examined in a doctoral thesis. Given this, the initial stage of my thesis involved literature review and qualitative exploration of views about fuel management in Australia using semi-structured interviews (described in detail in the methods, Chapter 2). The results were used to develop a specific set of thesis objectives and questions (Section 1.1), to make further decisions about the scope and nature of the research to be conducted, such as the fuel management strategies that would be compared (Section 1.2), and to select my theoretical approaches and the specific areas of literature that would be reviewed in-depth (Section 1.3). This approach to designing the thesis drew on the adaptive theory approach (Layder 1998). Adaptive theory argues that studies should evolve as information is gained through actions such as literature review, and qualitative and quantitative data collection, with theory iteratively developed and refined, and research evolving to explore the ideas that emerge from initial stages of the research.

1.1 Thesis objective and questions

The objective of this thesis is to understand the acceptability of fuel management strategies used to reduce wildfire risk to life and property in an Australian context, focussing on factors that influence acceptability of fuel management. Understanding this can assist wildfire managers in designing effective communication about, and implementation of, fuel management strategies. To achieve this objective, four research questions are asked:

1. How acceptable is the use of different fuel management strategies in Australia?
2. To what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?
3. How is acceptability influenced by the way people structure their thinking about fuel management?
4. What are the implications of better understanding acceptability for communication?

By examining these questions, this thesis contributes to the growing international literature through a focus on combining understanding of both what people think about fuel management and how people think about it, broadening the available knowledge on factors influencing acceptability of fuel management in different countries and climatic contexts. I begin to explore how combining understanding of both what and how people think can inform design of communication about fuel management, however, given the limitations of what can be examined in a doctoral study, the thesis focusses on initial recommendations about communication rather than testing specific communication strategies.

This thesis is a thesis by publication, with results of the research presented in the form of a technical report, two published journal papers, and two journal papers submitted and under review.

The remainder of this introductory chapter describes the key decisions made about what was included in the research, the theoretical approaches used, and outlines the structure of the thesis. The following chapters describe the methods used to collect and analyse data, presenting the results of this thesis in a series of papers. The concluding chapter synthesises the results of this thesis.

1.2 Key decisions and inclusions

During the course of my research various decision points shaped my ultimate research questions, theoretical approach and the focus of this thesis. Key decision points, limitations and opportunities are summarised in Table 1-1. The first key decision was to identify what aspects of fuel management would be examined. This involved making decisions about i) which types of fuel management strategy to examine, and ii) which factors influencing acceptability of fuel management identified in past studies I would focus on, shaping my theoretical approach. Semi-structured interviews were used (described in Chapter 2) to identify which aspects of acceptability of fuel management were most important to examine in an Australian context, in order to achieve my broader goal of identifying how understanding acceptability can better inform design of communication about fuel management practices. Interviews were conducted with two groups: i) wildfire managers and fuel management experts, and ii) members of the community. Wildfire managers and fuel management experts were asked to identify the key issues they experienced in their work managing fuel to reduce wildfire risk, and the types of insight that would be most useful to them to inform their work. Community members were asked how acceptable they found a range of fuel management strategies, and why. This helped better identify the topics of most importance, as well as which fuel management strategies to examine as part of the thesis.

Based on the interviews, a decision was made to focus on examining three fuel management strategies in this thesis - prescribed burning, mechanical thinning and livestock grazing:

- Prescribed burning involves the planned application of fire under specified environmental/weather conditions to meet particular management objectives, such as reducing fuel load (Nelson 1979; Esplin et al. 2003; Fernandes and Botelho 2003; Gill 2008; Penman et al. 2011; Coalition of Prescribed Fire Councils 2015).
- Mechanical thinning removes or alters the structure of trees or understorey to reduce the amount of combustible fuel. Thinned material is either left on-site (changing rather than reducing the fuel structure) or removed from the site (Stephens and Moghaddas 2005; Brooks et al. 2006; McCaffrey et al. 2008, Ximenes et al. 2017).
- Livestock grazing is the use of livestock to reduce edible fuel levels (predominantly grasses, herbs, forbs and shrubs), or change the structure of fine fuels (through trampling) (Davison 1996; Gill 2008, Launchbaugh et al. 2008; Davies et al. 2010).

These strategies were chosen as they are used in multiple landscapes and land tenures within Australia (in particular within the study region, discussed in more detail in Chapter 2), and were identified in interviews as being the subject of conflicting views about their effectiveness and the costs and benefits associated with them. They are described in more detail in Chapter 3.4.1. A fourth fuel management strategy initially considered (slashing/mowing) was excluded as it was not considered a controversial strategy by land managers and community members interviewed.

The interviews also informed my theoretical approach and the choice of factors potentially influencing acceptability that would be specifically focused on in the thesis, described in the next section.

Table 1-1 Key decisions, limitations and opportunities

Timing	Key decision, limitation or opportunity	Description
Early scoping phase, 2009	Key decision	After the initial literature review and discussions with supervisors, the decision was made to limit the scope of research to fuel management strategies used to reduce wildfire risk to life and property. Using fuel management strategies such as prescribed burning for ecological purposes was not included in the study as it was considered too large a topic, and there was a need to narrow the scope.
Scoping phase, 2009/2010	Limitation/ key decision	During the literature review and discussions with various people, including supervisors, investigating the theory that acceptability of fuel management is influenced by the *length of time* since experiencing a wildfire was considered important. However, limiting factors such as time constraints, funding constraints, and part-time study constraints limited the ability to investigate further, as it would require interviews and/or surveys in other parts of Australia. At this point in the research, it was decided that this theory would no longer be investigated.
Post interviews, 2010	Key decision	Four fuel management strategies were initially explored in qualitative interviews: prescribed burning, mechanical thinning, livestock grazing and slashing/mowing. During the interviews, informed experts acknowledged that slashing was a fuel management strategy, but in general had not experienced or heard of any public concern over its use. General public interviewees were generally unaware that slashing was also used as a fuel management strategy, and had only known it to be used for amenity. They also did not express any concerns over its use. In order to narrow the scope of the research once more, slashing was not explored further.
Post interviews, 2010 and literature review	Key decision	After the literature review and interviews, the following factors theorised to influence acceptability of fuel management were included in the quantitative surveys: the level of trust a person has; knowledge about fuel management; feelings of vulnerability to the risk of wildfires impacting a person's home; the location in which the fuel management takes place; beliefs about fuel management; previous experiences with wildfire; integrative complexity about fuel management; socio-demographic characteristics; and the importance placed on a person's own actions in reducing wildfire risk at home. The importance placed on reducing wildfire risk at home was not

Timing	Key decision, limitation or opportunity	Description
		something found in previous literature as a factor influencing acceptability of fuel management, however, it was mentioned in interviews of both informed experts and the general community and therefore included in the study.
Survey 2, 2016	Opportunity	In 2016 I was presented with the opportunity to include questions developed specifically for my research in the Regional Wellbeing Survey. This made it possible to once again consider whether the length of time since experiencing a wildfire is associated with acceptability of fuel management, because the Regional Wellbeing Survey uses an Australia wide sample that would allow comparison of people who had many different lengths of time since they last personally experienced wildfire. Questions were developed specifically for this study and included in the Australia wide survey.
Paper 4, 2018/ 2019	Opportunity	After using the quantitative methods of scoring integrative complexity in paper 3, some potential improvements to the scoring method were identified, presenting an opportunity to prepare a final paper exploring the integrative complexity scale.

1.3 Literature review and synthesis

The initial literature review identified many different aspects of acceptability of fuel management and theoretical approaches had been examined in existing studies. In particular, a large number of factors were identified in the literature as potentially influencing acceptability, and not all of these could be examined in depth as part of this thesis. The semi-structured interviews were used to assist in refining my theoretical approaches and which aspects of acceptability would be explored, with a focus on examining those which had specific relevance to this Australian context, and in informing design of communication about fuel management. This section summarises how the literature reviewed led to the selection of particular topics and theoretical approaches investigated in this thesis to address my research questions, and points to specific sections within this thesis where more detail can be found.

1.3.1 Social acceptability

The objective of this thesis is to better understand the social acceptability of fuel management in an Australia context. Social acceptability, simply put, is an aggregate of when individuals make judgements about a favourable condition after considering the perceived alternatives (Brunson 1996; Stankey and Schindler 2006). However, the formation of these judgements at an individual scale is not a simple process, and there is a large body of research examining attitude formation about a wide range of topics. Literature over the past two decades on attitude formation in a natural resource management context tends to focus on a belief, attitude and behaviour model. These types of models focus on the connection between both cognitive and affective beliefs, formation of attitudes and the resulting behaviours (such as the decision to support fuel management strategies), but at its core is mediated by personal values, societal norms and local contexts (Ajzen and Fishbein 1980; Stankey and Schindler 2006).

Cognitive beliefs are those resulting from mental processes that deal with logic, and forms a person's ideas, knowledge and perceived outcomes about a subject. Cognitive beliefs can be shaped through information processing, risk perception, and personal history or experiences. Affective beliefs on the other hand are influenced by emotions, feelings or mood, and include emotional and aesthetic influences, including fear and dislike. Cognitive and affective beliefs work in a synergistic fashion to form attitudes, in other words, they don't work in isolation (Eagly et al. 1994; Trafimow and Sheeran 1998; Brunson and Schindler 2004). Judgements formed based on cognitive and affective beliefs are therefore not set in stone. As new information presents itself, or local contexts change, judgements can also change (Stankey and Schindler 2006).

While there are many and varied processes that inform cognitive and affective beliefs and hence influence acceptability, my thesis draws on a few theories in particular. The remainder of this section draws on the literature reviewed and decisions made to narrow the scope of this study.

1.3.2 Factors theorised to predict acceptability of fuel management

In reviewing literature about acceptability of different land management practices, it was evident that there were too many different aspects of social acceptability to investigate in the scope of a traditional thesis. I narrowed my review to literature examining acceptability of wildfire management. In Chapters 3 and 4 I present literature review findings that focus on the factors found in previous studies to predict acceptability of fuel management more specifically. I theorised that the factors most commonly identified in previous studies to predict acceptability of fuel management might also predict acceptability in this Australian context, and became the focus of my theoretical approach to answering my research question "To what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?". These included:

- The level of trust a person has in those responsible for decision making, sometimes referred to as social trust (Siegrist and Cvetkovich 2000; Shindler and Toman 2003; Winter et al. 2004; Vogt et al. 2005; Borrie and Liljeblad 2006; Toman et al. 2006; Vaske et al. 2007; Lijeblad et al. 2009; Absher and Vaske 2011; Toman et al. 2011; McCaffrey et al. 2013; McCaffrey 2015)
- Knowledge about fuel management strategies (McCaffrey 2002; Blanchard 2003; Shindler et al. 2003; Shindler and Toman 2003; McCaffrey 2004; Absher and Vaske 2007; Blanchard and Ryan 2007; McCaffrey et al. 2013)
- Perceived outcomes of fuel management strategies (Vaske et al. 2007; McCaffrey et al. 2008; Vining and Merrick 2008)

- Previous experiences with wildfires and/or fuel management (Shindler et al. 2002; Blanchard and Ryan 2004; Brunson and Evans 2005; Stankey and Shindler 2006; Blanchard and Ryan 2007; Flint 2007; McCaffrey et al. 2013)
- Feelings of vulnerability to wildfire or perceptions of wildfire risk (Weible et al. 2005; Blanchard and Ryan 2007; McCaffrey et al. 2013)
- The location in which the fuel management operation takes place, particularly in relation to places of social, economic or environmental value (Winter et al. 2002; Brunson and Shindler 2004; Weisshaupt et al. 2005; Gunderson and Watson 2007; Gill 2008; Paveglio et al. 2010)
- Local values or context (Winter et al. 2002; Brunson and Shindler 2004; Gunderson and Watson 2007)
- Values and beliefs about wildfire management (Vaske et al. 2007; Czaja et al. 2016);
- Socio-demographic characteristics (Shindler and Toman 2003; Weible et al. 2005; McCaffrey et al. 2013).

When reviewing the literature, some factors were found to more consistently predict acceptability across multiple studies compared to others. In particular, the level of trust a person has in those making decision about fuel management and knowledge about fuel management (whether objectively measured or self-rated) were consistently found to predict acceptability across multiple studies, irrespective of the region or the type of fuel management being examined. In contrast, socio-demographic characteristics were not consistent predictors, often with different and sometimes contradictory findings regarding whether characteristics such as age, education or gender are associated with differing levels of acceptance of fuel management.

1.3.3 Issue attention

Initial qualitative interviews conducted for the study identified one theory that had not been extensively examined in past studies, and that was particularly relevant to identifying what and how much communication is needed about fuel management: whether the *length* of time since experiencing a wildfire is associated with acceptability of wildfire risk reduction strategies such as fuel management. This gap in better understanding acceptability of fuel management is particularly important as greater investment in communication may be needed by wildfire managers if time since experiencing wildfire leads to reduced acceptability.

Chapter 5 reviews the limited literature available about issue-attention on natural hazards more broadly, and finds there are varying and inconsistent conclusions. McCaffrey (2004b) argues that due to the relatively infrequent occurrences of natural hazards such as wildfires, experience does not provide a good source of information. Instead it is limited and biased, and can result in confusion or maladaptation when people rely on a single experience (Sims and Baumann 1983, McCaffrey 2004b). Winter and Fried (2000) found that experience with a wildfire left people feeling that the destructive nature of the event meant it is uncontrollable, regardless of any risk mitigation measures put in place (McCaffrey 2004b). Other communities that experience natural hazards more frequently have been found to feel the hazard becomes a part of normal life, and mitigation is no longer considered important (Tierney 1993, McCaffrey 2004b).

During the literature review on this topic Anthony Downs' (1972) issue-attention cycle model was explored in more detail. This model has been used to explain attention on other topics (McComas and Shanahan 1999; Petersen 2009; Daw et al. 2013), including issue-attention on wildfires in general (Whittaker and Mercer 2004), however, it has not been used to examine acceptability of fuel management used to reduce wildfire risk. While personal experiences of wildfires have been found to influence acceptability of fuel management (e.g. Blanchard and Ryan 2007; Flint 2007), the studies that identified this link did not examine how long ago the personal experience of wildfire occurred, or whether length of time since that experience modifies the relationship between personal experience of wildfire and acceptability of fuel management. Given the potential importance of this theory in (i) better understanding the different factors that predict acceptability of fuel management (my second research question), and (ii) in informing the nature and type of communication needed about fuel management at different times (my fourth research question), a specific investigation of time since personal experience of fire and acceptance of fuel management was conducted, reported in Chapter 5.

1.3.4 Integrative complexity theory

Having reviewed existing literature about *what* people think about fuel management and how understanding this may predict acceptability, the next part of the literature review focused on what is currently known about *how* people think, and whether understanding this can predict acceptability.

My review focused in particular on Integrative Complexity Theory (ICT), and also examined related information processing theories such as the Elaboration Likelihood Model (ELM) and Heuristic-Systematic Model (HSM). These theories represent a subset of the diverse literature examining the formation of attitudes, and how processes of attitude formation affect direction and extremity of attitude formation more specifically. While there is a wider body of theory related to attitude formation and associated behaviours, such as Theory of Reasoned Action (Vogt et al. 2005), I chose to focus on this particular group of related theories as it enabled me to draw on the limited work already undertaken in the area of fuel management and build on it. I also felt these theories had high relevance and applicability to communication, particularly because of their focus on information processing. For this reason, I chose to focus on ICT and related theory and contribute to increasing the relevance and use of this theory in the field of wildfire and fuel management, rather than attempt to also integrate additional theories on attitude formation into the thesis.

This part of the literature review is presented in Chapters 6 and 7. When reviewing existing studies, I found that integrative complexity consistently predicts the strength of attitudes about complex issues, with higher integrative complexity predicting more moderate attitudes, but does not typically predict the direction of those attitudes (positive or negative) (de Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000, Carroll and Bright 2009; Czaja et al. 2016). Literature examining ELM and HSM found that people who process information more systematically are more likely to have attitudes that are resilient to change (Chen et al. 1999; Chaiken 1980; Petty and Cacioppo 1984; Petty 1986; Eagly and Chaiken 1993). As systematic processing is, effectively, equivalent to higher integrative complexity, this suggests that those who think more complexly about wildfire may have attitudes that are more stable over time. However, evidence for this within ICT specifically is more limited.

The key gap identified in the literature review was that while ICT has been shown to predict more moderate attitudes, the communication implications of this have not been extensively examined. This reduces the ability of wildfire managers to draw on understanding ICT to inform communication about fuel management. Focussing on these theories addressed my third and fourth research questions. By exploring ELM and HSM, which have more specifically focused on how information is processed to design effective communication, and by identifying how they may relate to ICT, I identified a key question about what the goal of communication should be: to promote high levels of acceptance that are based on simpler understanding, and more subject to change, or more moderate attitudes that are more stable over time.

1.4 Thesis structure

This thesis has eight chapters. Chapter 1 (this chapter) establishes the context of this research thesis and outlines the structure of the thesis. Chapter 2 outlines the methods used to collect and analyse data.

Chapters 3 to 7 present the results of the thesis, in the form of a technical report and four journal papers, as well as much of the literature review and discussion of findings. The technical report, while limited to basic descriptive results, is included in this thesis because of the exploratory nature of this topic in Australia. Presenting these basic results provides an introduction into the research. This is followed by four papers published, or currently under review, in peer reviewed journals. Figure 1-1 outlines how the papers fit together to answer my research questions, and Box 1-1 describes the papers, their current status, co-authors, my contribution to the papers, and the chapters they are presented in.

The technical report (Chapter 3) and papers 1 and 2 (Chapters 4 and 5) focus on factors known or theorised to influence acceptability of fuel management strategies, exploring these factors in an Australian context. The technical report explores perceptions about and acceptability of three fuel management strategies: prescribed burning, livestock grazing and mechanical thinning. Data were collected using a quantitative survey distributed in and around the Australian Capital Territory in

2011. Paper 1 uses the same data set to examine whether factors found to influence acceptability of fuel management strategies in previous studies applied in this study, adding to the body of knowledge about the extent to which factors affecting acceptability apply globally versus being locally specific. Paper 2 examines in more depth a common theory that emerges in dialogue about acceptability of fuel management, and which is critical to decisions about how best to communicate about fuel management – that the length of time since people experience a wildfire is associated with their acceptability of fuel management. This paper explores whether length of time since experiencing a wildfire is associated with acceptability of prescribed burning, using data collected in the Australia-wide Regional Wellbeing Survey in 2016.

Paper 3 (Chapter 6) explores whether and how acceptability of fuel management strategies is related to the way people structure their thinking about fuel management, using Integrative Complexity Theory. This paper explores the integrative complexity of prescribed burning, livestock grazing and mechanical thinning, how integrative complexity (IC) is related to acceptability of these strategies, and the potential communication implications of understanding these interactions. The paper presents the results from the same survey used in the technical report and Paper 1, and uses the quantitative measure of scoring IC first proposed and demonstrated by Carroll and Bright in 2009. IC was traditionally explored using qualitative methods that do not enable examination of differences in IC across a population, and this quantitative scoring approach enabled application of IC to large samples of people, opening up new opportunities to draw on ICT in understanding social acceptability in the wider population – and new opportunities to draw on this knowledge to inform design of communication strategies. However, in the application of the quantitative measure, some limitations of the measure were identified. In paper 4 (Chapter 7), I propose and test a new approach to scoring IC designed to align more closely with key aspects of IC theory that underpin qualitative measures, and compare its results to that of the original quantitative measure used by Carroll and Bright (2009 & 2010).

The text presented in the technical report and papers presented in Chapters 3 to 7 is identical to that published, with the exception of minor formatting edits made for the integration into this thesis, including revising citation and referencing styles for consistency throughout the thesis.

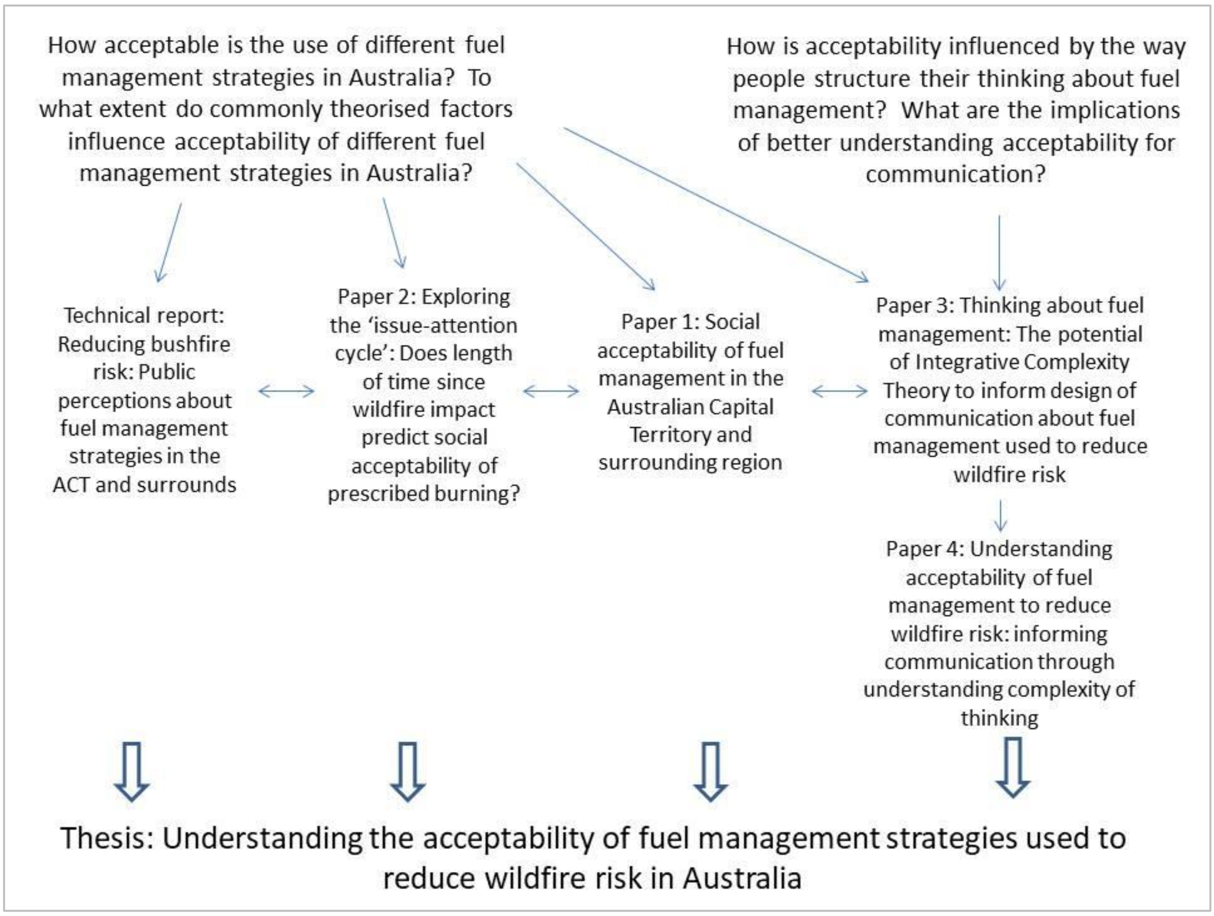

Figure 1-1: Overview of papers and reports

Box 1-1: Papers and reports presented in this thesis

Technical report (presented in Chapter 3): Mylek, M., and J. Schirmer. (Published 2012) Reducing bushfire risk: public perceptions about fuel management strategies in the ACT and surrounds. Technical report 221, Cooperative Research Centre for Forestry

My contribution is approx. 80%. I gathered the data and drafted the technical report, with Ass. Prof. Jacki Schirmer's guidance and review of the draft report.

Paper 1 (presented in Chapter 4): Mylek, M.R., and J. Schirmer. (Published 2016) Social acceptability of fuel management in the Australian Capital Territory and surrounding region. *International Journal of Wildland Fire* 25, 1093-1109

My contribution is approx. 80%. I gathered the data and drafted the paper, with Ass. Prof. Jacki Schirmer's guidance and review.

Paper 2 (presented in Chapter 5): Mylek, M.R., and J. Schirmer. (Published 2020) Exploring the 'issue-attention cycle': Does length of time since wildfire impact predict social acceptability of prescribed burning? *Environmental management* 65, 433-447.

My contribution is approx. 80%. The data was gathered via the Regional Wellbeing Survey (RWS), managed through University of Canberra. I am a core member of the team that collects the RWS data each year, and together with Ass. Prof. Jacki Schirmer we drafted the questions that are used in this paper. I drafted the paper, with Jacki's guidance and review.

Paper 3 (presented in Chapter 6): Mylek, M.R., and J. Schirmer. (Published 2019) Thinking about fuel management: The potential of Integrative Complexity Theory to inform design of communication about fuel management used to reduce wildfire risk. *Society and Natural Resources* 32(9), 983-1002.

My contribution is approx. 75%. I gathered the data and drafted the paper, with Ass. Prof. Jacki Schirmer's guidance and review. Following journal peer review, Jacki contributed to the overall restructure of the paper.

Paper 4 (presented in Chapter 7): Mylek, M.R., and J. Schirmer. (Published 2020) Understanding acceptability of fuel management to reduce wildfire risk: informing communication through understanding complexity of thinking. *Forest Policy and Economics* 113, 1-10.

My contribution is approx. 80%. I gathered the data and drafted the paper, with Ass. Prof. Jacki Schirmer's guidance and review.

2 Methods

Using an adaptive theory approach (Layder 1998), I used qualitative and quantitative methods to examine acceptability of fuel management strategies used to reduce wildfire risk in Australia. Research began with a period of in-depth literature review about the factors theorised to influence acceptability of fuel management, and how Integrative Complexity Theory can be used to explain acceptability and communicate about fuel management. The literature review together with several supervisory meetings shaped the initial research focus.

This was followed by qualitative interviews with a sample of informed experts and members of the public living in and around the Australian Capital Territory (ACT). The literature review, supervisory meetings and qualitative interviews provided the input needed to guide the overall study questions, as well as to design the quantitative data collection. Two quantitative surveys were distributed, one in and around the ACT, the other Australia wide.

This chapter outlines the methods used to undertake the qualitative interviews and quantitative surveys, and is presented in six parts, describing:

1. The study regions
2. Qualitative interview methods (data collection and analysis)
3. ACT survey methods (quantitative survey 1)
4. Australia-wide survey methods (quantitative survey 2)
5. Survey data analysis
6. Human ethics approval.

These methods are a broad summary of the steps taken in this study, with more detailed descriptions of specific aspects of the research and analyses presented in the results chapters. Where more detailed information is provided subsequently as part of specific papers, reference is made to the chapter where the detail can be found.

2.1 Study regions

Data analysed in this thesis were collected in two nested regions. First, data were collected in a case study of the Australian Capital Territory (ACT) and surrounding areas of New South Wales (NSW). This was followed by an opportunity to collect a set of Australia wide data, which included the ACT, NSW and all other states and territories of Australia.

2.1.1 Study region 1: ACT and surrounding areas of NSW

The study region where interviews and the first quantitative survey were conducted included the Australian Capital Territory (ACT) and surrounding areas of New South Wales (NSW), Australia (Figure 2-1). This region was selected for four reasons: (i) this region experienced a significant wildfire in 2003, (ii) it is covered by a single local address directory, (iii) it is a region commonly referred to as the ‘ACT region’ with the ACT at its centre and many people in surrounding areas of NSW working or accessing services in the ACT, and (iv) it was located in close proximity to the researcher, making it practicable for this study.

The region boundaries were based on the boundary set in the local telephone directory (Yellow and White Pages) for Canberra, Yass and Queanbeyan, as seen on page 1138 of the 2011/2012 edition. These boundaries were used because the sample frame was derived from the directory and was used to identify addresses for urban dwellers, peri-urban dwellers and some rural landholders (see Section 2.3.2 for further details). The region includes the Australian capital city of Canberra, nearby regional towns (Queanbeyan and Yass), peri-urban areas, small country townships, small rural properties used principally for residential purposes rather than for agricultural production (rural residential properties), productive farming properties, commercial forestry plantations (predominantly *Pinus radiata*), small conservations areas located within and around the urban centres and a large area of National Park (Namadgi National Park).

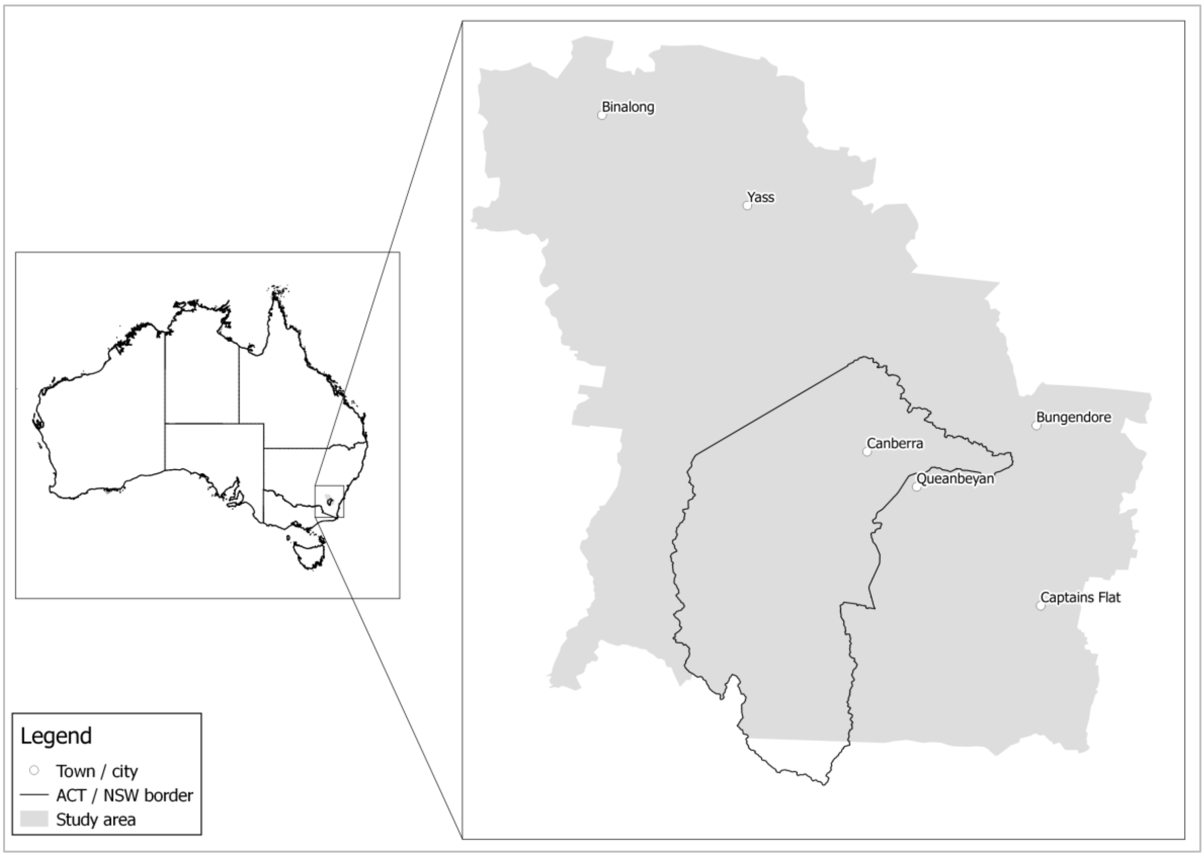

Figure 2-1: Study region 1 – Australian Capital Territory and surrounding New South Wales *(Source Mylek and Schirmer (2016) – Chapter 4)*

In January 2003, the southern and western parts of the study region experienced a very large wildfire that caused four deaths, the destruction of more than 500 homes with many more damaged, loss of infrastructure and severe damage to almost 70 per cent of the ACT's pasture, forests and nature parks. A total of 160,000 hectares burnt in the ACT, and a further 100,000 hectares in adjoining areas of NSW (McLeod 2003). The extent of the wildfire damage is shown in Figure 2-2. While the entire study region was not directly impacted by the 2003 wildfire (for example damage to or loss of assets, illness or loss of life), the region as a whole was exposed to the wildfires through smoke, embers and psychological impacts.

Multiple other wildfires have been experienced in and around the ACT both prior to and since 2003, usually of much smaller size and impact than the 2003 fire. For example, on 24 December 2001 a wildfire rapidly burnt into the city limits through the western side of the ACT, crossing one of the capital city's major roads (Tuggeranong Parkway) before stopping at Lake Burley Griffin. The wildfire destroyed 210 hectares of commercial *Pinus radiata* plantation and threatened suburban areas (ACT ESA 2019). More recently in early November 2018, a wildfire remained out of control for several days on public land to the southwest of Canberra, prompting the Emergency Services Authority of the ACT Government to directly contact residents whose homes were adjacent to nature reserve areas in the southwest suburbs of Canberra, advising them to prepare for the possibility of the wildfire entering suburbs.

The three fuel management strategies explored in this thesis are used in multiple landscapes and land tenures within the study area. Prescribed burning is the most commonly used of the three, and is used on private land, in farming areas, in National Parks, as well as on public lands and in conservation areas within the city of Canberra. ACT is one of the few regions in Australia that permits livestock grazing in conservation areas. When used, it is particularly applied in conservation areas located within the city of Canberra or on the outskirts of the city, where it is strategically used to achieve fuel reduction. It is not used in areas declared as National Park. Mechanical thinning for the purpose of managing fuel load is undertaken in commercial forestry plantations and public lands surrounding Canberra, within urban areas and in the conservation areas within Canberra, but not typically in the National Parks. While livestock grazing and mechanical thinning are used, their use is less commonly publicised in local media and they are typically used on smaller areas of land compared to prescribed burning. In other Australian jurisdictions, prescribed burning is also common, while the other two fuel reduction methods are not consistently used as a strategy for reducing fuel load, and usually restricted to relatively small use by some jurisdictions and not others.

The ACT and surrounding areas of NSW's exposure to past wildfire events, together with the inclusion of both urban and rural areas, the use of all three fuel management strategies throughout the region (including within urban areas), and its proximity to the researcher motivated choice of this study region for interviews and a survey.

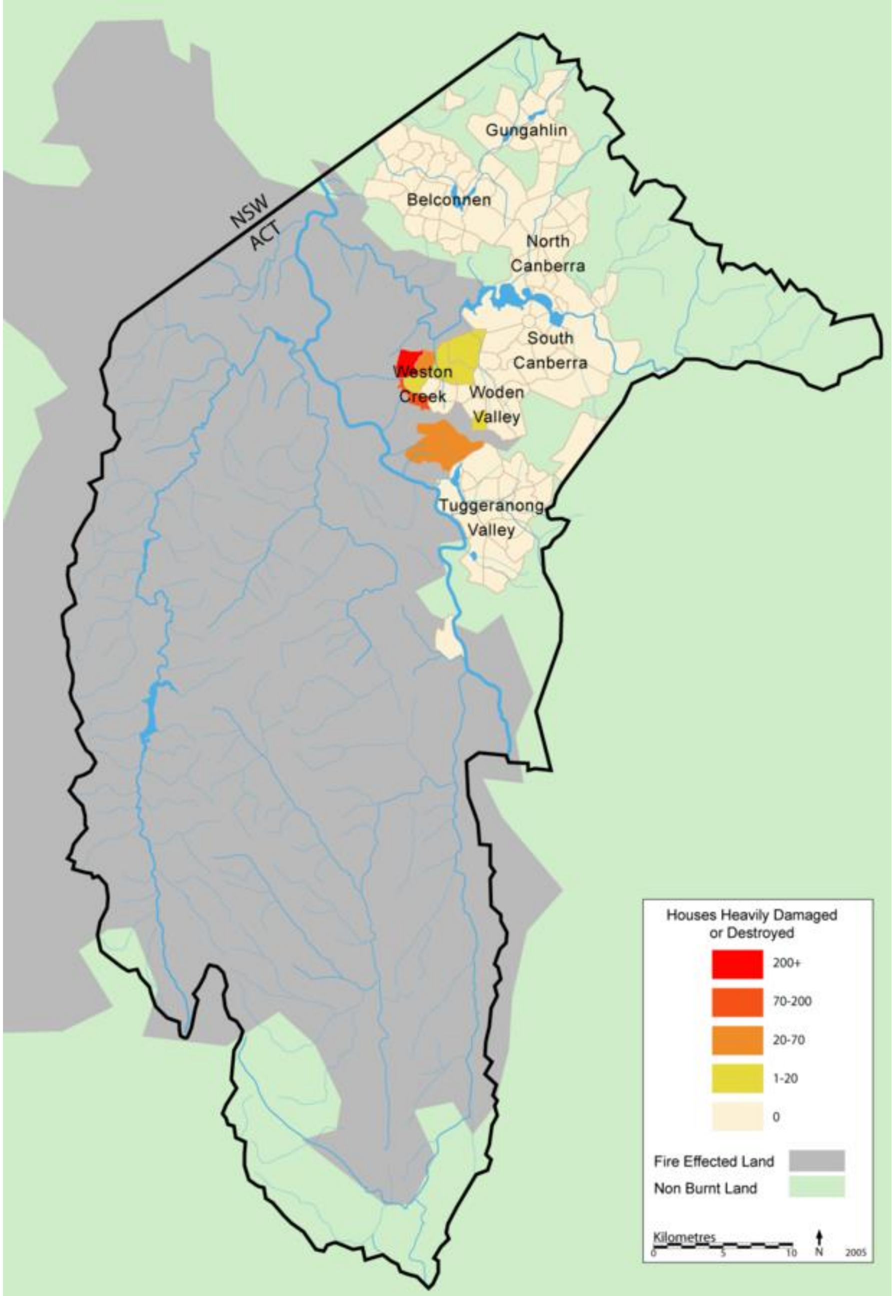

Figure 2-2 Extent of 2003 Canberra wildfires ***(Source: Wikipedia Commons 2006)***

2.1.2 Study region 2: Australia wide

In 2016 questions about wildfire experience and perceptions about prescribed burning were included in wave 4 of the Australia wide Regional Wellbeing Survey (described in more detail in section 2.4). These questions were designed to better understand whether the length of time since experiencing a wildfire is associated with acceptability of prescribed burning, exploring the issue-attention cycle. This question had been identified as one relevant to answering my research questions when the questions were first designed, however it was not possible to examine this question with sufficient robustness using the ACT case study region only. In the ACT region a large proportion of people had experienced fire in 2003 and thus had a very similar length of time since experiencing fire. It was only subsequent to this that an opportunity to ask questions of a sample of people likely to have much more variation in time since experiencing fire emerged, providing an opportunity to include exploration of this aspect of acceptability as part of this thesis.

The Regional Wellbeing Survey samples adult Australians nationwide, with oversampling of those living in rural and regional areas, and a smaller sample of those living in larger cities. This provided an opportunity to explore whether the length of time since experiencing a wildfire is associated with acceptability of fuel management. This topic could not be effectively examined in the study region of the ACT and surrounds, as many residents in this region have similar histories of wildfire experience, limiting variability in time since experiencing a wildfire. Collecting data in a nationwide survey provided sufficient diversity of experience of wildfire, and length of time since that experience, in the survey sample to be able to analyse whether this commonly theorised factor predicted acceptability of fuel management.

The data collected is analysed in the paper presented in Chapter 5.

2.2 Qualitative interviews

Qualitative interviews were undertaken early in the research to (i) further shape development of the overall study questions, particularly identifying which aspects of acceptability of fuel management would be focused on in the thesis, (ii) explore acceptability of fuel management strategies and gain an understanding of the main issues faced by wildfire scientists, land managers and policy makers, and the main concerns of the public, and (iii) inform the design of the quantitative postal surveys, through identifying appropriate content as well as understanding the phrases and terminology used by the public, drawing on these to structure the specific wording of the survey questions. This was a sequential mixed methods approach, where qualitative methods preceded quantitative. There was limited mixing of methods, and quantitative methods were dominant with the qualitative component principally supporting the quantitative component and assisting in interpretation of findings to a limited degree (Doyle et al. 2009).

Interview participants consisted of ten informed experts such as wildfire scientists, land managers and policy makers, and 14 members of the general public. Informed experts were interviewed to assist in identifying which issues were of highest priority for them in terms of what was most relevant to designing and implementing fuel management policy. They were also interviewed to provide insight into which of the factors associated with acceptability examined in past studies were observed in their interactions and application of fuel management practices. Community members were interviewed to add to the understanding of diversity of views, and to provide insight about typical language, phrasing and issues raised to inform design of the surveys. At the time of interviews, all interviewees resided or worked in the ACT, for practical reasons (proximity to the researcher for face-to-face interviews). Most interviewees had lived or worked elsewhere in Australia at some stage.

A purposive sampling strategy was used with the objective of recruiting participants representing the diversity of views likely to exist about fuel management (Judd et al. 1991; Emmel 2013; Palinkas et al. 2015; Moser and Korstjens 2018). The ten informed experts were selected based on their knowledge of wildfires and land management, fire management, the science behind wildfires, and fire policy. The group included scientists, land managers and policy makers. These are the groups who typically inform, design and implement fuel management strategies, and therefore are the most relevant people who can identify the key information needs about the extent and nature of acceptability of fuel management. Contact details were obtained through the public domain or via recommendations from experts in the field. The informed experts were contacted with information about the project, and an invitation to participate as an interviewee. An example email invitation is included in Appendix 1. Interviews with informed experts were conducted in July and August 2010.

The 14 community members interviewed were selected to ensure a diversity of views were represented. This sample was selected to specifically include men and women, people of differing ages, people residing in rural and urban areas, and people with varying professions and interests. Past studies suggested these characteristics are sometimes associated with differing views about fuel management, and deliberately seeking a sample with all these characteristics enabled identification of a wide diversity of views about and acceptability of fuel management and exploration of why. In addition, it helped to inform the design of the surveys, ensuring the language and speech styles of different groups were understood. Emails were initially sent to my friends, colleagues and family, who were asked to forward the invitation to others outside my social, work or family circle. Recipients were asked to initiate contact if they wished to participate in the study. They were then asked to provide details about themselves, specifically age, occupation, gender, interests, and area of residence. This information was used to ensure the inclusion of as wide a range of views as possible. The information also helped to ensure no main sector of the community was omitted from the study, so a range of interests and areas of residence were covered (Judd et al. 1991). No friends or family were interviewed, to avoid bias towards people holding similar views to me. Example email invitations are included in Appendix 2. Interviews with members of the general public were conducted during August and September 2010.

Interviews for both informed experts and community members continued until saturation was achieved, with common themes being repeated in the last interviews and no new themes emerging (Fusch and Ness 2015; Moser and Korstjens 2018). The sample of informed experts and community members interviewed is described in Table 2-1. The sample of community members was dominated by men, people living in urban or peri-urban areas, and people aged 45 or under. It is unknown whether the dominance of these groups was due to higher interest in the subject matter by these groups, or the types of people who were initially sent the emails by friends and family. However, to ensure these were not the only views, the sampling continued until at least one person representing different groups was interviewed, including people from all age groups, women as well as men, and rural residents.

Table 2-1 Purposive sampling selection elements ***(Source: Mylek and Schirmer, under review – Paper presented in Chapter 5)***

Selection element		**Number of interviewees**
Informed experts involved in wildfire management		
Scientists	Focussing on wildfire behaviour, ecology and management	4
Land managers	Wildfire managers & emergency wildfire responders	3
	Land manager	1
Policy	Forest and environment governance and policy	1
	Environment, health and safety regulation and governance	1
General public		
Gender	Female	4
	Male	10
Age	25 and under	2
	26-35	2
	36-45	5
	46-55	4
	Over 55	1
Location of residence	Urban	7
	Peri-urban[a]	5
	Rural area	2

[a] Interviewees resided in suburbs located on the outskirts of Canberra

Semi-structured interviews were used in the qualitative data collection. The aim was to gain an in-depth understanding of a specific topic - the issues and concerns faced by informed experts and community members in relation to fuel management strategies. For this reason, a broad and flexible method of questioning was needed (Korstjens and Moser 2017), that allowed in-depth discussion about some pre-determined issues and topics. Semi-structured interview questions were chosen to keep the interview focussed on my desired topic, but to allow for a deeper exploration of the issues and concerns presented (Jamshed 2014). An interview guide was used that specified the desired topics to cover, with the discussion of those topics left open. Follow up questions were asked to enable exploration of the responses initially given in response to each topic. Informed experts were asked to describe, in their own opinion, the most appropriate fuel management strategies needed to reduce the risk of wildfires. They were also asked what types of community reactions they had personally observed to each of four fuel management strategies (prescribed burning, livestock grazing, mechanical thinning and slashing/mowing – the last of which was not pursued further in my research, explained in Chapter 1.2, Table 1-1), and how understanding public perceptions about fuel management could assist in policy development and land management. The full interview guide is presented in Appendix 3, with the questions asked in the interviews of informed experts focusing on:

- In your opinion, what are the most appropriate fuel management strategies needed to reduce the risk of wildfires to life and property? And why?
- Have you heard about mechanical thinning?
- What community reactions have you observed with the different fuel management strategies?
- Would knowing more about perceptions and attitudes about fuel management improve policy development and land management?

Community members were asked about their experience with, knowledge of, interest in, understanding of and views about wildfires, wildfire management and fuel management. They were initially asked some questions about their experience with, knowledge of and interest in wildfires, wildfire management and fuel management in general, as well as where they had seen information about wildfires in the past. They were then asked more specifically about whether they had heard of using prescribed burning, livestock grazing, mechanical thinning, and slashing/mowing as fuel management strategies, if they'd seen or experienced each strategy, if they'd heard it called by any other names and if they thought that strategy should be undertaken more or less. They were then asked to list all the advantages and disadvantages they could about the strategy and what would make it more or less acceptable. Where interviewees were unsure if they knew what a particular fuel management strategy was or what the practice involved, descriptions were provided. Finally, interviewees were asked some basic questions about themselves, such as age, occupation and interests. The full interview guide is presented in Appendix 4, with the overarching questions asked in the interviews of community members being:

- Have you seen/experienced a major wildfire? How did it affect you?
- Is this a topic that you have thought about in the past? Discussed with friends/family/colleagues? Or are interested in?
- Where have you/do you see information about wildfires? i.e. what sources of information?
- Have you ever heard of [prescribed burning/mechanical thinning/livestock grazing/slashing], and how would you describe it if you have?
    - Have you ever heard [it] called by a different name?
- Have you ever seen/experienced [it]? Describe the circumstances.
    - Do you think we need to do more or less of [this]? and why?
    - What are the advantages and disadvantages (plusses and minuses) of [prescribed burning/mechanical thinning/livestock grazing/slashing]?
- What would make [it] more or less acceptable?
- Has experiencing a wildfire (if applicable) changed your feelings about fuel management?

All but two of the interviews were audio recorded. The two that were not recorded were undertaken in busy café environments where the recording would not be audible. In these two cases, detailed notes were taken. Descriptive codes were used to describe the cases (e.g. policy makers, scientists, land managers, men, women, people living on a rural property etc.) in order to understand whether themes identified across the discussions varied across different groups of people interviewed. Responses were analysed more interpretively into topics and themes using analytical (or pattern) coding (Miles and Huberman 1994, Richards 2005; Richards and Morse 2007). Topic codes helped to organise the data into areas of key interest to the overall research questions. The interviews were then coded to identify the key themes that emerged in interviews within each of the topic codes, for example in what ways experiencing a wildfire might (or might not) be associated with acceptability.

All interview participants had in some way experienced a wildfire in the past, with nine informed experts having direct involvement with wildfires (wildfire risk management, wildfire suppression or research), and 13 community members describing how their household had been affected by a wildfire in the past (such as loss of assets, being evacuated or being on standby for evacuation, extinguishing burning debris falling onto their property, or having a family member involved in fire suppression). Additionally, nine informed experts and 12 members of the public lived in or near Canberra during the 2003 Canberra wildfires.

As noted in Chapter 1.2, an objective of the interviews was to assist in guiding the overall study questions. Although views about slashing or mowing used as a fuel management strategy were explored in the interviews, it was later excluded from this study as it was considered the least controversial strategy by land managers and community members interviewed as part of this study. It was also often not associated with fuel management, but rather as a public amenity endeavour. Another objective of the interviews was to help design the quantitative survey. It was important in the survey to use simple language that was not ambiguous, vague, or directive towards a particular response (De Vaus 1985; Fowler 1995; Moser and Kalton 1971), and so the interviews were used to identify the technical language that was understood by the general public. For example, the terms ‘prescribed burning’ and ‘mechanical thinning’ were not identified as common terms used or understood by the general public interviewees, so the terms ‘controlled burning’ and ‘vegetation thinning’ were used in the survey instead.

2.3 Quantitative survey 1: ACT and surrounding areas of NSW

A quantitative postal survey was distributed in and around the ACT in October 2011 to explore perceptions about and acceptability of three fuel management strategies: prescribed burning, livestock grazing and mechanical thinning.

2.3.1 Survey design

A detailed literature review and the qualitative interviews described above were used to design survey questions that were relevant, clear and easy to interpret for the respondents (De Vaus 1985). Key findings of this review are presented in the results, Chapters 3 to 7. The survey was limited to 12 pages of questions, so not to deter respondents from answering all questions (Burchell and Marsh 1992; Dillman et al 2008; Fowler 1988).

The final survey consisted of a combination of yes/no questions, Likert scales, ‘tick the appropriate box’ questions and open-ended questions. The survey was pilot tested by twelve people, before a final revision was undertaken. The survey pilot testers were asked to provide feedback if questions appeared vague or complicated. A summary of the final survey questions is provided in

Table 2-2 and Appendix 5 provides the full survey showing the exact questions asked and response options. The survey was professionally printed in A4 size booklets and distributed in and around the ACT in October 2011.

Table 2-2 **Summary of questions included in quantitative survey 1**

Section	Description	Summary of questions included
1	Section one aimed to gain an understanding of where the respondent lived; their previous exposure to wildfires, including the 2003 Canberra wildfires; their perceptions about wildfire risks; and their level of knowledge about fuel management. This section also asked respondents to indicate the usefulness of information about fuel management delivered in a variety of ways.	Location of residence
		Whether respondent lived in a rural or urban area
		Length of time at current address
		Experience with the Canberra 2003 wildfire
		Experience with other wildfires
		Perceptions about vulnerability to wildfires at the current residence
		Perceptions about the importance of own actions around residences in reducing wildfire risk
		Self-rated knowledge about fuel management
		Past information seeking about fuel management
		Usefulness of different information delivery methods
2	Section two focused on how complexly people thought about fuel management. This section was designed to capture the elements of Integrative Complexity Theory, which was first used in a survey format by Carroll and Bright (2009 & 2010) and described in detail in Chapters 6 and 7. This section also asked respondents to indicate the level of trust they had in a variety of sources delivering information about fuel management.	List of arguments for and against prescribed burning, mechanical thinning and livestock grazing (measures differentiation)
		Strength of arguments made (measures integration)
		Level of trust placed in information about fuel management delivered by different sources
3	Section three asked respondents to indicate how acceptable they considered the three fuel management strategies to be in general, as well as in a variety of specific circumstances. This section also asked respondents to indicate how effective they considered the three methods to be, along with how risky/sensible, and how acceptable they considered it not to carry out any fuel management.	Acceptability of prescribed burning, mechanical thinning and livestock grazing in the following circumstances: in general; in conservation areas; in native forests; in farming areas; in plantations; and close to home
		Effectiveness of prescribed burning, mechanical thinning and livestock grazing
		Riskiness of undertaking prescribed burning, mechanical thinning and livestock grazing
		Acceptability of doing NO fuel management
4	Section four was designed to gain an understanding about the respondents themselves, including basic demographic questions, as well as interests and organised groups.	Gender
		Age
		Employment status
		Education level
		Previous residences/areas
		Income level
		Spare time activities
		Organised group membership

2.3.2 Survey sample

It was considered possible that there would be differences in acceptability between the different fuel management strategies depending on the location in which a person lives, in particular urban versus rural areas. To explore this further, the survey was sent to a stratified random sample of urban dwellers, peri-urban dwellers and rural landholders in study region 1. Canberra, Queanbeyan and Yass were considered urban centres. Properties were considered peri-urban if they were within approximately 500 metres to 1000 metres of the outskirts of an urban area, or within 300 metres to 500 metres of a nature reserve within the city. Properties within a rural township settlement were categorised separately, and properties in rural areas outside township settlements were considered rural properties.

The sample frame was derived from the 2011/2012 edition of the Canberra, Yass and Queanbeyan Yellow and White Pages (the region's telephone directory), with the region boundary depicted on page 1138 of the directory (see Figure 2-1 above in section 2.1.1). First, the urban and rural populations were stratified. The population of Canberra, Queanbeyan and Yass (considered urban) was estimated at approximately 378 800 residents according to the 2006 Census of Population and Housing (Australia's four yearly Census of Australian residents conducted by the Australian Bureau of Statistics), and was considered to be the urban sample frame (ABS 2008a). The remaining population from the Yellow and White Pages region (equivalent to the total Yellow and White Pages region population minus the 2006 Census population of Canberra, Yass and Queanbeyan) was assumed to be rural or small townships, and was estimated at approximately 30 800 residents, and considered to be the rural sample frame. Assuming a 50% response rate would be achieved, a total of 1250 residents were invited to participate, stratified into 650 urban/peri-urban and 600 rural landholders. This sample size would result in suitable capacity for statistical analysis of respondents based on estimates of statistical power for different questions using 95% confidence intervals.

The Canberra, Yass and Queanbeyan Yellow and White Pages 2011/2012 edition was used to identify addresses for urban dwellers, peri-urban dwellers and some rural landholders. Every fifth residential address from each column was recorded, up to the letter D. It then became apparent that this would result in too many addresses. From the letter D onwards, every fifth residential address from the second and fourth column of each page was recorded.

In addition to the White Pages, a real estate database called RP Data was used to gather rural property information, in order to identify which properties from the Canberra, Yass and Queanbeyan Yellow and White Pages were considered rural. The database provided landholder and property information for all landholders in the region; however, postal addresses were more than five years old. A service provided by Sensis (2011) was used to check address information for all landholders identified from the database. Only those addresses that were publicly available in the Yellow and

White Pages were included in the final sample, to ensure that only people with publicly available addresses were contacted for the survey.

These two methods of obtaining addresses resulted in more than the 650 urban and 600 rural addresses needed. A random sample was selected from each after classifying addresses as being urban or rural.

A total of 1250 surveys were posted in October 2011. After removing 140 invalid addresses (defined as instances in which the resident had shifted, died or was otherwise ineligible to complete the survey) there was a total valid sample of 1110, with 552 reaching urban addresses and 562 reaching rural addresses.

2.3.3 Survey distribution

At the time of the survey being distributed (2011), using a postal survey was chosen as the method of data collection for several reasons: (i) postal surveys were more cost- and time-effective than telephone or face-to-face interviews, (ii) postal surveys enabled a wider comparison of views by selecting participants across a range of geographic areas (including both urban and rural dwellers), (iii) online surveys at the time could not guarantee an adequate sample from a range of geographic areas, and (iv) online surveys at the time were not widely used, and in discussion with several people were more likely to be viewed as ‘spam mail’.

A modified version of the Tailored Design Method was used to recruit respondents (Dillman et al. 2014). First, the survey was sent together with an introductory letter, information sheet and a pre-paid return envelope. The surveys were coded in order to identify non-respondents. Two reminder cards were sent to non-respondents in week one and two following the initial mail out. A second copy of the survey was sent in week three, and a final reminder card was sent in week four. Each reminder card was coloured differently, with the week one reminder coloured blue, week two reminder yellow, and week four reminder orange. No further surveys were accepted after the end of the 10th week. A copy of the introductory letter, information sheet and reminder text can be found in Appendix 6.

2.3.4 Survey response

A total response rate of 44% was achieved (a 40% response rate from urban residences and 47% response rate from rural residences). No completed surveys were unusable.

2.3.5 Sample biases

Using the Yellow and White Pages as the basis for the random sample resulted in potential for sample bias towards those listed in the directory and those with landline telephones. The use of landline telephones is becoming less common, particularly among younger people and those with lower incomes (Dal Grande and Taylor 2010; ACMA 2012), and the proportion of people listed in the telephone directory is higher among older people (Dal Grande and Taylor 2010).

A separate non-response bias study was not conducted because the survey delivery strategy used multiple reminders to increase response rate and reduce non-response bias. The addition of a non-response bias study was considered likely to increase survey burden (Schirmer 2009). Instead, non-response bias was explored by comparing survey respondents to the 2011 Australian Census of Population and Housing (ABS 2013) benchmarks. A response bias was identified towards male, older, more educated, wealthier people, described in detail in Chapter 4. Using the telephone directory sample method likely provides one explanation for the bias towards older, and possibly wealthier people.

The main objective of the survey was to understand acceptability of fuel management between different types of people, not to make overall claims that were representative of the entire population, and therefore survey weighting was not used in the analyses (de Vaus 2002; Data analysis Australia 2012).

2.4 Quantitative survey 2: Australia-wide

I designed a small number of questions to be included in wave 4 of the Regional Wellbeing Survey (RWS). The data collected provided me with the opportunity to explore whether length of time since experiencing a wildfire was related to acceptability of fuel management. This required a larger-scale survey that went beyond the ACT case study region, as experiences of wildfire were too uniform amongst those living in the ACT region to robustly examine whether length of time since experiencing wildfire predicts how acceptable a person finds fuel management strategies. A detailed description of the sample and methods is provided in Chapter 5.

The RWS is a large omnibus survey measuring the wellbeing of Australian residents undertaken by the University of Canberra. In each wave of the survey, core questions are included related to the health and wellbeing of Australian residents and communities. In addition to these core questions, the survey offers opportunity to include project specific questions about farming, environmental issues and natural resource management. In 2016, questions about the acceptability of prescribed burning and mechanical thinning were included in the RWS, with responses to questions about prescribed burning and length of time since being impacted by a wildfire analysed for this thesis in Chapter 5.

I focussed on prescribed burning because it is widely used across Australia, whereas the other two fuel management strategies are not used in many regions of Australia. This meant prescribed burning could be more readily and meaningfully asked about in a nationwide survey in relation to length of time since fire. For a more detailed outline of the RWS methods used by the team at University of Canberra, see Chapter 5 and Schirmer et al. (2016).

2.4.1 Survey design

The design of questions included in the RWS was informed by the literature review, qualitative interviews and responses to the first survey conducted in the ACT and surrounding NSW. The questions focused on identifying acceptability of prescribed burning across Australia, and length of time since a person had been personally impacted by a wildfire. Survey questions were drafted with input from a broader group of researchers involved in the National Partnership for Mechanical Fuel Load Reduction Trials, who had an interest in understanding the acceptability of mechanical thinning compared to prescribed burning, examined in a project separate to this thesis.

Draft questions were first tested in focus groups, before making revisions and professionally formatting the survey. The questions were formally pilot tested by a sample of 77 people, and a final revision undertaken before the survey was launched. Table 2-3 summarises the questions used in this thesis, and the final survey questions related to this thesis are described in Chapter 5 and presented in Appendix 7.

Table 2-3 Summary of questions included in quantitative survey 2

Description	Summary of questions included
Acceptability	Acceptability of prescribed burning
Previous experience with wildfires	Extent of household impact by wildfires in the ten years previous to the survey
	The year of wildfire impact (if relevant)
Perceptions about wildfire risk and impacts	Perception about the level of wildfire risk near residence
	Concern about wildfire impacts on property of business
	Perceptions about fuel loads in the local region
Perceptions about prescribed burning	Perceptions about prescribed burning effects on vegetation
	Perceptions about prescribed burning impacts on animals
	Concern about prescribed burns escaping
	Health concerns due to smoke from prescribed burns
	Perceptions about ability to undertake prescribed burning
Socio-demographic characteristics	Gender
	Age
	Geographic location (State/Territory)
	Residential location (urban/rural)
	Geographic remoteness
	Farmer status

The survey could be completed online or on paper. The online survey was used as it provided a more cost effective method of collecting data than other survey platforms. However, as not all people prefer internet surveys, and in some parts of Australia internet connections are poor, a paper version of the survey was also offered. Participants could phone a free-call number to request a paper survey, and a number of farmers were directly posted a paper copy as they were known to live in areas with poor internet connection.

2.4.2 Survey sample

The RWS is open to all adult residents of Australia. While the focus is on rural and regional Australia, with the majority of survey participants residing outside of the capital cities, the survey is also open to residents living in the capital cities of Sydney, Melbourne, Brisbane, Adelaide, Perth and Canberra.

The RWS predominantly samples using a stratified random sampling method, with proportionally higher sampling in less populated areas compared to highly populated areas, of farmers compared to non-farmers, and of some specific communities that were the focus of specific questions on the survey. In 2016 these included:

- Three mechanical thinning trial sites, one in Victoria near Cann River, one in Western Australia near Collie, and one in NSW near Wauchope
- Victorian rural and regional areas
- Communities in Victoria, Tasmania, South Australia, Western Australia, Queensland and the South West Slopes of NSW with high numbers of jobs in the forest industry

Due to the size of the RWS, questions are typically split into different 'panels'. The 2016 RWS consisted of four 'panels', where a core set of questions were asked of everyone, and a subset of questions were asked of only those who completed a certain panel. The questions about acceptability of prescribed burning, as well as the socio-demographic characteristic questions, were asked in all four panels. A smaller group of survey participants were asked about their perceptions about the impacts of prescribed burning and experiences with wildfires. The specific sample able to be analysed is described in Section 2.4.4.

2.4.3 Survey recruitment

Survey participants were recruited using multiple methods:

- Flyers were used to invite participations to complete the survey, and were sent to (i) all post boxes in intensively sampled regions and (ii) randomly selected addresses in less intensively sampled regions. The publicly available mailing database 'Aus-On-Disc' was used to obtain postal addresses.
- Paper versions of the survey were also delivered directly to a random sample of farmers selected from the 'FarmBase' database.
- Additionally paper surveys were posted to previous paper survey participants of RWS where they had given permission to do so in the past.

In addition to random stratified sampling using the methods above, emails, social media, newsletter and traditional media were used to promote the survey, to support higher response rates from both previous participants and new participants being recruited into the survey. A prize draw was also offered to encourage participation, and used as a means of reducing salience bias towards those particularly interested in the topics included in the RWS (Groves et al. 2000; Groves et al. 2004). A prize pool of $9,000, comprised of 20 gift cards to differing values, was offered.

2.4.4 Survey responses

In 2016, a total of 13,302 participants took part in the RWS. A total of 10,395 participants were asked all questions analysed in Chapter 5 related to prescribed burning.

As explained in the Regional Wellbeing Reports (e.g. Schirmer et al. 2016), the RWS does not use traditional survey distribution methods, and therefore estimating a survey response rate is not possible. Johnson and Wislar (2012) argue that response rates give a relatively poor indication of the quality of survey responses, so instead survey representativeness was explored by comparing the characteristics of survey respondents to those of people living in rural and regional Australia using data from the 2016 Census of Population and Housing. In addition to the groups and regions that were deliberately over-sampled as part of the random stratified sampling there was also a bias towards older, and female respondents, a common issue observed in surveys (Moore and Tarnai 2002; Cheung et al 2017).

After removing ‘don’t know’ responses and using listwise deletion of missing data (discussed in more detail in Chapter 5), a final valid sample of 4390 was used in analysis. Chapter 5 discusses in detail how potential bias resulting both from the known biases in the sampling and bias in missing data was addressed by controlling for these biases as part of the analysis, through including key bias variables such as gender and age as potential confounding variables.

2.5 Quantitative data analysis

Data cleaning and coding of open-ended questions included in the first survey was undertaken prior to analysis (the second survey did not include open-ended questions). Coding of open-ended questions was initially very detailed, followed by further grouping to allow for data analysis and illustrating results. The data were initially explored using univariate analyses using both the Statistical Package for Social Science (SPSS) and Microsoft Excel.

The first survey was specifically designed to examine acceptability across the three fuel management strategies and to calculate integrative complexity (with results presented in Chapters 3, 4, 6 and 7). The second survey was used more specifically to identify whether the length of time since experiencing a wildfire predicted acceptability of fuel management, when other theorised predictor variables were taken into account. It was also used to explore whether the associations identified in the ACT specific case study were also found nationwide (with results presented in Chapter 5).

Specific data analysis techniques are described in detail in Chapters 3 to 7. The data analysis techniques included:

- Exploratory Factor Analysis (EFA) to develop scales of acceptability of the three fuel management strategies, described in detail in Chapter 4
- Calculation of IC for the three fuel management strategies using Carroll and Bright's (2009 & 2010) quantitative measure, described in detail in Chapter 6 and 7
- A modified method of calculating IC, developed for this thesis, described in detail in Chapter 7
- Univariate and bivariate analyses examining associations between acceptability, IC and a range of predictor factors, described in Chapters 3 to 7
- Multiple regression analysis to identify which of the range of theorised predictor factors explained the greatest amount of variance in acceptability of the fuel management strategies, detailed in Chapters 4, 5 and 6

2.6 Human ethics approval

Ethics approval was sought so as not to harm any participants (Fontana and Frey 2000), with particular consideration given to ensuring sensitivity to those who may have experienced trauma during wildfires in the past. This was an explicit consideration in survey design.

Ethical approval was gained from the Australian National University Human Research Ethics Committee (Protocol number 2010/060) before commencing the interviews (approved June 2010) and the first survey of residents of the ACT and surrounding NSW (approved October 2011). Ethical approval was gained from the University of Canberra for the 2016 Regional Wellbeing Survey (Protocol number 12-186, approved annually since 2012).

3 Reducing bushfire risk: public perceptions about fuel management strategies in the ACT and surrounds

3.1 Foreword

This chapter presents a descriptive overview of the results of survey 1, which was distributed in and around the Australian Capital Territory (ACT). It identifies the key perceptions held by survey respondents about prescribed burning, mechanical thinning and livestock grazing, and the level of acceptability of these practices in and around the ACT. This chapter begins to address my first research question: *How acceptable is the use of different fuel management strategies in Australia*?

While not a journal article, this technical report is useful in setting the scene for this research, given the exploratory nature of investigating social acceptability of fuel management in an Australian context. The report presents the distributions of responses to survey questions, and describes the survey respondents in more detail than journal papers allow. Many of the descriptive results presented in this chapter were not included in the subsequent journal papers, and hence including them provides a more comprehensive understanding of the data collected and findings.

The survey used the terms ‘bushfire’, ‘controlled burning’, and ‘vegetation thinning’, as they were better understood by the Australian public than the international or more academic equivalents of these terms. In this report, the terms ‘bushfire’ and ‘vegetation thinning’ are used, and while the term ‘prescribed burning’ is used throughout the report, ‘controlled burning’ is used when presenting direct responses to survey questions that used this term.

The report was primarily written by me, with input and review by my co-author Associate Professor Jacki Schirmer. With the exception of minor formatting edits, the text presented in this chapter is identical to that published in 2012 by the Cooperative Research Centre for Forestry, Tasmania:

Mylek M, and J. Schirmer. 2012. Reducing bushfire risk: public perceptions about fuel management strategies in the ACT and surrounds. Technical report 221, Cooperative Research Centre for Forestry, Tasmania.

3.2 Acknowledgments

We acknowledge the time and effort provided by those who participated in interviews and surveys for this project, and thank them for their time and contributions. This research was funded by the Cooperative Research Centre for Forestry, Hobart.

3.3 Executive Summary

Bushfire management is an emotive and controversial issue in Australia, generating sustained conflict over both preparatory strategies and bushfire response. This study explored public perceptions about this complex issue, with the aim of gaining a better understanding of how people view fuel management. A postal survey was conducted in the Australian Capital Territory (ACT) and the surrounding region of New South Wales (NSW), seeking views on three fuel management strategies used specifically to reduce bushfire risk to life and property: prescribed burning, livestock grazing and vegetation thinning.

The survey was sent to a random selection of households in both urban and rural areas of the ACT and surrounding region of NSW. A total of 1250 surveys were posted, with 140 later removed from the sample as invalid (for example, an incorrect address). In total, a 44.2% response rate was achieved from 1110 valid surveys.

The survey asked respondents to list their own arguments for and against each of the fuel management strategies, with the results illustrating a range of levels of understanding about the issues surrounding fuel management, in and around the ACT. There is some public recognition of the key arguments discussed in relevant literature, both for and against the three fuel management strategies. However, not all arguments are necessarily supported by scientific findings. The most common argument for all three strategies was the resulting fuel/hazard/risk reduction.

The results of the survey indicate overall strong support for fuel management strategies, with a large majority of respondents describing fuel management as an essential and acceptable activity and 87% of respondents saying it was ‘highly unacceptable’ not to undertake any fuel management. Only a small proportion of respondents found one or more of the fuel management strategies unacceptable (8.3% for prescribed burning, 6.8% for livestock grazing and 7.5% for vegetation thinning).

This technical report is the first report from this study, and identifies the key perceptions held by survey respondents towards fuel management. It forms part of a PhD project that will further analyse these data, to identify whether different types of survey respondents had different perceptions, and the level of understanding about the complex nature of fuel management. The project draws on Integrative Complexity Theory (ICT) to inform the analysis.

3.4 Introduction

The complex and controversial nature of bushfire management in Australia has generated a sustained public debate about the merits of both preparatory strategies and bushfire response. The argument is strongest in southern Australia, where bushfires have had the most devastating impact, the results of which are graphically presented by the media (Gill 2008). Public controversy has led to debates about whether fuel management should be undertaken at all and how much should be carried out. There are two main arguments commonly used for and against the practice of reducing bushfire risk through fuel management: that fuel management will increase the controllability of bushfires and, therefore, protection of life and assets, and that no amount of fuel management will assist in controlling a severe bushfire, because fire behaviour is affected less by fuel than by other factors such as temperature and wind strength. Another argument about fuel management, and prescribed burning in particular, focuses on ecological principals rather than risk mitigation, namely how much or how often areas should or should not be burned to enhance or protect an ecological asset. The media debate often focuses on the negative impacts of these arguments but, with few studies conducted into public perceptions about fuel management in Australia, little is known about how the public actually feels about the issue.

Fuel management strategies cannot be successfully implemented without public backing, and practices that do not have public backing are unlikely to be widely implemented, regardless of their effectiveness in reducing fuels and bushfire risk (Shindler et al. 2002; Brunson and Evans 2005; Toman et al. 2011). Adverse public attitudes towards fuel management can postpone, change, or even prevent the implementation of any management strategy, regardless of the underlying science, risk analysis or cost-benefit relationship (Shindler et al. 2002). It is important that managers recognise the importance of public perceptions and attitudes, and understand the social acceptability of their fuel management strategies within multiple spatial, temporal and social contexts (Arno and Brown 1989; Brunson and Shindler 2004; Brunson et al. 2006). They also need to understand how people interpret and respond to changes in landscape settings, policy decisions and land management organisations (Shindler et al. 2002).

Social acceptability has been defined by Brunson (1996) as “a condition that results from a judgemental process by which individuals (1) incorporate the perceived reality with its known alternatives; and (2) decide whether the ‘real’ condition is superior, or sufficiently similar, to the most favourable alternative condition”. Therefore, understanding social acceptability first requires an explanation of perceptions and attitudes. Understanding perceptions about fuel management can help decision makers and land managers develop appropriate strategies and policies that address the needs and priorities of the community. It can also help decision makers and land managers recognise when existing policies might be supported by the public, help alert them when proposed or existing policies are likely to run into opposition, and help them develop information campaigns designed to increase public understanding about potential and existing controversial strategies.

While there have been various social studies in Australia on issues such as perceptions about bushfires, community preparedness, communication, the social construct of fuels, and community resilience; there is little published information or detailed understanding of public perceptions about fuel management strategies, in particular. The primary exception was a study undertaken by Bell and Oliveras (2006). This research examined prescribed burning in the Wombat State Forest in Victoria, via a short questionnaire that looked at how members of the public used the forest, their level of knowledge about bushfires and prescribed burning in the area and in wider Victoria, and their perceptions of the appearance, effectiveness of protection and accessibility to the forest after burning. This study identified the need for more extensive research on community perceptions in Australia.

A more substantial body of work has been conducted in North America, where public perceptions and attitudes about various land management activities used to reduce bushfire risk have been examined (Manfredo et al. 1990; Shindler et al. 2002; Winder et al. 2002 & 2004; Shindler and Toman 2003; Brunson and Shindler 2004; Brunson and Evans 2005; Toman and Shindler 2006; Carroll et al. 2007, Lijeblad et al. 2009; Carroll and Bright 2010). The research highlights that public perceptions are not simple to understand; multiple factors influence the way a person feels about fuel management strategies. For example, Whittaker and Mercer (2004) argue that public debate about fuel management and its role in reducing bushfire risk is partly a result of the varying levels of risk different people are willing to accept, but also stems from different perceptions about the likely success of different approaches to fire management. Carroll et al. (2007) suggest that the issues and dilemmas associated with fire management in the US can be collapsed into three major categories: public trust in government and land management agencies, tolerance for any given strategy when it is actually carried out on the ground, and policy uncertainty.

This research project aims to address the gap in knowledge surrounding public perceptions about fuel management strategies used specifically to reduce bushfire risk to life and property in Australia. It examines three strategies: prescribed burning, livestock grazing and vegetation thinning (the rationale for selecting these three strategies is discussed in the following section ‘Fuel management strategies’). In order to fully appreciate public perceptions, an understanding is needed of the proportions of the public that view fuel management in a particular way as well as when and under what circumstances fuel management strategies are considered appropriate, in order to better understand the factors that lead to the development of particular types of views about fuel management.

This technical report is the first report from this study, and identifies the key perceptions of fuel management held by survey respondents living in the ACT and the surrounding region of NSW. It forms part of a PhD project that will further analyse these data, to identify whether different types of survey respondents had different perceptions, and their level of understanding of the complex nature of fuel management. The project draws on Integrative Complexity Theory (ICT) to inform the analysis.

The following section provides a more detailed description about the three fuel management strategies examined in this study, before providing an explanation of the study methodologies and a discussion about the results.

3.4.1 Fuel management strategies

The three fuel management strategies examined in this study (prescribed burning, livestock grazing and vegetation thinning) have been identified in literature as highly controversial, and among the most difficult bushfire management issues confronting land managers, in terms of public understanding. The arguments both for and against these strategies are strongly debated by some members of the public. A fourth strategy—slashing (or mowing) —was also identified, but was not included in this study as it was generally considered the least controversial strategy by land managers and members of the public interviewed as part of this study.

There are common arguments both for and against the use of prescribed burning, livestock grazing and vegetation thinning as techniques to manage fuels, and these arguments are often the focus of media attention and scrutiny. A brief description of each of the fuel management strategies is provided here, and includes common arguments found in the literature for and against the use of each strategy.

3.4.1.1 Prescribed burning

Prescribed burning is the planned application of fire under specified environmental conditions, weather conditions and area, to meet particular management objectives (Nelson 1979; Fernandes and Botelho 2003; Bushfire CRC and AFAC 2006; IFA 2006). Common management objectives of prescribed burning include fuel reduction to reduce the risk of unplanned fire events, back-burning during suppression efforts of unplanned fires, for silvicultural or forest management purposes, and for ecological maintenance (Nelson 1979; Arno and Brown 1989; Esplin et al. 2003; Fernandes and Botelho 2003; Bushfire CRC and AFAC 2006; IFA 2006; Gill 2008). Australian fire and land management agencies have identified prescribed burning as one of the most important issues confronting them, both in a technical and scientific sense, and in terms of community perception and understanding of bushfire control and management (Bushfire CRC and AFAC 2006).

Prescribed burning reduces fuel load and continuity in a cost-effective way, by treating a range of different fuels (grasses, bark, leaves and heavier timber) over a large area. It can be argued that the potential fire intensity is, therefore, reduced and that this, in turn, increases the chances of controlling a bushfire, while decreasing the chances of the loss of human life and economic assets (Gill 2008). The final report from the 2009 Victorian Bushfire Royal Commission states that "Properly carried out, prescribed burning reduces the spread and severity of bushfire. It makes a valuable contribution to reducing the risks to communities and firefighters by complementing effective suppression and is one of the essential protective strategies associated with making it safer for people to live and work in bushfire-prone areas in the state” (Victorian Bushfire Royal Commission final report 2010).The role of prescribed burning in reducing fuels and, subsequently, bushfire risk is often highlighted after a major bushfire has impacted on life, health and assets (e.g. after the Victorian Black Saturday fires of February 2009).

Some common arguments against prescribed burning include its effect on wildlife and wildlife habitat and on plant ecosystems when implemented in the wrong areas, at the wrong time, at the incorrect frequency (i.e. too often/not often enough); the effect of carbon emissions on climate change; the impact of smoke on health and visibility, as well as the resulting ash/dust and smell; the impact on water quality; and, perhaps most concerning, the risk of the prescribed fire escaping (Manfredo et al. 1990; Winter et al. 2002; Gill 2008).

3.4.1.2 Grazing

Livestock grazing refers to the use of livestock to reduce edible fuel levels. Livestock predominantly eat such fuels as grasses, herbs, forbs and some shrubbery, thereby reducing the volume and height of these fine fuels. Livestock grazing can reduce fine fuels and have benefits for fire suppression and control without the need for ‘risky’ prescribed burning. Livestock grazing is also promoted as it can be used to assist drought-affected local pastoralists; because it has a cultural legacy in some areas; and because, by reducing the amount of grass, it may have benefits for some indigenous plants (Gill 2008).

However, grazing livestock in nature reserves for any purpose, including fuel reduction, has been a controversial issue in Australia for a long time (Department of Sustainability and Environment 2005; Gill 2008). Grazing can affect native pastures, soil erodibility, soil productivity, vegetation cover, the state of ecosystems and the spread of weeds. These effects have seen the phasing out of grazing in reserves and national parks across much of Australia. For example, grazing in the mountainous regions of southeast Australia has been controversial for at least 60 years. Grazing was banned in the Kosciuszko National Park from 1943 (Gill 2008), and ceased in the Alpine National Park in the Victorian high country in 2005 (Department of Sustainability and Environment 2005).

Some studies have also found that grazing does not substantially reduce the amount of fuel in the area. Cattle selectively eat grasses in open areas, and do not eat other flammable materials, so only the least flammable type of fuel is reduced. The available evidence, based on long-term ecological research and the behaviour and impacts of the widespread 2003 Canberra fires, suggests that grazing does not reduce the incidence and intensity of wildfires in the alpine regions (CSIRO 2008).

3.4.1.3 Vegetation thinning

Vegetation thinning involves ‘thinning out’ forest trees and understorey shrubs by removing a proportion of stems in a given area, in order to reduce the amount of combustible fuels in a landscape. The thinned material is either left on-site (changing the structure of the fuel rather than reducing it) or removed off-site. In some circumstances, thinned material can be sold as timber, woodchips, mulch or firewood.

Thinning is promoted by advocates as a means of reducing fuels in a landscape, or changing the arrangement of fuels, which in turn reduces fire intensity and changes fire behaviour (for example, removing ladder fuels such as bark, shrubs or low branches that can transfer ground fires into crown fires). By reducing the fuel loads (if the fuel is taken off-site or burned) or changing the structure and, therefore, the behaviour of bushfires it is argued that fire intensity is reduced and, therefore, controllability is increased (Brooks et al. 2006; NAFI 2010; Victorian Bushfire Royal Commission 2010). Vegetation thinning can be targeted at specific areas or specific types of fuels, with some fuels attracting a commercial benefit if sold (Stephens and Moghaddas 2005; McCaffrey et al. 2008).

Common arguments against vegetation thinning include visual and environmental effects, including habitat loss, as well as the effect on plant communities, water quality and soil. In North America, where vegetation thinning is a commonly used fuel management method, concerns are often raised when thinned material has a commercial value, with the public questioning the decision and reasoning behind thinning for ‘fuel reduction’, as well as what should be removed from the forest and in what proportion (Winter et al. 2002; Nakamura 2004).

3.5 Methodology

The main data collection method for this study was a quantitative postal survey. In order to guide the study and effectively design a comprehensive and realistic survey, an extensive literature review was undertaken and interviews were conducted with a sample of informed experts and a representative sample of members of the public from the study region.

3.5.1 Qualitative interviews

Qualitative interviews were undertaken to help guide the study as well as guide the design of the quantitative postal survey. The interviews identified the main issues faced by bushfire scientists, land managers and policy makers, and highlighted the main concerns of the public. The interviews also helped identify the phrases and terminology used by the public to inform the specific wording of the survey questions.

The interview stage of this project used a purposive sampling strategy where interview participants were selected based on information gathered about them, rather than using a random sample. This sampling strategy was used in order to reduce costs, and because it allows the selection of different participants that adequately reflect the goals of the research and the study population (Judd et al. 1991).

Interview participants consisted of:

- Informed experts such as bushfire scientists, land managers and policy makers; and
- Members of the general public, of different ages, gender and occupations.

A total of 10 informed experts were selected for interview, based on their knowledge of bushfires and land management, fire management, the science behind bushfires, and fire policy. The group included scientists, land managers and policy makers. Contact details were obtained through the public domain or via recommendations from other experts in the field. These experts were then contacted with information about the project, and an invitation to participate as an interviewee. The informed experts were asked to describe, in their own opinion, the most appropriate fuel management strategies needed to reduce the risk of bushfires. They were also questioned about any community reactions they had personally observed to each of the strategies, and how understanding public perceptions about fuel management could assist in policy development and land management.

A total of 14 community members were interviewed. They were also specifically selected, but with a different recruitment method. Emails were initially sent to the researcher's friends, colleagues and family, who were asked to forward the information about the project to people they knew. People were asked to initiate contact if they were interested in participating in the study as an interviewee. Interested people were then asked to provide some details about themselves, such as age, occupation, gender, interests, and areas of residence. This information was used to ensure the inclusion in the study of a range of different people, typical of the population in the study area (using basic 2010 ABS statistics such as gender, age and background). The information also helped to ensure no main sector of the community was omitted from the study, so a range of interests and areas of residence were covered (Judd et al. 1991). No friends or family of the researcher were interviewed as part of this study, in order to avoid bias towards people holding similar views to the researcher.

Community members were initially asked some questions about their experiences with, knowledge of and interest in bushfires, bushfire management and fuel management in general, as well as where they'd seen information about bushfires in the past. They were then asked more specifically about whether they had heard of using prescribed burning, livestock grazing, vegetation thinning, and slashing/mowing as fuel management strategies. The interviewees were asked if they'd ever seen or experienced each strategy, if they'd heard it called by any other names and if they thought that strategy should be undertaken more or less. They were then asked to list all the advantages and disadvantages they could about the strategy and what would make it more or less acceptable. Where interviewees were not sure if they had heard of a strategy before, descriptions were provided. Finally, interviewees were asked some basic questions about themselves, such as age, occupation and interests.

Interviews were recorded and basic coding analysis was undertaken to identify core issues and themes, as well as to identify the phrases and terminology used by the public in the region. This information was used to inform the specific wording of the survey questions.

Both the interview and survey stage (described below) of this project required ethical clearance from the Australian National University Human Research Ethics Committee before commencing. Ethics approval was sought so as not to harm any participants (Fontana and Frey 2000), and involves the consideration of the moral implication of social science inquiry, including consent, privacy and protection from harm (Minichiello et al. 1995; Patel et al. 2003).

3.5.2 Quantitative postal survey

The quantitative survey had three purposes:

1. to identify the different perceptions and attitudes towards fuel management (the results of which are discussed in this report)
2. to explore whether different types of people have different perceptions and attitudes towards fuel management (relationship analysis)
3. to examine the complexity of thinking in relation to fuel management and whether this affects people's perceptions about the practice. The social theory known as the Integrative Complexity Theory (ICT) was used as the basis of this complexity analysis (subsequent publications will explore this theory in more detail; it is not described in detail in this report).

Quantitative methods require respondents to supply data that have been pre-ordered by the researcher, with the emphasis on measurement and analysis of relationships between variables, not processes (Minichiello et al. 1995; Denzin and Lincoln 2000). Therefore, it is important to ensure the careful design of survey questions to make them relevant, clear and easy to interpret for the respondents. It is critical to think ahead and anticipate what information will be needed to ensure all relevant questions are included in the survey (De Vaus 1985). In this study, this was addressed by using the literature review and qualitative interviews to inform the design of the survey.

The wording of the survey was very specific, as it was important to use simple language that was not ambiguous, vague, or directive towards a particular response. The interviews were used to identify the technical language that was understood by the general public. For example, the term 'prescribed burning' was not identified as a common term used or understood by the general public interviewees, so the term 'controlled burning' was used in the survey instead. It was also important to consider whether the questions should be personalised, whether they could be embarrassing, or if they relied on memory (Moser and Kalton 1971; De Vaus 1985; Fowler 1995). The length of a survey was also important, as a long survey form can deter respondents from answering all questions (Fowler 1988; Burchell and Marsh 1992; Dillman et al. 2008). This survey was limited to 12 pages of questions.

The final survey consisted of a combination of yes/no questions, Likert scales, 'tick the appropriate box' questions and open-ended questions (the final survey can be found in Appendix 5). The survey was comprised of four sections:

1. Section one aimed to gain an understanding of where the respondent lived; their previous exposure to bushfires, including the 2003 Canberra bushfires; their perceptions about bushfire risks; and their level of knowledge about fuel management. This section also asked respondents to indicate the usefulness of information about fuel management delivered in a variety of ways.

2. Section two focused on how complexly people thought about fuel management, and asked respondents to list their own arguments for and against each of the three strategies (prescribed burning, livestock grazing and vegetation thinning). The respondents were also asked to indicate how strongly they felt about each of their arguments. This section was designed to capture the elements of Integrative Complexity Theory, which was first used in a survey format by Carroll and Bright (2009 & 2010). This theory has traditionally been tested using qualitative methods of interviews or essay writing. Section two provided respondents with the opportunity to list their own thoughts about fuel management, rather than list a number of arguments for them to agree or disagree with. This section also asked respondents to indicate the level of trust they had in a variety of sources delivering information about fuel management.

3. Section three asked respondents to indicate how acceptable they considered the three different fuel management strategies to be in general, as well as in a variety of specific circumstances, such as in conservation areas, native forests, farming areas, plantations and close to their homes. This section also asked respondents to indicate how effective they considered the three methods to be, along with how risky/sensible, and how acceptable they considered it not to carry out any fuel management.

4. Section four was designed to gain an understanding about the respondents themselves, including basic demographic questions such as gender, age, education, employment and income, as well as interests and organised groups. This section is important in further examination of the data to identify whether different types of people have different perceptions and attitudes towards fuel management.

The survey was pilot tested by twelve people, a final revision was undertaken and the survey was professionally printed in A4 size booklets. The surveys were posted to respondents, together with an introductory letter, information sheet and pre-paid envelope for survey return, following the Dillman Method (Dillman et al. 2008). The survey process is described in more detail below.

Postal surveys were chosen as the method of data collection, because they are more cost-effective and enable a wider comparison of views by selecting participants across a range of geographic areas (for example, including both urban and rural dwellers). Telephone and face-to-face interviews are time-consuming and expensive, while internet surveys cannot guarantee an adequate sample from a range of geographic areas.

3.5.3 Survey sample

The Canberra region was chosen as the case study for this project because of its proximity to the researcher and its experience with a major bushfire in the past. The study region boundaries were based on the boundary set in the Yellow and White Pages for Canberra, Yass and Queanbeyan, as seen on page 1138 of the 2011/2012 edition. This includes as far south as Michelago, NSW, as far west as Wee Jasper, NSW, as far north as Binalong, NSW, and as far east as Mulloon, NSW.

The survey was sent to a representative sample of urban dwellers, peri-urban dwellers and rural landholders in this region. First, the urban and rural populations were stratified. The population of Canberra, Queanbeyan and Yass (considered urban) was calculated as being approximately 378 890. The remaining population from the White Pages region (equivalent to the total white pages region population minus the 2006 Census population of Canberra, Yass and Queanbeyan) was assumed to be rural or small townships, and was calculated as being approximately 30 810. Using these population calculations, various sample size calculators on the internet were used to calculate the preferred sample size for each (Raosoft 2004; Creative Survey Systems 2012; National Statistical Service 2012). For both urban/peri-urban dwellers and rural landholders, a sample of approximately 600 was calculated for each, based on a 95% confidence interval and a 0.5 response[1].

The White Pages directory was used to identify addresses for urban dwellers, peri-urban dwellers and some rural landholders. Approximately every fifth residential address from each column of the 2011/2012 edition of the White Pages was recorded, up to the letter D. At this point, it became evident that this would result in too many addresses. From the letter D onwards, approximately every fifth residential address from the second and fourth column of each page was recorded until the end of the White Pages.

The addresses obtained from the White Pages were categorised into urban, peri-urban, rural town and rural property, by cross-referencing the address with Google Maps. Canberra, Queanbeyan and Yass were considered urban centres. Properties were considered peri-urban if they were within approximately 500 m and 1000 m of the outskirts of an urban area, or within 300 m and 500 m of a nature reserve within the city. Properties within a rural township settlement were categorised separately, and properties in rural areas outside township settlements were considered rural properties.

As well as the White Pages, a real estate database called RP Data was used to gather rural property information. The database provided landholder and property information for all landholders in the region; however, postal addresses were more than five years old. Therefore, Sensis[2] (2011) was

[1] There is no single ‘right’ survey sample; however these sample size calculators provided a useful guide to the number of surveys that would need to be delivered to achieve a response that, assuming a 50% response rate and appropriate distribution of views in responses, would enable meaningful statistical analysis.
[2] Sensis Pty Ltd has the responsibility for the production of the Yellow and White Pages directories and related products.

used to check address information for all landholders identified from the database. Only those addresses that were publicly available in the 2011/2012 White Pages were included.

A total of 1250 surveys were posted in October 2011; 650 surveys were sent to urban and peri-urban dwellers, while 600 surveys were sent to rural towns and rural properties. After removing 'return to sender' letters from the sample, a total valid sample of 1110 was achieved. A total response rate of 44.2% of the valid 1110 posted survey was achieved.

3.5.4 Sample biases

Using the White Pages as the basis for the random sample creates the potential for sample bias towards people whose number is listed in the White Pages and those with landline telephones. The sample excludes people not listed in the White Pages and those who use mobile telephones or internet-based telephones instead of landlines. It's becoming more common for people not to use landlines, in particular the younger section of the population, who communicate via a mobile telephone only and are often not listed in the White Pages. This sample method may have excluded younger sections of the population in particular. Potential bias in the sample achieved is further explored in the presentation of survey results.

3.5.5 The survey process

Reminder cards were sent out each week for the first two weeks after the survey mail-out, in order to increase response rates. This is known as the Dillman Method (Dillman et al. 2008). In the third week, a second survey was sent to those who had not yet sent it back. One more reminder card was posted the following week. Reminders were only sent out to those who had not yet returned the survey. These people were identified by including an identification number on the back of surveys. No further surveys were accepted after the end of the 10th week.

3.5.6 Data analysis

Prior to data analysis, all open-ended questions required coding, particularly for section two, in which respondents were asked to list their own arguments for and against the three fuel management strategies. Coding of open-ended questions was initially very detailed, so that when further grouping took place for graphing, the original arguments could still be analysed.

The univariate analyses displayed in this report were undertaken using the Statistical Package for Social Science (SPSS) and Microsoft Excel. Where Likert scales were used, some were aggregated into larger groupings, in order to clearly display the results in graphs. For example, where respondents were asked to rate their acceptability of a practice on a scale of 1 to 7, where 1 was highly unacceptable, 4 was neutral/no opinion, and 7 was highly acceptable, the results were aggregated to represent 1–3 as 'unacceptable', 4 as 'neutral/no opinion', and 5–7 as 'acceptable'.

3.6 Results and discussion

A discussion about the preliminary results of the survey is presented here. First, a description of the survey respondents is provided, followed by the respondents' perceptions about fuel management. Finally, the arguments for and against each fuel management strategy is presented and the attitudes towards each of the strategies is discussed. The results are discussed and compared to literature as they are presented.

3.6.1 The survey respondents

3.6.1.1 Socio-demographic results and non-response bias

A number of studies indicate that public attitudes about natural resource management issues often differ amongst different socio-demographic groups (Shindler and Toman 2003). There are many dimensions to the public that may influence perceptions about particular land management issues, including (but not limited to) age, profession, education, occupation, income, gender, spare time activities, family history, as well as geographic dimensions such as the location of residence of the individual in relation to the land uses, fuel management and sources of information available.

The socio-demographic characteristics of survey respondents were compared to the average for the population of the region, to identify any bias in the responses received. It should be noted that, in this report, survey results have not been weighted to account for the biases identified; subsequent analyses may undertake this type of weighting once results of the 2011 Australian Census of Population and Housing (Census) are released later in 2012, providing data on demographic characteristics at the time the survey was undertaken. Key biases are identified here to enable some interpretation of the likely relevance and representativeness of the results to the general population.

The survey respondents were fairly evenly divided between males and females, with 60% male respondents and 40% female respondents (n=479). This leaves females slightly under-represented, with the 2006 population of the ACT and NSW being 49% male and 51% female (ABS 2008).

The mean age of respondents was 57 years old, with a median of 58 years, a range of 72 years from age 20 to age 92, and a standard deviation of 13 years (n=475). In the 2006 Census, the median age for residents of the ACT was 34 years and, for NSW, was 37 years (ABS 2008). Although some difference is expected—the survey was completed by adults only, whereas the Census includes people of all ages, including children—it is likely that younger people are under-represented in the survey responses. Older people, particularly those that are retired, may be more likely to take the time to fill in surveys.

Employment and retirement rates were high in the survey respondent population, with 56% of respondents being employed, 35% retired, 8% indicating 'other' and only 1% of respondents indicated they were unemployed (n=481). This compares with 72% of the population over 15 years of age in the labour force in the ACT and 63% in NSW, as measured by the ABS (ABS 2012).

Of the 269 respondents who were employed, the majority indicated they were farmers, graziers or land managers (19%), or public servants (10.4%), followed by those in the information technology industry (8.2%), construction industry (7.8%), business managers (5.6%) or in the health industry (4.8%). As a whole, approximately 26% of employed respondents were employed in some form of natural resource management, such as farming, horticulture, environmental management and apiary.

Survey respondents were biased towards the highly educated, as can be seen in Figure 3-1. Almost 80% of respondents indicated they had received a post-school qualification such as a certificate or diploma, a bachelor degree or postgraduate degree, compared with 63% of ACT residents in 2006 (ABS 2011).

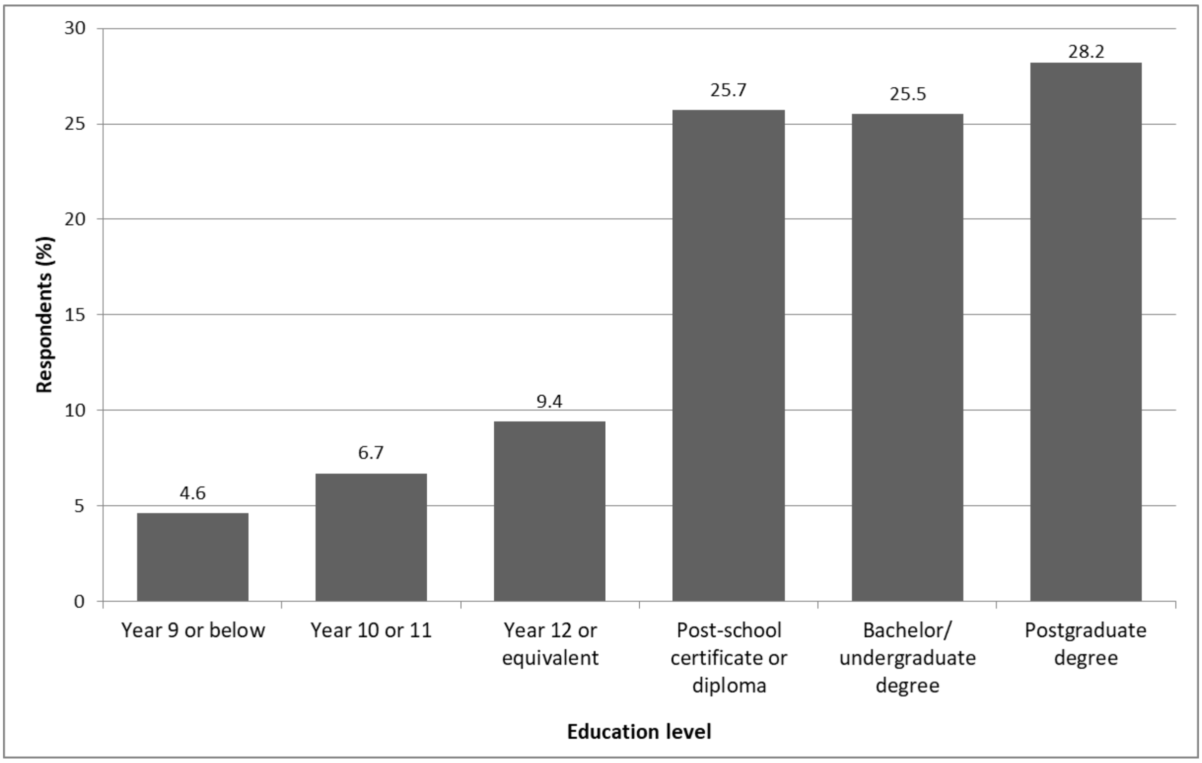

Figure 3-1 Highest level of formal education of respondents (n=479)

Figure 3-2 shows the household income reported by respondents. The median household income was between $50 001 and $80 000 per year, and more than 40% of respondents had a total household income greater than $110 001 per year. The 2006 Census data indicated that the median household income for the ACT was approximately $78 000 per year and that approximately 37% of households in the ACT had a total income greater than $104 000 per year (ABS 2008).

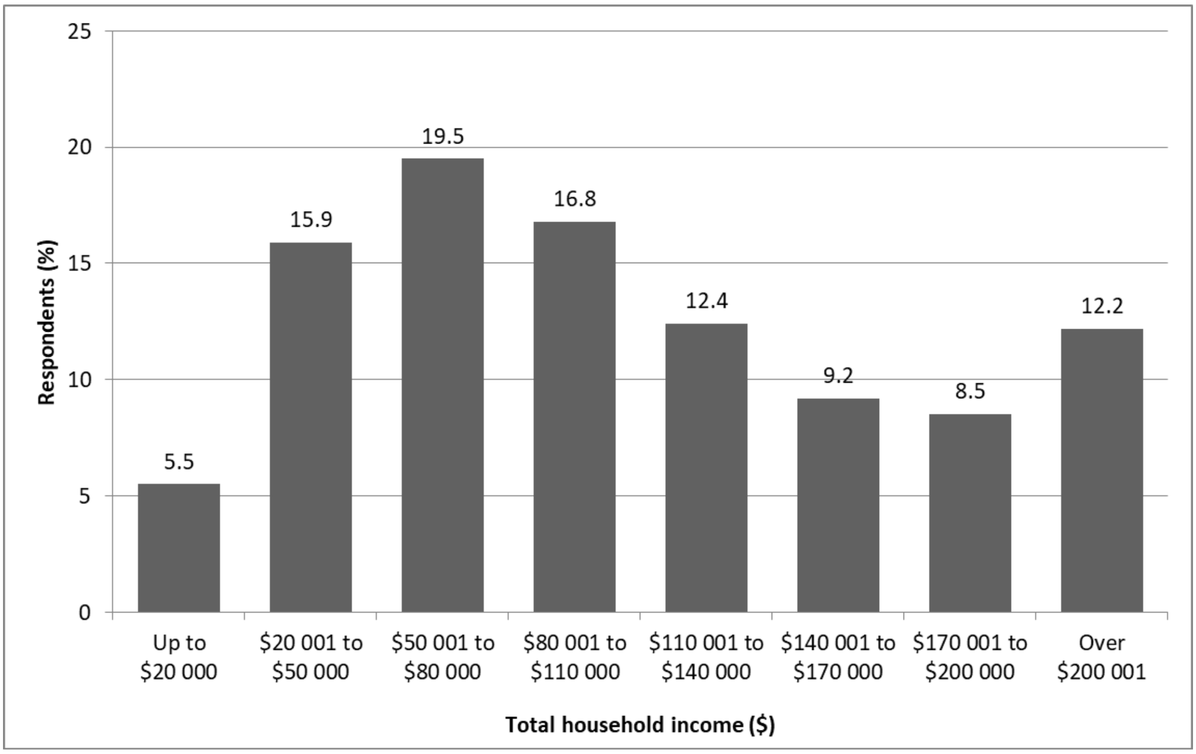

Figure 3-2 Total household income reported by survey respondents (n=435)

3.6.1.2 Area of residence

As can be seen in Figure 3-3, the majority of respondents indicated they lived in an urban area (39.5%), with the next biggest proportion of respondents living on a rural property (33.7%). The distribution of respondents over the four areas of residence (urban, rural property, rural township and peri-urban) somewhat reflected the proportion of surveys sent to each area—42% of surveys were sent to urban areas, 45% were sent to rural properties, 10% were sent to rural townships and 3% were sent to peri-urban areas. The sample stratification aimed to achieve an adequate sample from each type of zone to enable comparison; this was achieved for all except the peri-urban sample.

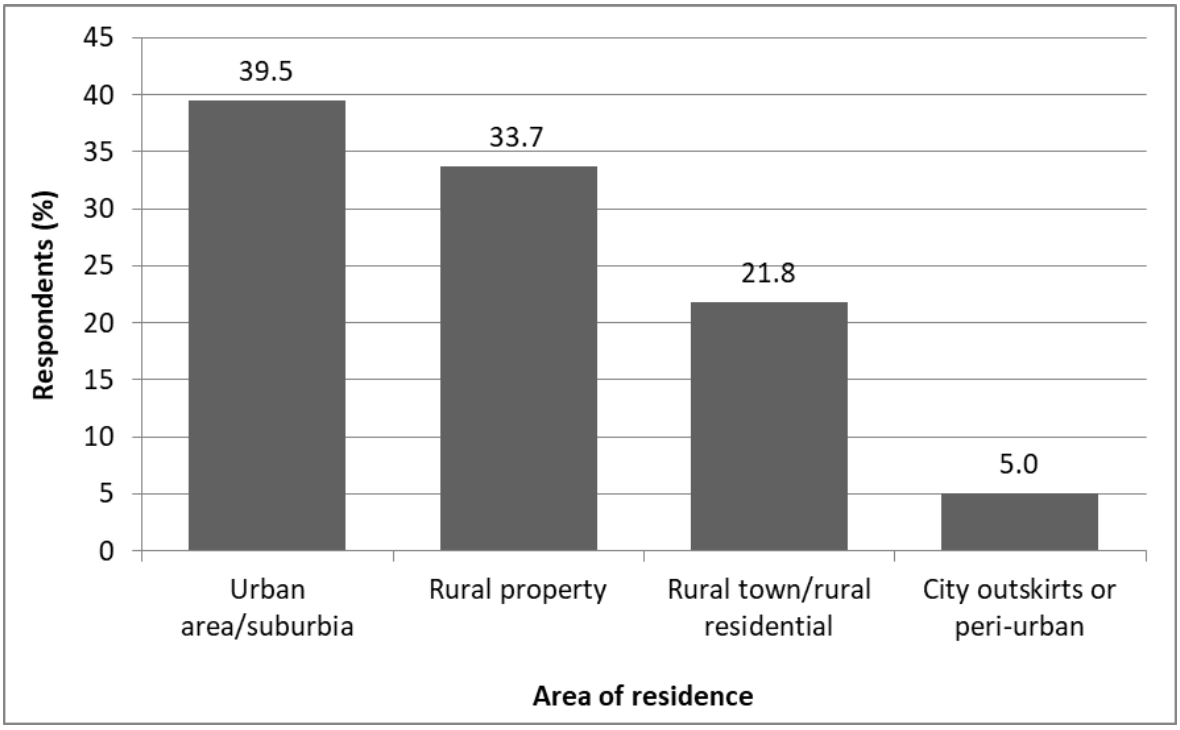

Figure 3-3 Area in which respondents resided (n=478)

About 20% of respondents indicated they had always lived in Canberra or the surrounding region, while the remaining 80% had lived in other places (n=485). Of those, the majority (53%) had lived in urban areas in another Australian city, followed by 34% who had lived overseas, 31% who had lived in an Australian rural town, 25% on a rural property in Australia and the remainder in other areas.

3.6.1.3 Interests and organised groups

Figure 3-4 shows the types of activities that respondents undertake in their spare time (n=388). Respondents could indicate multiple responses. As can be seen in Figure 3-4, in addition to the categories listed in the survey, 29.9% of respondents indicated they undertook ‘other’ activities. When asked to specify these other activities, the most common activities described were farming, travelling, horse riding, performing arts, cooking and volunteering.

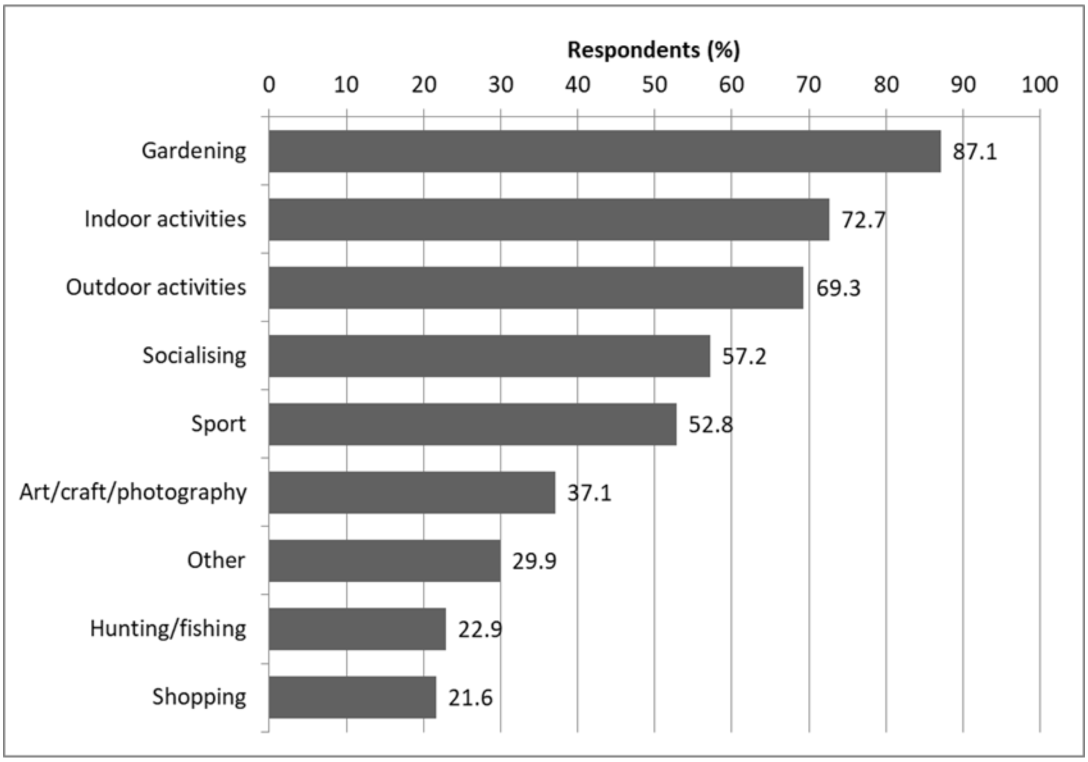

Figure 3-4 Activities respondents reported undertaking in their spare time (n=388)

Figure 3-5 shows the percentage of respondents who participated in organised community groups (n=485). The most common groups listed by survey respondents under the 'other' category were church groups, volunteer groups, performing arts groups and political groups.

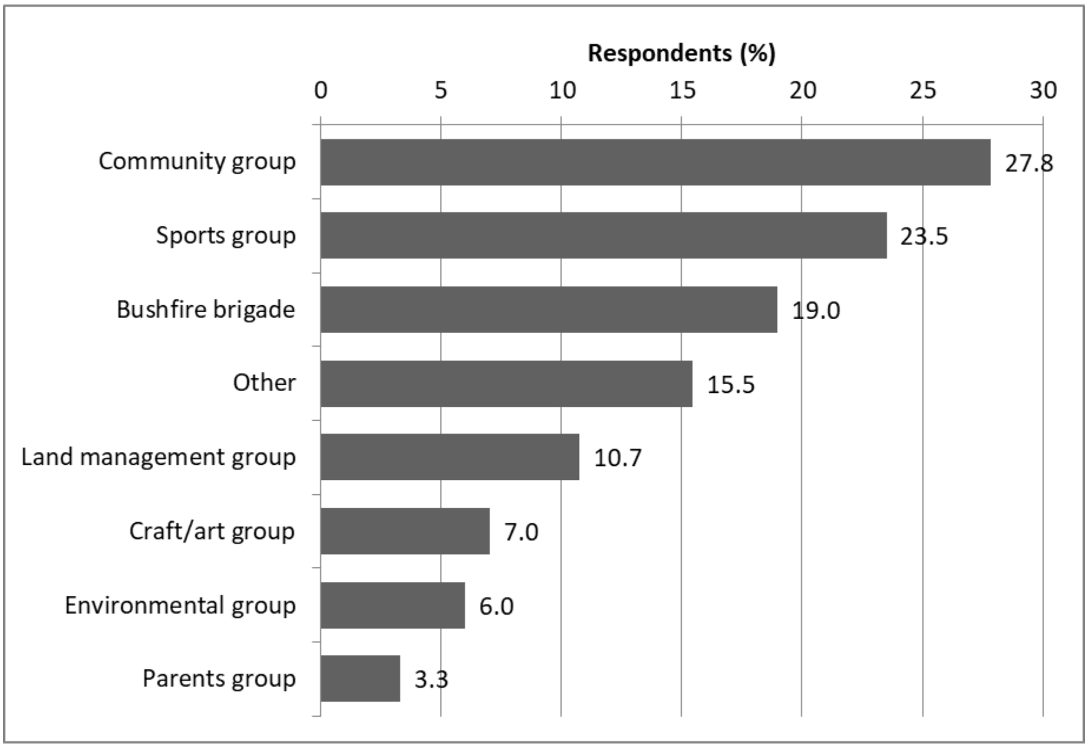

Figure 3-5 Types of community groups survey respondents participated in (n=485)

3.6.2 Fuel management

3.6.2.1 Knowledge and awareness of fuel management

Respondents were asked to rate their level of knowledge and awareness about fuel management. Figure 3-6 shows that in the ACT and surrounding regions, the majority of respondents felt they had a good or very good level of awareness and knowledge about fuel management. It is important to recognise that this self-perception may differ from levels of knowledge as measured by independent measures. In fact, this high level of residents' confidence in their own knowledge may actually present a challenge for bushfire risk management planners, as it may reduce the interest and willingness of residents to seek more information, due to their lack of awareness that they may be able to gain useful skills or knowledge by doing so. This hypothesis is somewhat supported by results relating to whether respondents had actively sought information about fuel management in the past.

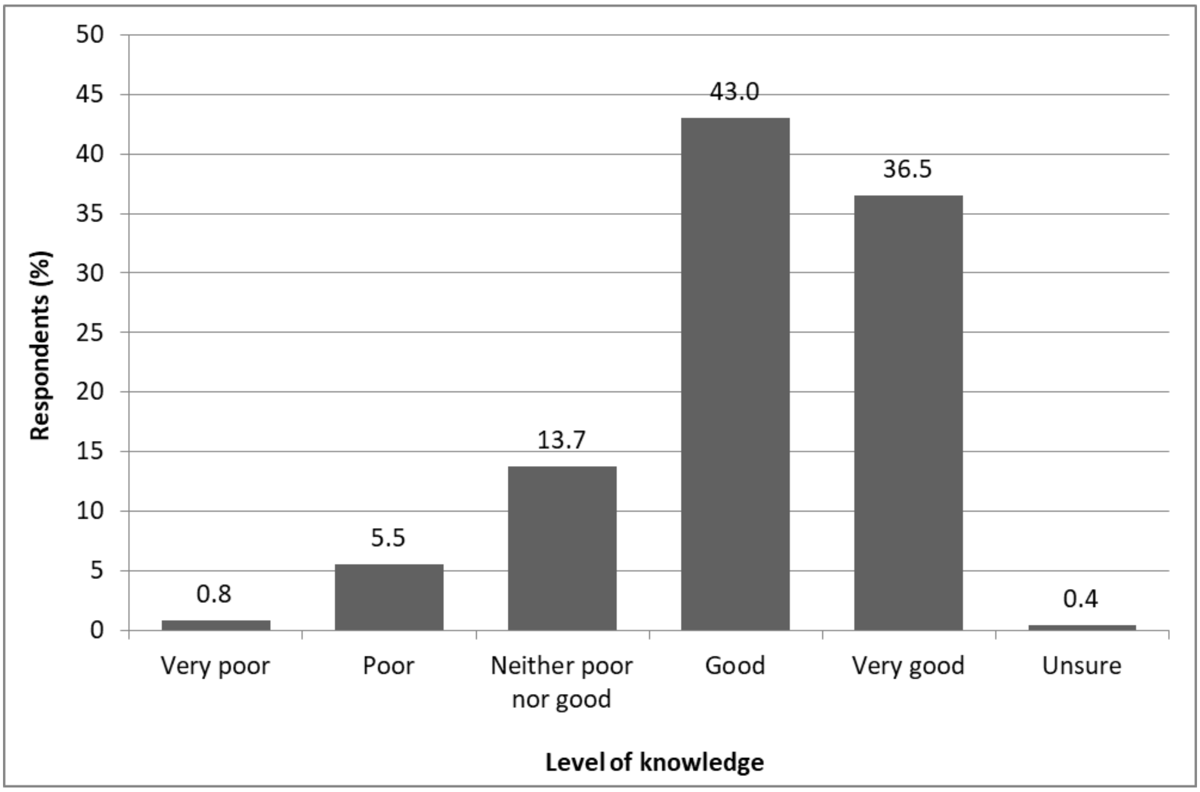

Figure 3-6 Respondents' level of awareness and knowledge about fuel management (n=488)

Less than half of the respondents (35%) had actively sought information about fuel management in the past (n=484) and, of those who had, 64% indicated that they were successful in finding the information they were looking for (n=170). The most common source of information sought was directly from emergency services, such as volunteer and paid bushfire brigades, the Rural Fire Service, the State Emergency Service or other bushfire authorities. Other common sources of information included the internet, government shopfronts, rangers and pamphlets/brochures.

Respondents were then asked to rate how useful they would find information about fuel management if it was delivered in a range of ways. The rating scale ranged from ‘not useful at all’ through to ‘highly useful’, on a 5 point Likert scale. Figure 3-7 show the results, with bushfire training courses being considered the most useful, followed by one-on-one discussions with experts, then pamphlets/brochures and material sent in the mail. Information received through education facilities was regarded as the least useful to the respondents.

3.6.2.2 Level of trust

Social trust is the willingness to rely on those who have the responsibility for decisions and actions related to risk management (Winter et al. 2004). Siegrist and Cvetkovich (2000) argue that people who lack personal knowledge and experience about a particular action cannot directly assess the risks and benefits associated with it. They argue that, without sufficient knowledge, decisions and judgements are guided by social trust. Having trust in someone or something reduces the complexity people are faced with, and they hypothesise that social trust influences both perceived risk and perceived benefit. For many strategies, the risks and benefits are not directly visible to those without the appropriate technical knowledge and, therefore, people rely on risk-benefit information provided by sources they trust. Acceptance of fuel management strategies relies heavily on communities’ confidence that the agencies conducting the fuel treatment will effectively manage risk (Shindler and Toman 2003).

Several studies, particularly in North America, have recognised that a key factor required for social acceptability of natural resource policies and actions is social trust (Siegrist and Cvetkovich 2000; Winter et al. 2004; Absher and Vaske 2011; Toman et al. 2011). Shindler et al. (2002) identified a lack of trust as a barrier to social acceptance of natural resource policies and actions, and said trust can be central to an agency’s ability to act. Adults are not likely to believe information from a source they do not view as credible (Lachapelle et al. 2003; Toman et al. 2006), suggesting that in some areas, land managers may also need to implement trust-building initiatives to help gain wider acceptance (Shindler and Toman 2003; Winter et al. 2004).

Figure 3-8 illustrates the respondents’ trust in different sources providing information about fuel management. The most trusted source was the volunteer bushfire brigade, followed by paid bushfire brigades and bushfire councils. The least trusted source was the private forestry companies, followed by the media.

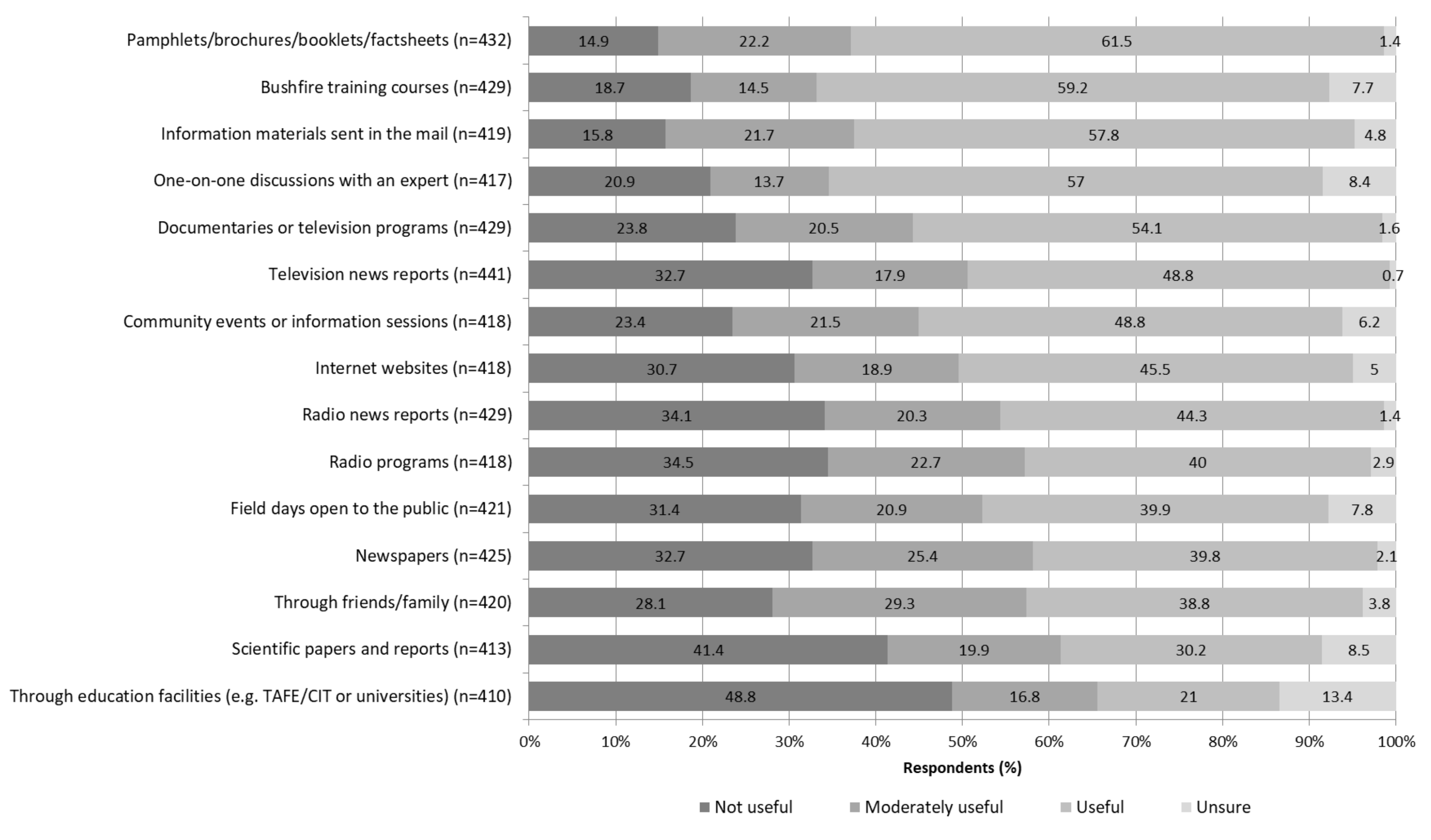

Figure 3-7 Usefulness of information about fuel management received in a variety of ways

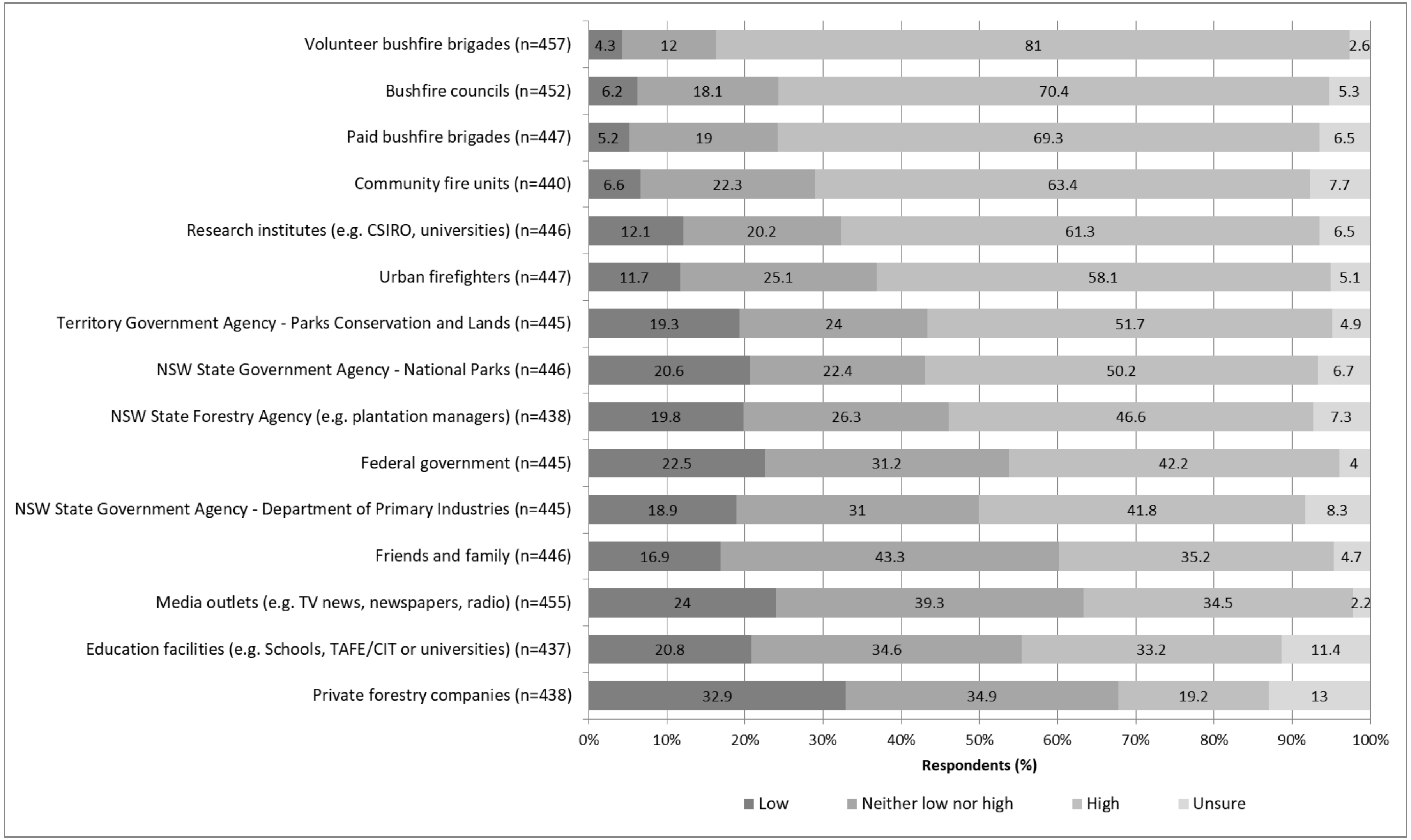

Figure 3-8 The level of trust in different sources of information about fuel management

3.6.2.3 Past experiences

Public perceptions about different practices can be a result of the awareness gained from personal experiences (Stankey and Shindler 2006).

The majority of respondents (87%) were present during the 2003 Canberra bushfires (n=487). Of those, 25% indicated they were not affected at all. Of the remainder, 41.5% indicated that they were affected through personal anxiety, 37.8% knew someone who was affected, 34% had family or friends who experienced damage or loss of assets, 14% had family or friends who experienced health impacts or injury. Other effects included the loss of family or friends, personal injury or health impacts, working/volunteering in the Rural Fire Service, loss of power, and damage to or loss of personal assets.

65% of respondents had experienced a bushfire other than the 2003 Canberra fires (n=488). Respondents reported similar effects from those fires to the Canberra fires, with personal anxiety being the most common.

3.6.2.4 Perceptions about vulnerability

Respondents were asked to indicate how vulnerable they felt to the possible threat of future bushfires at their current residence. Figure 3-9 shows a fairly even number of respondents on each side of the vulnerability scale.

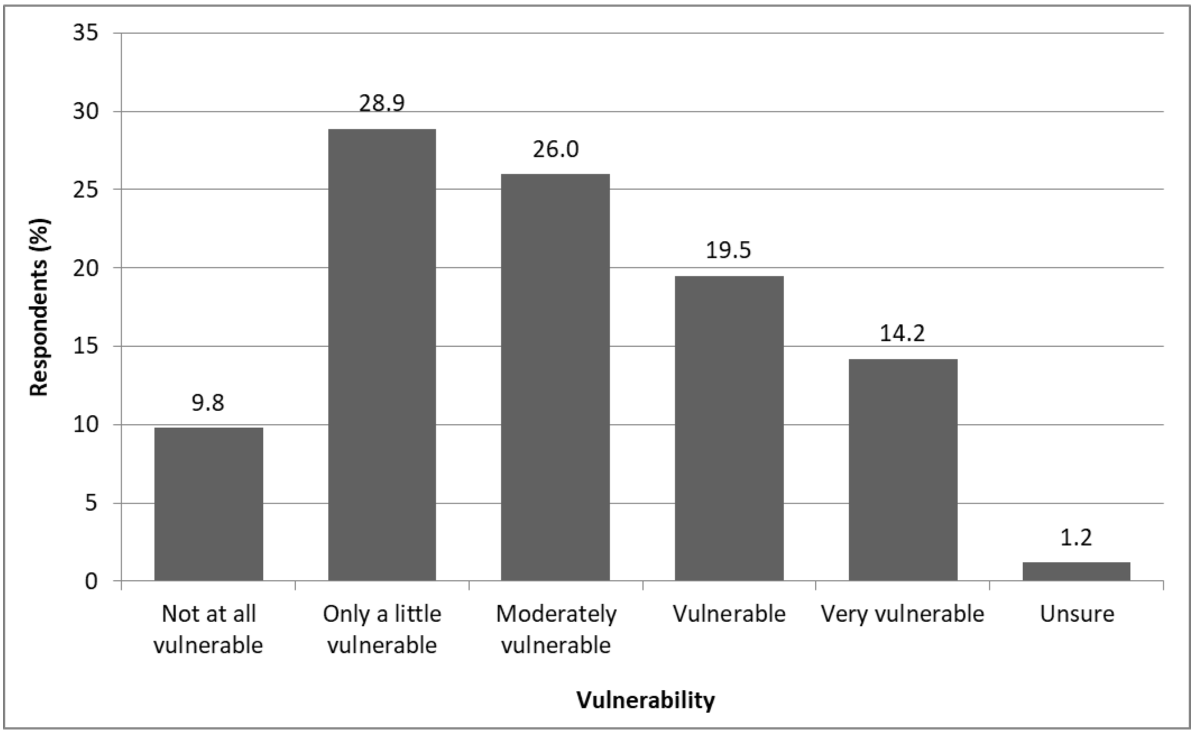

Figure 3-9 Vulnerability at current residence (n=490)

McCaffrey (2009) indicated that, contrary to common belief, a major fire event does not necessarily increase acceptability of fuel reduction. Instead, it can create the opposite effect, whereby the public believes 'it couldn't happen again in the same place' or 'the area has been burnt out and there is no fuel left to burn'. Further exploration of the data in future will examine if this is the case in areas around Canberra that were affected by the 2003 fires.

3.6.2.5 Importance of own actions

During the qualitative interviews with informed experts and members of the public, interview participants commonly mentioned the importance of residents' own actions in preventing loss of assets. To further explore this, the survey included questions asking respondents to rate the importance of their own actions around their homes in the role of fuel management. Almost 60% of respondents believed that their own actions in fuel management were very important (Figure 3-10). This highlights an awareness of the importance of taking preventive action to reduce bushfire risks, although the extent to which this then triggers action is not known.

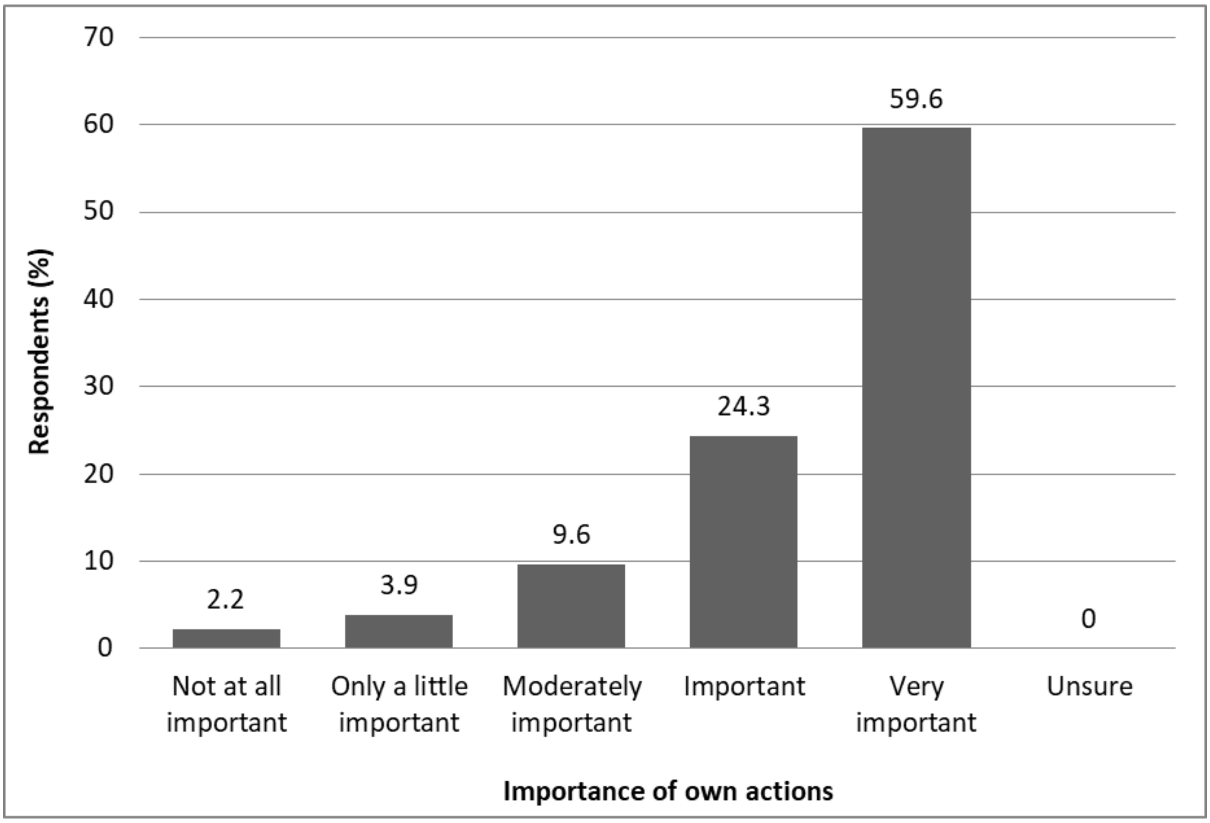

Figure 3-10 Importance of respondents' own actions in fuel management (n=489)

3.6.3 Perceptions about fuel management

Land managers often focus on the objectives, strategies and outcomes of fuel management, with little understanding of how members of the general public interpret the same issues. It is sometimes unknown whether the public has the same views about the benefits and costs of the choices made regarding fuel management used to reduce bushfire risks. Even when there is agreement on the facts, different interpretations are possible, with consequences for judgements of acceptability (Shindler et al. 2002).

Survey respondents were asked to write their own arguments for and against the three fuel management strategies (prescribed burning, livestock grazing, and vegetation thinning), in order to better understand their perceptions of the pros and cons of these three strategies. The method of obtaining these arguments was based on the studies carried out by Carroll and Bright (2009 & 2010) to determine integrative complexity of thought, a main driver for this broader study. By asking participants to write their own arguments, it is possible to identify the number and complexity of arguments they make about these issues, without being prompted by pre-formed survey questions. This allowed respondents the freedom to make their own assessments and judgements about each strategy. A large number of arguments were made and the method illustrated a wide range in the level of understanding about the fuel management strategies. Some respondents' arguments were minimal, with one or two general comments for each, while others listed several meaningful arguments for each strategy. In general, more arguments were made for prescribed burning and livestock grazing than for vegetation thinning. A drawback of the method was that it required independent thought and considerable effort from the respondents. Some respondents chose not to answer this question, or answered with very basic comments.

More than 100 positive and 100 negative arguments were made for each strategy. The majority of arguments made have also been raised in the literature published on these strategies. In order to display these arguments, it was necessary to group the arguments into broader categories. For a full list of arguments, see Appendix 8.

3.6.3.1 Prescribed burning

Common arguments made by survey respondents for and against prescribed burning are shown in Figure 3-11 and Figure 3-12.

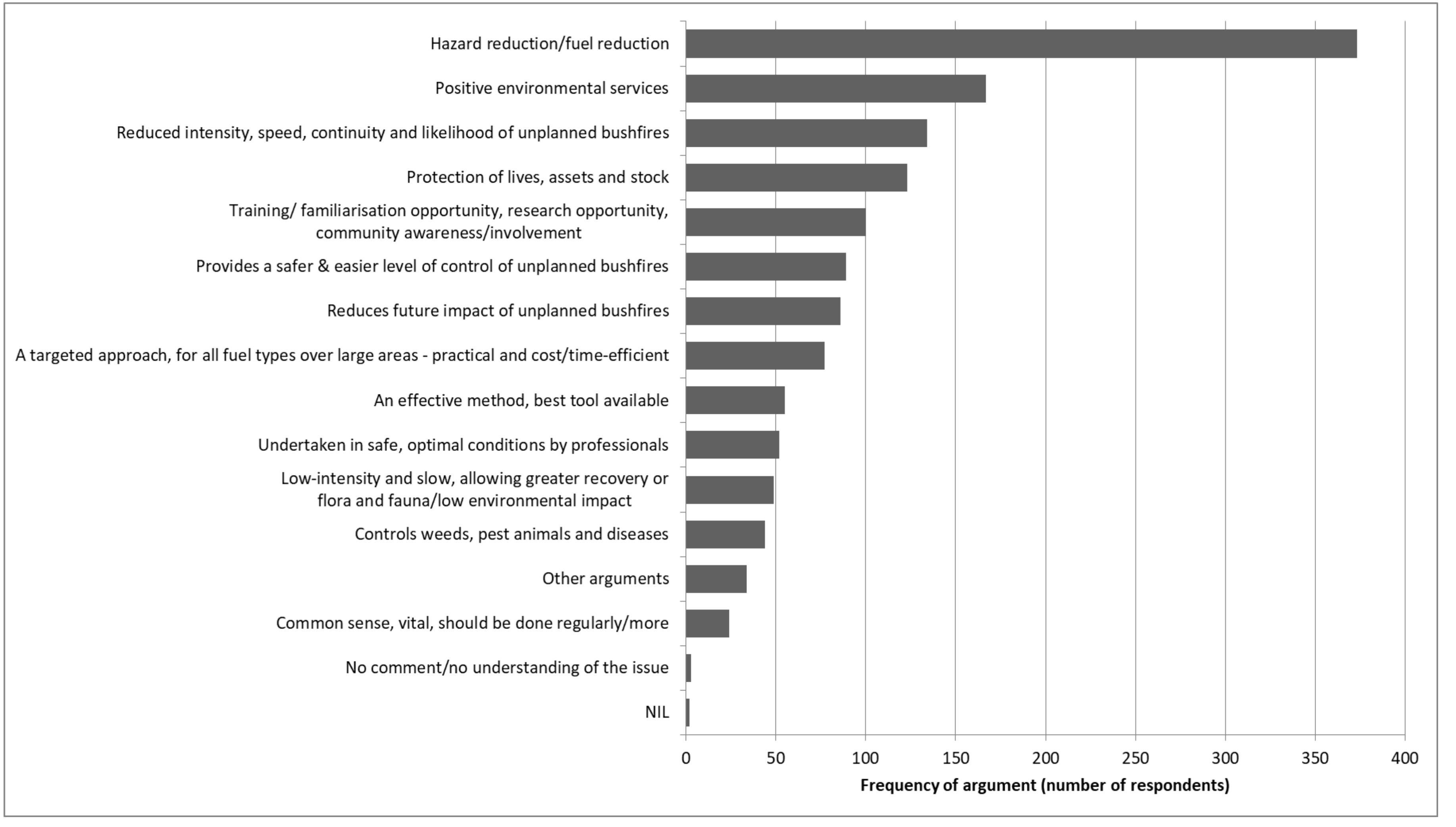

Figure 3-11 Arguments made by survey respondents for prescribed burning

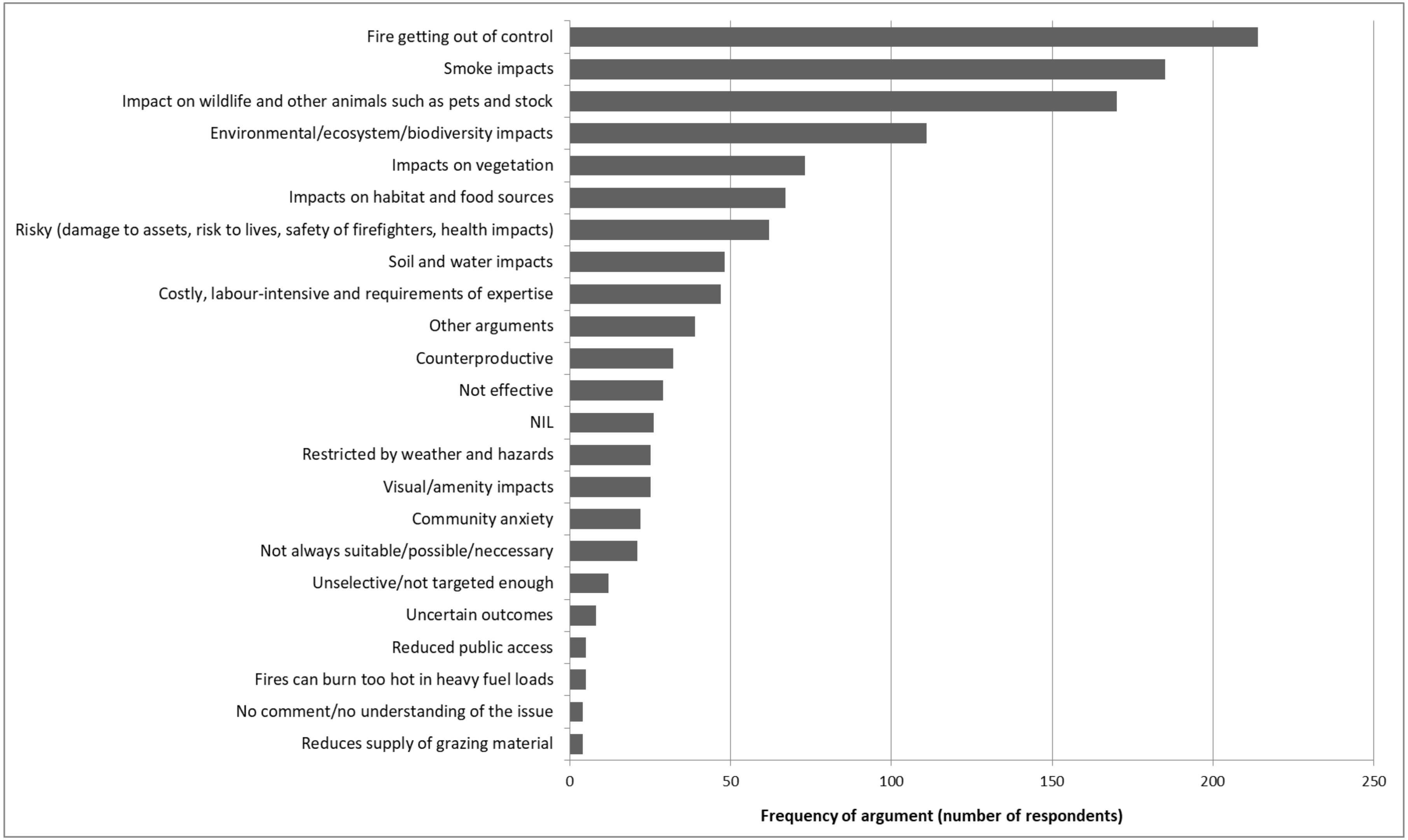

Figure 3-12 Arguments made by survey respondents against prescribed burning

The most common argument, by far, in favour of prescribed burning was that it can achieve a reduction in fuel or fire hazards. This was followed by its perceived potential to achieve an improvement in the environment or to maintain key characteristics of the environment, through arguments such as ‘rejuvenates/regenerates native plant life’, ‘it’s a natural phenomenon’, ‘it is part of Australia’s ecosystem’, ‘increases soil fertility from the ash’, and ‘it is necessary to maintain some ecosystems’. The next most common argument was that prescribed burning can reduce adverse fire characteristics such as intensity or speed of travel, followed by the argument that the strategy contributes to the protection of life and property. Many respondents used technical language in their arguments, such as specifically arguing that prescribed burning reduces the intensity of fires, the rate of spread/speed of fires or the continuity of fires; all terms specific to fire management and indicating a high knowledge of these concepts. It is possible that these results are biased towards those with a higher level of knowledge about fuel management. Subsequent analyses will be able to compare the types of respondents who thought more or less complexly about the strategies, in order to be able to help identify ways of targeting those who have lower levels of understanding.

The most common concern for respondents in arguing against prescribed burning was the potential loss of control and subsequent impacts of the fire. Approximately two weeks after the survey was distributed, a prescribed burn escaped containment lines at Margaret River in Western Australia, destroying more than 40 homes and resulting in graphic media coverage. Many respondents made a comment referring to the Margaret River incident in their argument about loss of control. It would be interesting to analyse the number of ‘loss of control’ arguments of surveys returned before and after the Margaret River incident.

Other common arguments against prescribed burning included the effect of smoke (including general statements about smoke pollution, through to specific arguments such as carbon emissions, greenhouse gas pollution, atmospheric pollution, effects on climate change, smell, health effects, visibility effects and effects on the community), the effect on animals (particularly wildlife) and the effect on the environment, ecosystems or biodiversity.

3.6.3.2 Livestock grazing

Figure 3-13 and Figure 3-14 illustrate the common arguments made by survey respondents for and against livestock grazing.

As with prescribed burning, the most common argument in favour of livestock grazing was that it can reduce fuel levels and fire hazard in general. This was followed by the argument that livestock grazing has the dual benefit of reducing fuels while also achieving advantages for livestock graziers (by enabling access to stock feed), particularly when feed is low on farms. Another common argument for livestock grazing was that it was considered to be a safe, low-impact method, and perceived to remove the need for ‘risky’ burning practices.

The most common arguments against livestock grazing were that it may have a negative impact on the land or the environment as a result of overgrazing or overstocking, leading to land degradation; effects on native vegetation; effects on soils (including compaction, erosion and damage to the soil structure/profile); and other effects on the environment, ecosystems or biodiversity.

3.6.3.3 Vegetation thinning

Figure 3-15 and Figure 3-16 show the arguments made by survey respondents for and against vegetation thinning.

As was the case with the other two fuel management strategies, the most common argument for vegetation thinning was that it can reduce fuel volumes and fire hazard in general. This was followed by arguments that it has a low environmental impact, and that the action of thinning reduces competition between plants, thus improving growth of the remaining vegetation.

The most common argument against vegetation thinning was, by far, that it was a labour-intensive and costly exercise. This was followed by concerns about the environmental impact, with arguments that it is ‘unnatural’, or has negative impacts on wildlife and habitat. The next most common argument against using thinning was the view that it is ineffective, particularly that it may be counterproductive if the fuel is left in situ and not removed, or if it encourages new or increased rates of plant growth in the remaining vegetation, as a result of reduced competition from the vegetation that has been removed.

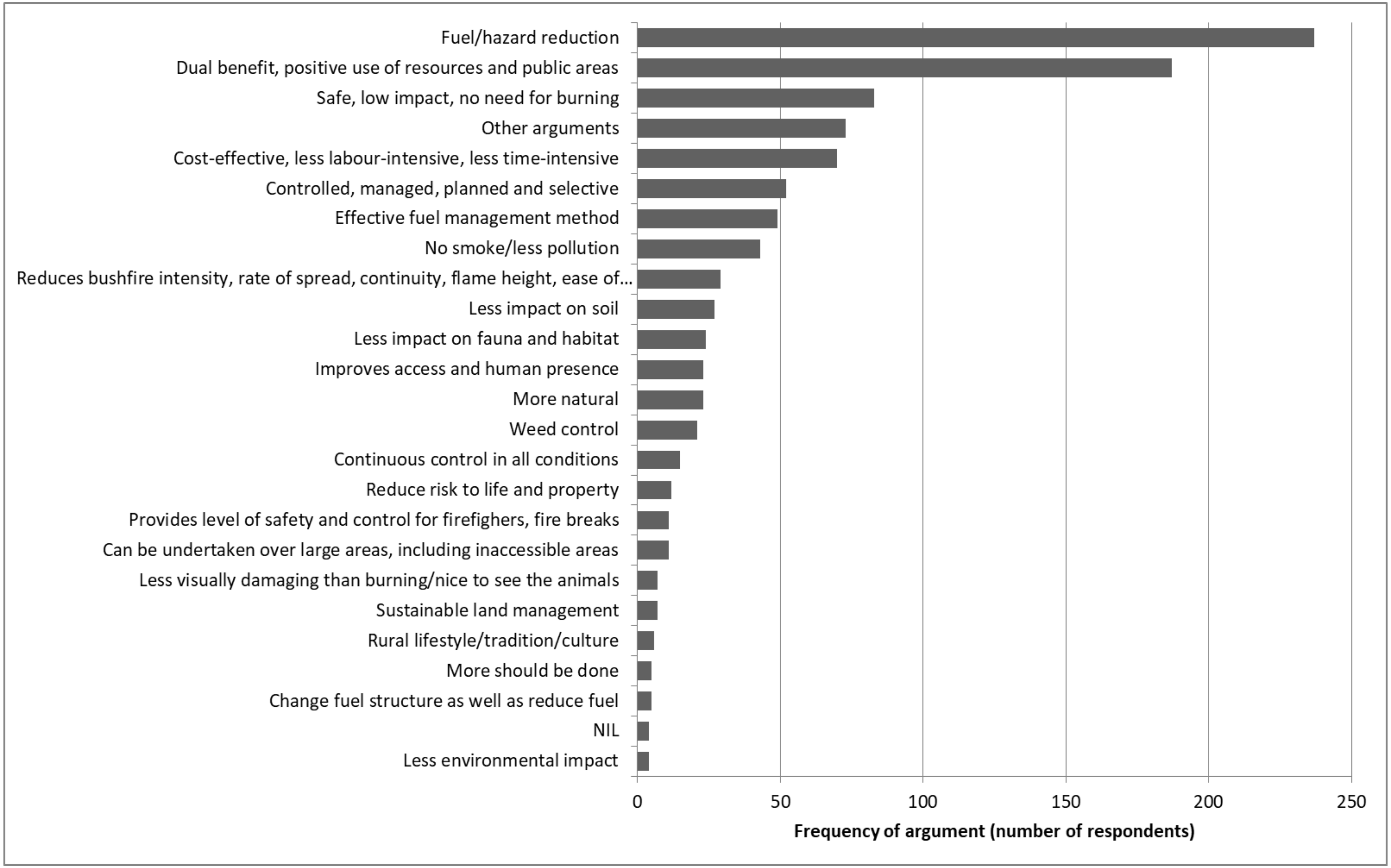

Figure 3-13 Arguments for livestock grazing

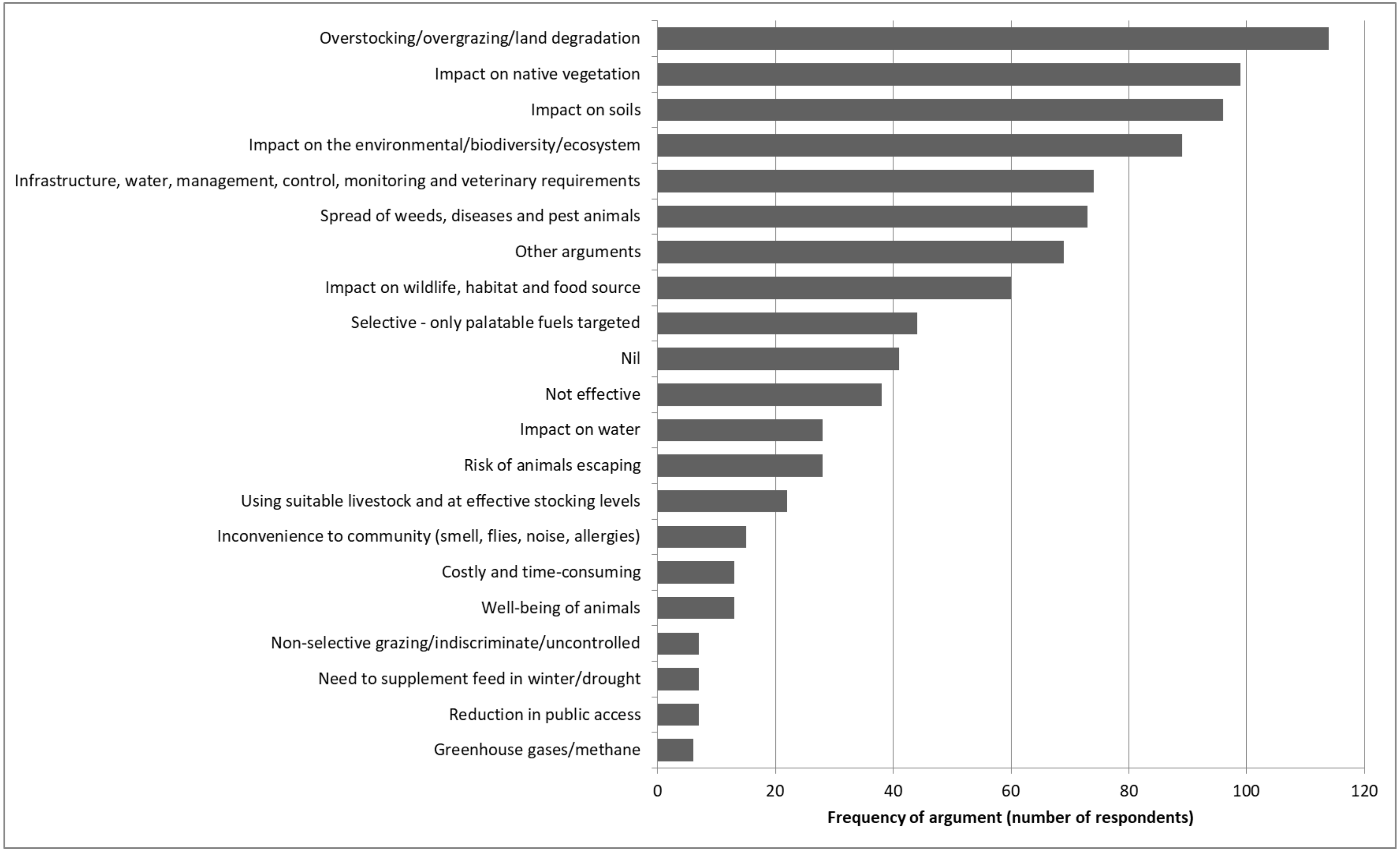

Figure 3-14 Arguments against livestock grazing

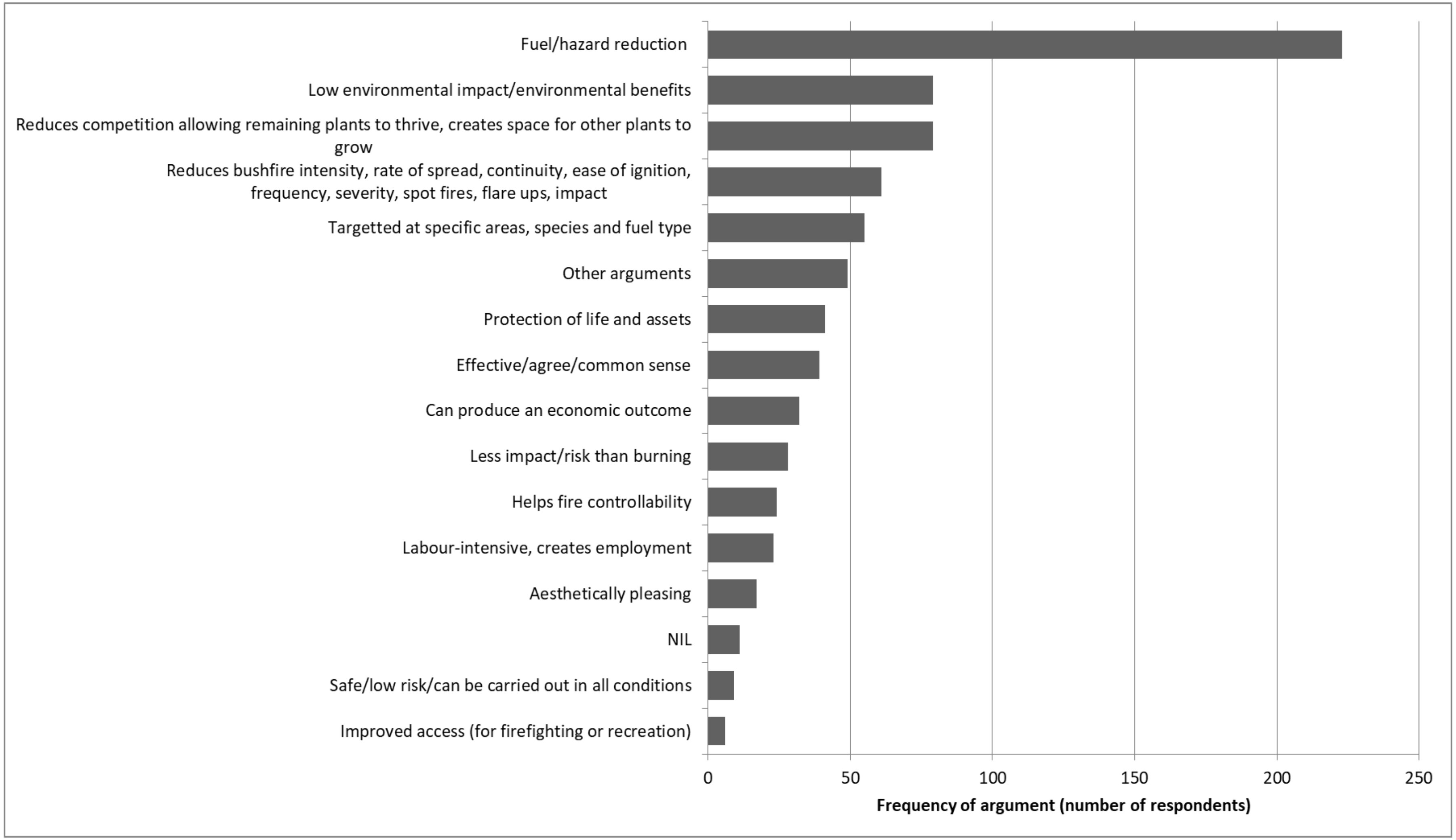

Figure 3-15 Arguments for vegetation thinning

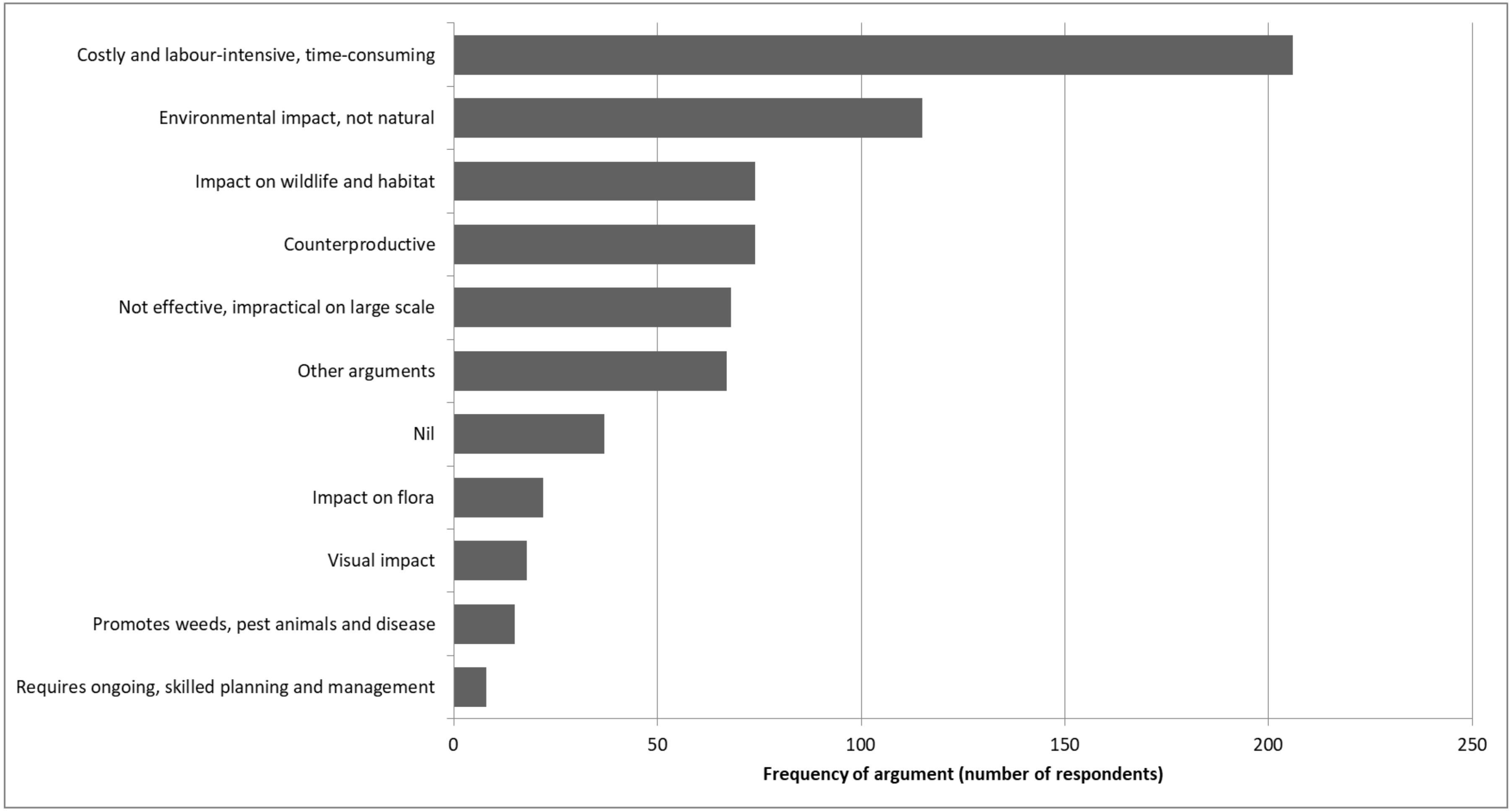

Figure 3-16 Arguments against vegetation thinning

3.6.4 Attitudes towards fuel management

Beliefs about the acceptability of fuel management in different circumstances are critical to predicting whether and what types of public debate might emerge around fuel management. They can also help evaluate whether the presentation of these debates in the media is representative of the actual distribution of views held in the general population.

Respondents were asked to rate how acceptable they found the three different fuel management strategies in general, and also in a variety of circumstances related to the proximity of the activities to their personal lives and assets. Respondents were asked to rate their acceptability using a 7-point Likert scale, where 1 was ‘highly unacceptable’, 4 was ‘neutral/no opinion’, and 7 was ‘highly acceptable’. In order to display the data, the scores 1–3 were grouped to ‘unacceptable’ and 5–7 were grouped to ‘acceptable’. Figure 3-17, Figure 3-18 and Figure 3-19 illustrate the acceptability of the three management strategies.

All three fuel management methods were more likely to be rated as ‘acceptable’ than ‘unacceptable’ by survey respondents, for all circumstances. The highest proportion of respondents indicated the methods were ‘highly acceptable’ for all situations and all management strategies. The situations most likely to be rated as ‘unacceptable’ were those in which fuel management strategies are undertaken in conservation areas and native forests, for all three fuel management strategies. In these situations, a quarter or more of respondents considered the strategies unacceptable—a significant minority—helping explain some of the public debates that emerge over fuel management in these areas.

These results suggest that acceptability is not closely related to the proximity of strategies to a person’s ‘backyard’, contrary to ‘not in my backyard’ (NIMBY) theories. This is consistent with a range of recent studies that have discredited the NIMBY theory (Devine-Wright 2005 & 2009). The results do suggest a range of underlying value judgments about where human management is considered acceptable, with human intervention to reduce fuel considered more acceptable in areas where human activities already dominate management (for example, farming, plantation and residential areas) than in areas where common thoughts suggest the environment is natural (conservation areas and native forests). This underlying value appears strong, irrespective of the actual consequences of burning for some areas (for example, prescribed burning can have significant negative impacts on plantation timber if undertaken in plantation areas).

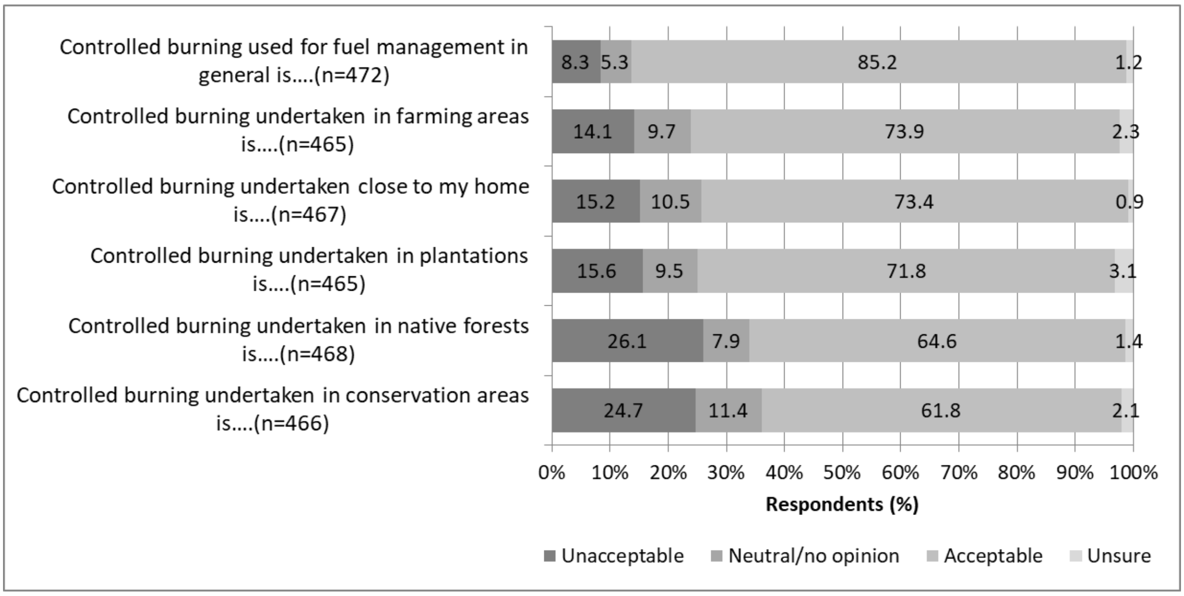

Figure 3-17 Survey respondents' views about acceptability of prescribed burning

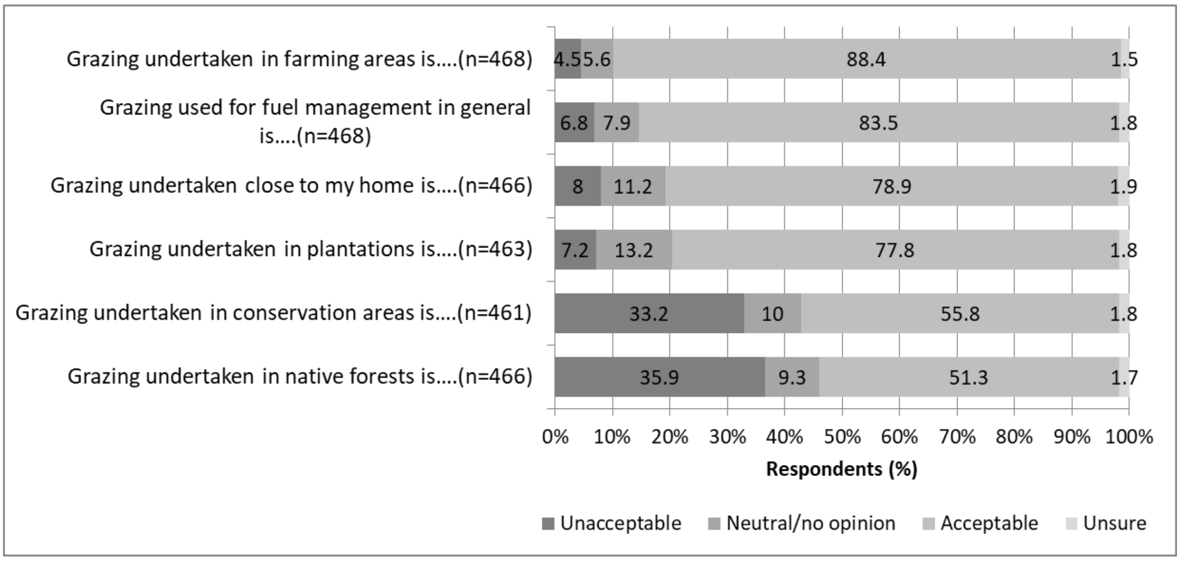

Figure 3-18 Survey respondents' views about acceptability of livestock grazing

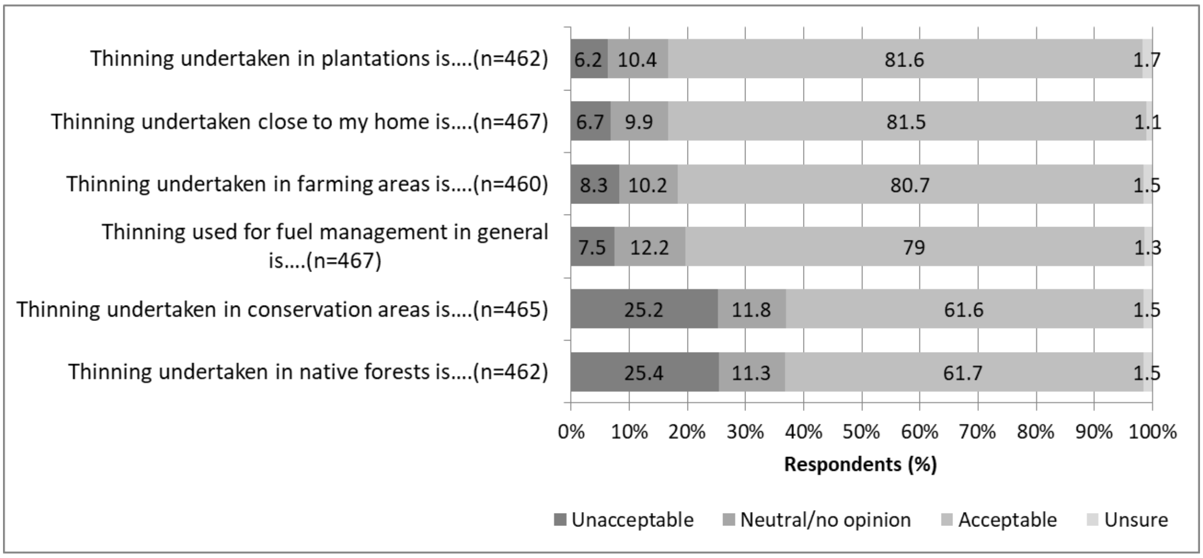

Figure 3-19 Survey respondents' views about acceptability of vegetation thinning

Survey respondents were also asked to rate how acceptable it was not to undertake any fuel management for the purposes of reducing bushfire risk to life and property (using the 7-point Likert scale). The large majority (87%) of respondents indicated that it was 'highly unacceptable' not to undertake any fuel management, indicating overall strong support for fuel management strategies in general.

Survey respondents were then asked to indicate how effective they felt each of the fuel management strategies were in reducing bushfire risk to life and property (again using a 7-point Likert scale, where 1 was 'highly ineffective', 4 was 'neutral/no opinion' and 7 was 'highly effective'). In order to display the data, the scores 1–3 were grouped to 'ineffective' and 5–7 were grouped to 'effective'. Figure 3-20 illustrates the respondents' general belief that all three methods were effective in reducing bushfire risk, with prescribed burning considered the most effective method.

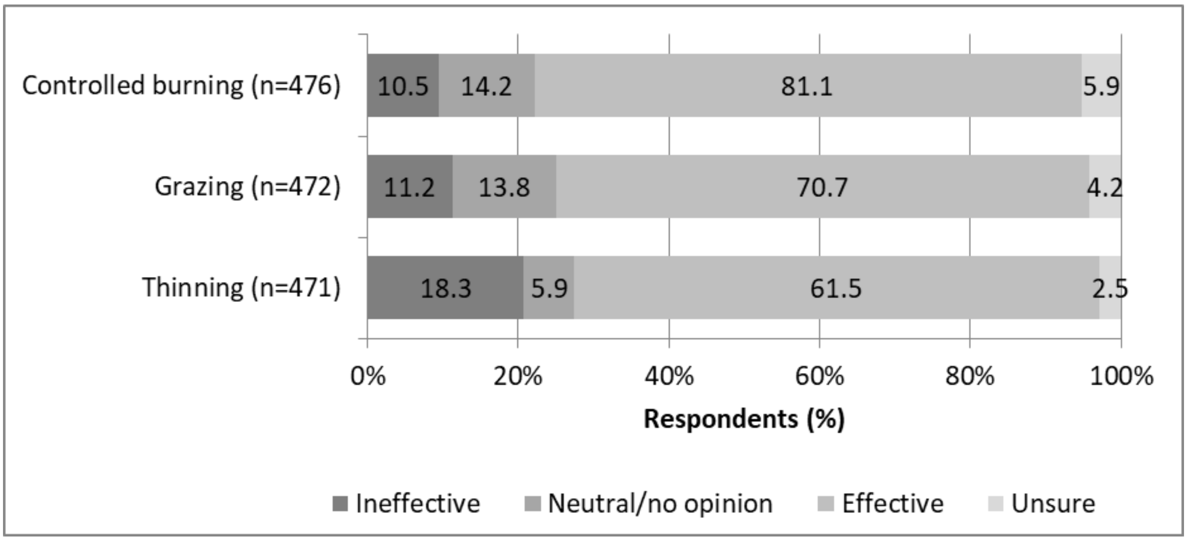

Figure 3-20 Perceived effectiveness of fuel management strategies, as rated by survey respondents

Finally, respondents were asked to rate how sensible or risky they considered all three fuel management strategies, where 1 was 'highly risky', 4 was 'neutral/no opinion' and 7 was 'highly sensible'. In order to display the data, the scores 1–3 were grouped to 'risky' and 5–7 were grouped to 'sensible'. Figure 3-21 illustrates that prescribed burning was more likely to be considered a risky strategy than the other strategies, and livestock grazing was more likely to be considered a sensible strategy.

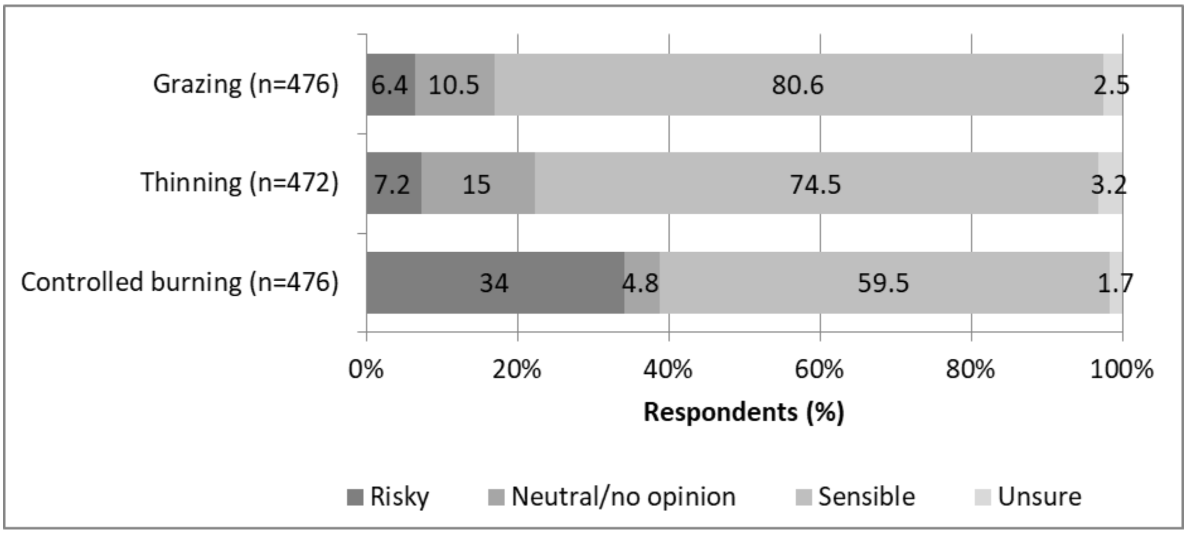

Figure 3-21 Proportion of survey respondents who considered each fuel management strategy risky versus sensible.

3.7 Conclusion

The results of the fuel management survey of the ACT and surrounding NSW region indicate different levels of knowledge and understanding about fuel management issues faced by land managers. The large majority of respondents consider fuel management an essential and acceptable activity, suggesting that some media debates misrepresent the nature and strength of opposition to fuel reduction strategies, sometimes unnecessarily polarising public debate by misrepresenting the level of public support that exists for these practices. However, it is important to note that these results cover respondents of the ACT and surrounding region only, and it is unknown if these results are transferable to other regions of Australia.

There is some public recognition of the key arguments for and against the three fuel management strategies discussed in relevant literature; however not all arguments are supported by scientific findings. Although members of the public have the general ability to make these arguments, our findings suggest there is a need to target information more effectively, acknowledging that there is a real challenge in doing so. In particular, the majority of respondents felt confident in their knowledge about fuel management, including many who had never actively sought information about fuel management in the past. This suggests it may be difficult to influence people to access more information. People tend to trust community groups to deliver information (for example volunteer bushfire brigades); however, these groups often do not have the resources needed to reach the entire community with a broad campaign. Our research suggests there is a need to target funding through these groups and support their capacity to achieve practical on-ground education.

There are clear value judgements about the areas in which it is less acceptable to undertake fuel management, in particular, areas where common discourses suggest the environment is natural (conservation areas and native forests). Fuel management was considered more acceptable in areas where human activities already dominate management (for example farming, plantation and residential areas).

The results of this survey can assist land managers to appreciate the level of understanding the public has (or does not have), and help target information campaigns to the strengths and weaknesses of the perceptions identified by respondents. The results can also help to identify the information mediums that the public are most responsive to, and the level of trust they place in different organisations.

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4 Social acceptability of fuel management in the Australian Capital Territory and surrounding region

4.1 Foreword

This chapter presents the first journal paper prepared for the thesis, which was published in 2016 in the *International Journal of Wildland Fire*. The paper analyses data from survey 1 to explore the extent to which prescribed burning, mechanical thinning and livestock grazing are considered acceptable, and by whom. The paper focusses on factors associated with social acceptability of fuel management examined in previous literature, predominantly from North America, providing a useful comparison between North American findings and those of this Australian study.

Factors potentially influencing acceptability explored in this paper included trust in information about fuel management delivered by different groups, self-rated knowledge about fuel management, previous experiences with wildfire, the location in which fuel management takes place, feelings of vulnerability to the threat of wildfire, perceptions about the importance on undertaking fuel management activities at home, and various socio-demographic characteristics.

This chapter contributes to addressing three of my research questions:

(i) Together with Chapter 3, it addresses the question *how acceptable is the use of different fuel management strategies in Australia?*

(ii) It begins to address the question *to what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?* through examining these factors in the ACT case study; Chapters 5 and 6 provide further analysis of these for both the ACT and the nationwide survey.

(iii) In the discussion, the paper begins to consider what the results mean for the question *what are the implications of better understanding acceptability for communication?*, through examining which of the factors found to be associated with acceptability can (and cannot) be modified or partly modified through communication strategies or other actions by wildfire managers. The key recommendation is that communication should target perceptions of knowledge levels of fuel management, help build understanding of the importance of taking action to reduce fire risk, and consider whether and how to increase trust in agencies responsible for fuel management as key potential 'leverage' points.

In this paper, the term ‘wildland fire’ is used to suit the terminology used in the publishing journal. Trust in sources of information about fuel management was examined in this paper rather than direct trust in organisations. This is an important distinction to note, as trust in a particular source of information or type of information may vary depending on the specific organisation that produces, endorses or communicates the information. While not a comprehensive analysis of trust, the analysis still provides insight into some aspects of trust. The limitations of the analysis of trust are further highlighted in the synthesis chapter (8.3), and discussed more in the limitations chapter (8.6).

This paper was primarily written by me, with input and review by my co-author Associate Professor Jacki Schirmer. With the exception of minor formatting edits, the text presented in this chapter is identical to that published in 2016 in *International Journal of Wildland Fire*:

Mylek, M.R., and J. Schirmer. 2016. Social acceptability of fuel management in the Australian Capital Territory and surrounding region. *International Journal of Wildland Fire* 25, 1093-1109 DOI: 10.1071/WF15164

4.2 Abstract

Managing fuel to reduce wildland fire risk often creates substantial public debate. Although the acceptability of various fuel management strategies has been explored in some regions, particularly North America, the social acceptability of fuel management is less well understood in other countries. This paper begins to address this knowledge gap by exploring acceptability by residents living in and near the Australian Capital Territory, Australia of three fuel management strategies (prescribed burning, livestock grazing and mechanical thinning) used to reduce wildland fire risk to life and property. All three were considered acceptable by most survey respondents. Acceptability did not vary substantially between strategies or by the location in which the strategy was undertaken. Acceptability of fuel management was associated with trust in fire management agencies, having knowledge of fuel management, feeling vulnerable to wildland fire and respondent characteristics such as previous effects of wildland fires, location of residence, gender, age, income and employment status.

Additional keywords: livestock grazing, mechanical thinning, prescribed burning.

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4.3 Introduction

Wildland fire management is an emotive and controversial issue worldwide (Zaksek and Arvai 2004; Gill 2008; Gill et al. 2013). One topic that often generates debate is undertaking fuel management to reduce wildland fire risk to life and property (Pyne et al. 1996; Zaksek and Arvai 2004; Gill et al. 2013). Lack of public support can in some cases result in postponement, change or prevention of implementation of fuel management strategies (Shindler et al. 2002; Brunson and Evans 2005; Toman et al. 2011; Ryan et al. 2013). It is therefore important for wildland fire managers to understand the social acceptability of their fuel management strategies (Arno and Brown 1989; Brunson and Shindler 2004; Toman et al. 2006).

Although several studies have examined social acceptability of fuel management strategies in North America (e.g. Shindler et al. 2002; Shindler and Toman 2003; Brunson and Shindler 2004; Winter et al. 2004; Brunson and Evans 2005; Toman et al. 2006; Carroll et al. 2007; Lijeblad et al. 2009; Carroll and Bright 2010), few have explored these issues in other countries, including Australia, the focus of this paper. Major wildland fire events are a common occurrence in Australia and preparation for such events is often a controversial matter. Both destruction of economic assets and loss of human life as a result of wildland fires are often graphically presented by the media, resulting in heightened debate about the need for and extent of fuel management to reduce wildland fire risk (Gill 2008). However the relevance to Australia and other regions of the social acceptability of fuel management strategies and potential management responses identified in North America is unknown.

This paper contributes to addressing this gap in understanding, focusing on acceptability of fuel management used to reduce wildland fire risk to life and property, by residents living in and near the

Australian Capital Territory(ACT), Australia. The paper has two main objectives: (1) to analyse survey responses from ACT residents and compare the results with those of previous research into the social aspects of fuel management, principally from North America; and (2) to explore when fuel management strategies are considered acceptable, and by whom, to provide wildland fire managers with a deeper insight into the social aspects of fuel management in Australia.

Three fuel management strategies commonly used to reduce wildland fire risk to life and property are examined here:

- Prescribed burning (sometimes called management-ignited fires or controlled burning) involves the planned application of fire under specified environmental/weather conditions to meet particular management objectives, such as reducing fuel load (Nelson 1979; Esplin et al. 2003; Fernandes and Botelho 2003; Bushfire Cooperative Research Centre, Australian Fire Authorities Council 2006; IFA 2006; Gill 2008; US Department of Agriculture 2009; US Fish and Wildlife Service 2009; Coalition of Prescribed Fire Councils 2015).
- Livestock grazing is the use of livestock to reduce edible fuel levels (predominantly grasses, herbs, forbs and shrubs) (Gill 2008).
- Mechanical thinning removes or alters the structure of trees or understorey to reduce the amount of combustible fuels. Thinned material is either left on-site (changing rather than reducing the fuel structure) or removed from the site (Stephens and Moghaddas 2005; Brooks et al. 2006; McCaffrey et al. 2008).

These strategies are commonly used in multiple contexts and regions, including in Australia, North America and Europe (Conard et al. 2001; Winter et al. 2002; Xanthopoulos et al. 2006; Gill 2008).

First, we review current understanding of factors influencing acceptability of fuel management strategies. We then describe the study region and data collection methods. The results examine how acceptability of fuel management varies by type of management used, the location in which it is carried out and the various factors influencing acceptability. Finally, we discuss implications of our findings for wildland fire managers seeking to increase social acceptability of existing fuel management strategies or develop new strategies that incorporate social expectations.

4.4 Social acceptability of fuel management

Wildland fire managers not only need to know if a fuel management strategy is acceptable or not, but why it is, and what factors change acceptability of the strategy. This not only helps them identify which strategies to use, and when and how to communicate about them, but can also assist in the development of new fuel management policies and strategies that are more in line with social and cultural expectations.

Social acceptability is 'a condition that results from a judgemental process by which individuals (1) incorporate the perceived reality with its known alternatives; and (2) decide whether the ''real'' condition is superior, or sufficiently similar, to the most favourable alternative condition' (Brunson 1996, p.9; Shindler et al. 2004). This definition can be translated to any natural resource management issue, including fuel management.

Previous studies have identified multiple factors that can influence a person's perceived reality (and hence acceptability) of fuel management, including the perceived outcomes of fuel management strategies, social trust in agencies undertaking fuel management, previous experiences with wildland fires and fuel management, knowledge about fuel management, feelings of vulnerability to wildland fire, the location in which the fuel management operation is taking place, and to some extent socio-demographic characteristics. These factors are discussed in more detail below.

4.4.1 Perceived outcomes of fuel management strategies

The acceptability of fuel management strategies can be influenced by a person's beliefs about the outcomes and perceived benefits versus costs (Vaske et al. 2007; McCaffrey et al. 2008; Vining and Merrick 2008), with commonly argued costs and benefits for each strategy described below.

Prescribed burning is argued to cost effectively reduce fuel load and provide breaks in fuel continuity across the landscape, by treating a range of fuels (grasses, bark, leaves, timber) over a large area. This reduces fire intensity and increases the chances of controlling a wildland fire (Gill2008). Prescribed burning can also be used for ecological purposes, where fire is required to maintain some ecosystems' composition, structure and diversity (Brockway et al. 2002; Woinarski et al. 2004; Burrows 2008). A common criticism about prescribed burning includes its effects on wildlife, wildlife habitat and plant ecosystems when implemented in the wrong areas, at the wrong time or at an inappropriate frequency. Other common arguments against prescribed burning focus on carbon emissions from burns; effects of smoke, ash, dust and smells on health, visibility and water quality; and the risk of the prescribed fire escaping (Manfredo et al. 1990; Winter et al. 2002; McCaffrey 2006; Gill 2008; Ryan et al. 2013).

Livestock grazing proponents argue that grazing reduces the volume and height of fine fuels and hence fire intensity and spread (Cheney and Sullivan 1997; Cheney et al. 1998; Gill 2008), as well as providing additional feed for livestock outside their normal grazing areas. Critics believe it has minimal positive effects and can negatively affect native pastures, soil erodibility, soil productivity, vegetation cover, the health of ecosystems, and native plants and wildlife, and that it can aid the spread of weeds (Ashton and Williams 1989; Friedel and James 1995; Dorrough et al. 2004; Williams et al. 2006; Lunt et al. 2007; Gill 2008).

Mechanical thinning is used to reduce fuels or change their arrangement, which is argued to reduce fire intensity and change fire behaviour (Brooks et al. 2006; Native Vegetation Framework

Review Task Group 2010; Victorian Bushfire Royal Commission 2010). Benefits also include the ability to easily target thinning to specific areas or fuel types with little effect on other areas or fuels and potential for commercial sale of thinned material (Stephens and Moghaddas 2005; McCaffrey et al. 2008). Common arguments against mechanical thinning include its high cost; visual impact; effects on plant and animal communities, water quality and soil; and potential to increase weeds (Winter et al. 2002; Brooks et al. 2006).

4.4.2 Social trust

Key to achieving social acceptability of management actions can be social trust (Siegrist and Cvetkovich 2000; Winter et al. 2004; Vogt et al. 2005; Toman et al. 2006; Lijeblad et al. 2009; Absher and Vaske 2011; Toman et al. 2011). Social trust refers to a person’s willingness to rely on those responsible for decision making (Winter et al. 2004). People with little knowledge and experience about an issue like reducing fuel loads cannot directly assess the risks and benefits of different approaches, and therefore judge acceptability based on social trust (Siegrist and Cvetkovich 2000), for example, their confidence that agencies implementing fuel management are competent and manage risk effectively (Winter et al. 2002; Shindler and Toman 2003; Winter et al. 2004). Adults are not likely to believe information from a source they do not view as credible (Lachapelle et al. 2003; Toman et al. 2006), suggesting that in some areas, land managers may also need to implement trust-building initiatives to help gain wider acceptance (Shindler and Toman 2003; Winter et al. 2004).

4.4.3 Experiences

Acceptance of fuel management strategies may also be influenced by personal experiences (Blanchard and Ryan 2004; Stankey and Shindler 2006), and strategies can lack support when people have no prior experience of them (Shindler et al. 2002). Support for fuel management strategies can also be influenced by positive or negative experiences of wildland fire or different fuel management strategies (Blanchard and Ryan 2007; Flint 2007; McCaffrey et al. 2013). For example, observing a good outcome from prescribed burning can increase its perceived acceptability, whereas an escaped prescribed burn can negatively influence acceptance (Brunson and Evans 2005).

4.4.4 Knowledge

Having greater knowledge about fuel management strategies has been found to be positively associated with support for those strategies (McCaffrey 2002; Blanchard 2003; Shindler et al. 2003; Shindler and Toman 2003; McCaffrey 2004; Absher and Vaske 2007). However, increasing a community’s knowledge of a strategy is not straightforward. The effectiveness of outreach media varies (McCaffrey 2004; Toman et al. 2006) and people receive and process information in different ways (Toman et al. 2006).

4.4.5 Location

The location where fuel management is taking place, particularly in relation to areas on which people tend to place a high personal value (e.g. homes or conservation areas), may influence its acceptability (Gill 2008).

For example, some US studies have found fuel management strategies are more acceptable if they occur away from residential areas (e.g. Winter et al. 2002; Weisshaupt et al. 2005). Other studies (Winter et al. 2002; Brunson and Shindler 2004; Paveglio et al. 2010) found mechanical thinning was preferred over prescribed burning in close proximity to residential areas and prescribed burning was more acceptable further from residential areas. Although it is sometimes believed that people will automatically disapprove of a controversial practice taking place close to their home (sometimes referred to as ‘not in my backyard’ syndrome), studies have discredited this line of thought in various land management situations, describing them as overly simplistic (e.g. Wolsink 1994; Upreti 2004; Kempton et al. 2005; Devine-Wright 2005 & 2009).

Gunderson and Watson (2007) found that people were strongly attached to natural landscapes, even if they had not visited them, and that attachment was associated with lower acceptability of fuel management due to a perception it interfered with ‘nature taking its course’.

4.4.6 Risk perception and feelings of vulnerability

A person’s perception of the risk of wildland fire has been found to influence their views about the acceptability of fuel management strategies, but in complex ways that depend on factors such as their personal risk tolerance, the consequences considered, how easy it is to evacuate a residence and previous experiences with wildland fire (Weible et al. 2005; McCaffrey et al. 2013). Although risk perception is a concept associated with how likely it is that an event such as a wildland fire will occur, vulnerability is more about how individuals assess whether the event will affect them and how they would cope if that event should occur, which includes various social, physical and economic considerations (Cardona 2003; Birkman 2006). Risk of exposure to an event and feelings of vulnerability are connected – without the risk, there is no feeling of vulnerability, and feelings of vulnerability do not exist unless there is a hazard to feel vulnerable to (Cardona2003). However, vulnerability is a particularly useful measure as it is a more global measure of how a person feels they will be personally affected by wildfire, combining their assessment of both the risk of the fire occurring, and of the consequences to them of fire if it did occur. In this study we considered it more appropriate to measure vulnerability than perceptions of risk.

4.4.7 Socio-demographic characteristics

Socio-demographic characteristics may influence acceptability of fuel management strategies; however, previous studies have reported inconsistent findings regarding the most influential characteristics (Shindler and Toman 2003; Weible et al. 2005; McCaffrey et al. 2013).

The factors influencing acceptability of fuel management identified in this literature review are core to the aims of this paper – exploring acceptability of fuel management strategies by residents living in and near the ACT, and how the results compare to those of similar studies in North America.

4.5 Methods

A quantitative postal survey was used to collect data examining acceptability of prescribed burning, livestock grazing and mechanical thinning specifically used to reduce wildland fire risk to life and property.

4.5.1 Study region

The study region was the ACT and surrounding areas in New South Wales (NSW), Australia (Figure 4-1). The region includes a large city (Canberra), nearby towns (Queanbeyan, Yass), peri-urban areas, small country townships, small rural properties used principally for residential purposes rather than for agricultural production (referred to in this paper as rural residential properties), productive farming properties, commercial forestry plantations, small conservations areas located within and around the urban centres and a large wilderness area (Namadgi National Park). In January 2003, a devastating wildland fire resulted in four deaths, destruction of more than 500 homes with many more damaged, loss of infrastructure and severe damage to almost 70% of the ACT's pasture, forests and nature parks (McLeod 2003).

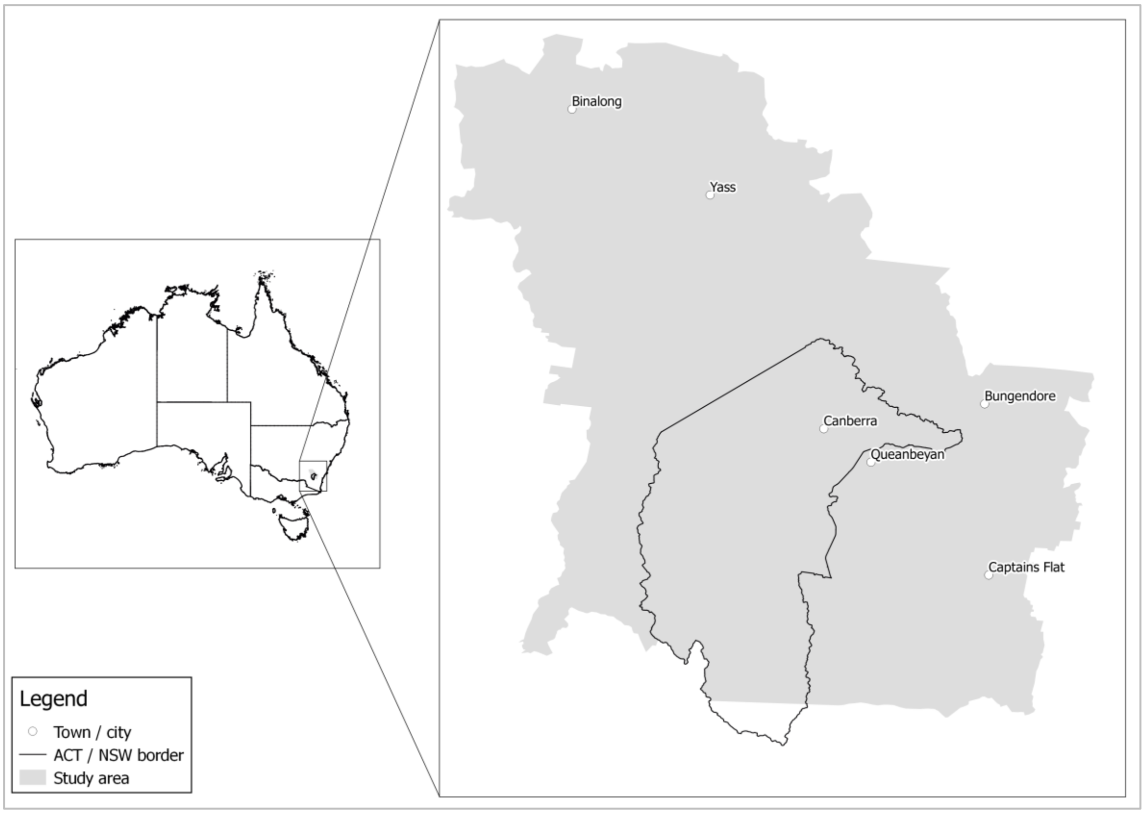

Figure 4-1: Fuel management survey region – Australian Capital Territory and surrounding New South Wales.

All three strategies are used in multiple types of landscapes and on different land tenures within the study area, both before and after the 2003 wildland fires. For example, prescribed burning is used on private land, in farming areas, in wilderness areas (national parks), as well as on public lands and in conservation areas within the city of Canberra. ACT is one of the few regions in Australia that still allows livestock grazing in conservation areas, particularly within the city of Canberra or on the outskirts of the city; however it is not used in wilderness areas. Mechanical thinning is undertaken in commercial forestry plantations surrounding Canberra, within urban areas and in the conservation areas within Canberra, but generally not in wilderness areas outside of Canberra.

The region's exposure to past wildland fire events, together with the inclusion of both urban and rural areas, the use of all three fuel management strategies throughout the region (including within urban areas), and its proximity to the researcher motivated choice of the study region.

4.5.2 Survey development

A literature review and semi-structured interviews were used to develop survey items. Interviews were conducted with 14 members of the general public and 10 informed experts (wildland fire scientists, land managers and policy makers), identifying topics of interest related to fuel management. For example, many interviewees discussed the importance of residents' actions around their home in reducing wildland fire risk; as a result, this topic was included in survey questions despite not appearing in the literature as a predictor of acceptability of fuel management strategies.

The interviews were also used to identify appropriate terminology to use in survey questions. For example, the terms 'controlled burning' rather than 'prescribed burning' and 'vegetation thinning' rather than 'mechanical thinning' were used in the survey, as the interviews revealed a lack of understanding of the terms 'prescribed burning' and 'mechanical thinning' by non-experts. The typical Australian-specific term 'bushfire' was used to ask about wildland fire. The terms 'controlled burning', 'vegetation thinning' and 'bushfire' are used in this paper when presenting specific survey questions, or when discussing groups such as bushfire brigades and bushfire councils.

The survey instrument was tested by 12 people to further refine the survey, particularly to ensure questions were understood correctly and to test interpretation of different response labelling options. The survey testers were asked to provide feedback if questions appeared vague or complicated. The survey questions were revised based on the results of survey testing and professionally printed in A4-sized booklets. Table 4-1 summarises the survey items analysed in this paper.

4.5.3 Survey delivery

The survey sample was drawn by randomly selecting names and addresses from the public telephone directory. This directory was used as it is the only publicly available source of addresses able to be used in Australia, with other sources such as the electoral roll not permitted for most types of research. Additionally, the study area boundary was the same as the telephone directory boundary. The sample was stratified, with half of the surveys being sent to urban and peri-urban dwellers and half to rural towns and properties. Properties were considered urban if situated within Canberra, Queanbeyan or Yass; peri-urban if located 500–1000m away from the outskirts of an urban area or 300–500m away from a nature reserve within urban areas; and rural if located outside the urban areas (Properties anywhere inside the study site boundary, but outside of Canberra, Queanbeyan or Yass, were considered rural).

A total of 1254 surveys were mailed across both strata in October 2011. Subsequently, 140 of those mailed were removed as invalid as the addressed resident had shifted, died or was otherwise ineligible to complete the survey. In total, 552 valid surveys reached urban residences, and 562 reached rural residences. To increase responses, a modified version of the tailored design method was used (Dillman et al. 2014). Surveys were posted to respondents with an introductory letter, information sheet and pre-paid return envelope. Reminder cards were sent weekly to non-respondents for 2 weeks, followed by a second mailed survey in the third week and another reminder card in the fourth week (Dillman et al. 2014).

Table 4-1 Summary of measures used in the survey

Note: respondents were given definitions for the terms 'fuel', 'fuel management', 'controlled burning', 'livestock grazing' and 'vegetation thinning' throughout the survey before being asked questions relating to them

Topic	Specific questions asked in survey	Measure/scale
Information about survey respondents and their experiences	Please describe the area in which you live	Response options: Urban/suburban; City outskirt or peri-urban; Rural town/rural residential; Rural property
	Please write down your suburb, town or nearest town	Open ended
	How would you rate your current level of awareness and knowledge about fuel management?	Scale: 1 (very poor) to 5 (very good)
	How vulnerable do you personally feel to the possible threat of future bushfires at your current residence (for example, direct loss of life or assets, or significant health impacts)?	Scale: 1 (not at all vulnerable) to 5 (very vulnerable)
	How important do you personally feel your own actions around your property/place of residence are in reducing bushfire risk to you? (for example clearing your gutters, removing debris and dead vegetation, keeping your grass and trees/bushes trimmed etc.)	Scale: 1 (not at all important) to 5 (very important)
	(i) Were you living (or visiting) the Canberra region during the bushfires in January 2003? (ii) Have you seen or experienced any other bushfires close to where you live/lived, whether in Canberra or elsewhere?	Response options: Yes; No
	If the respondent had experienced the 2003 Canberra bushfires, or other bushfires, they were asked: How were you impacted?	Response options (could select more than one): Loss of family/friends; loss of personal assets; damage to personal assets; personal injury or health impacts; personal anxiety; friends/family experienced damage/loss of assets; friends/family experienced injury or health impacts; colleagues/neighbours/other associates were negatively impacted in some way; not impacted at all; other impacts (describe)
Trust in information from various sources	What is your level of trust in the information about fuel management delivered by the following sources? Sources included media outlets; federal government; territory government agency – Parks Conservation and Lands; NSW state government agency – Department of Primary Industry; NSW state government agency – National Parks; NSW state forestry agency; private forestry companies; urban firefighters; bushfire councils; paid bushfire	Scale: 1 (very low) to 5 (very high)

Topic	Specific questions asked in survey	Measure/scale
	brigades; volunteer bushfire brigades; community fire units; education facilities; research institutes; friends and family	
Acceptability of prescribed burning	How unacceptable/acceptable do you personally feel it is to carry out controlled burning, specifically for the purpose of reducing bushfire risk to life and property … in general? in conservation areas?.in native forests? in farming areas? in plantations? close to home?	Scale: 1 (highly unacceptable) to 7 (highly acceptable)
	How ineffective/effective do you personally feel controlled burning is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly ineffective) to 7 (highly effective)
	How risky/sensible do you personally feel controlled burning is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly risky) to 7 (highly sensible)
Acceptability of livestock grazing	How unacceptable/acceptable do you personally feel it is to carry out livestock grazing, specifically for the purpose of reducing bushfire risk to life and property … in general? in conservation areas? in native forests? in farming areas? in plantations? close to home?	Scale: 1 (highly unacceptable) to 7 (highly acceptable)
	How ineffective/effective do you personally feel livestock grazing is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly ineffective) to 7 (highly effective)
	How risky/sensible[A] do you personally feel livestock grazing is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly risky) to 7 (highly sensible)
Acceptability of mechanical thinning	How unacceptable/acceptable do you personally feel it is to carry out vegetation thinning, specifically for the purpose of reducing bushfire risk to life and property… in general? in conservation areas? in native forests? in farming areas? in plantations? close to home?	Scale: 1 (highly unacceptable) to 7 (highly acceptable)
	How ineffective/effective do you personally feel vegetation thinning is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly ineffective) to 7 (highly effective)
	How risky/sensible do you personally feel vegetation thinning is, for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly risky) to 7 (highly sensible)
Acceptability of NO fuel management	How unacceptable/acceptable do you personally feel it is for land managers to do no fuel management at all for the purpose of reducing bushfire risk to life and property?	Scale: 1 (highly unacceptable) to 7 (highly acceptable)
Demographics	Are you male or female	Response options: Male; Female

Topic	Specific questions asked in survey	Measure/scale
	How old are you?	Open ended
	What is the highest level of formal education you have completed?	Response options: Year 9 or below; Year 10 or 11; Year 12 or equivalent; Post-school certificate or diploma; Bachelor/undergraduate degree; and Postgraduate university degree
	Please indicate the approximate total household income including all wages and salaries, pensions, investments, dividends, property returns, before tax in the last 12 months	Response options: Up to $20 000; From 20 001 to $50 000; From $50 001 to $80 000; From $80 001 to $110 000; From $110 001 to $140 000; From $140 001 to $170 000; From $170 001 to $200 000; and Over $200001
	Are you currently?	Response options: Employed; Unemployed; Retired; Other

[A]The scale ends for these items used different terms (risky and sensible), and the term ‘risky’ can be interpreted in different ways depending on the respondent, their views and their cultural background. The term‘risky’wasusedinthiscontextbecauseitisusedcolloquiallybyAustralianstomean‘non-sensible’ (and was tested in the design phase of the survey), not to be confused with formal measures of risk perception. This is known as a nemic construct, which is culturally specific and may be understood differently or not at all by other cultural groups, as opposed to a netic construct ,which is universal and understood across all cultural groups. It is therefore important to acknowledge this difference, and the potential problem in generalising the results across respondents of differing backgrounds (Warneckeetal. 1997)

4.5.4 Survey response

A total response rate of 44% was achieved (a 40% response rate from urban residences and 47% response rate from rural residences). No completed surveys were removed as unusable in our analysis.

Using the public telephone directory as the basis for the random sample created the potential for sample bias towards people with landline telephones listed in the directory. The use of landline telephones is becoming less common, particularly among younger people and those with lower incomes (Grande and Taylor 2010; ACMA 2012), and the proportion of people listed in the telephone directory is higher among older people (Grande and Taylor 2010).

A separate non-response bias study was not conducted. Our survey delivery strategy used multiple reminders as part of the tailored design method to increase the response rate and reduce non-response bias. The addition of a non-response bias study could have resulted in survey burden (Schirmer 2009). Instead, non-response bias was examined by comparing survey respondents to the 2011 Australian Census of Population and Housing (ABS 2013) benchmarks, to identify whether the sample was biased as a result of bias in those listed in the telephone directory, or bias arising from those who chose to respond to the survey. We identified a response bias towards male, older, more educated, wealthier people (Table 4-2). Using the telephone directory sample method likely provides one explanation for the bias towards older, and possibly wealthier people.

As the main objective was to understand acceptability of fuel management between different types of people rather than to make overall claims that were representative of the entire population, survey weighting was not used (Data Analysis Australia 2012).

Further details about survey methods are provided in Mylek and Schirmer (2012).

4.5.5 Data analysis

Microsoft Excel and the Statistical Package for Social Sciences (SPSS) Version 21 were used for data analysis. The dataset was explored using univariate and bivariate analyses as well as regression analysis to identify which factors best predicted acceptability of prescribed burning, livestock grazing and mechanical thinning. Three acceptability scales were developed following exploratory factor analysis: (1) acceptability of prescribed burning, (2) acceptability of livestock grazing and (3) acceptability of mechanical thinning. The results of the factor analysis are described in more detail as they are presented in the results. These scales were used in the bivariate analysis to explore variation in acceptability of fuel management strategies.

In bivariate analyses, Spearman's rho (r_s) was used to identify correlations between variables where one or both were ordinal; Kruskal–Wallis tests (H) were used to identify differences between ordinal or continuous variables for two or more independent groups; and Pearson chi-square tests (X^2)

were used to identify differences between two nominal datasets. Significant results were further explored using descriptive statistics to identify the nature of the differences.

We used multiple regression analysis to identify which of the variables explained the greatest amount of variance in acceptability of fuel management strategies.

Table 4-2 Characteristics of people who completed the survey

Information	Respondent characteristics	*n*	2011 Australian Census of Population and Housing (ABS 2013)
Gender	60% male, 40% female	479	The 2011 population of the ACT was 50% male and 50% female. Females were under-represented in the survey respondents.
Age	Mean age: 57, s.d. 13. Median age: 58. Majority of respondents were aged over 50 years	475	The median age for residents of the ACT that were over the age of 18 was 42 years of age (this survey was completed by people over the age of 18). Although some difference is expected – half of our sample was from rural areas, which on average have an older age profile – it is likely that younger people are under-represented in the survey responses.
Employment	56% employed, 35% retired, 8% ‘other’, 1% unemployed	481	This compares with 72% of the population over 15 years of age in the labour force in the ACT and 63% in NSW. The survey respondents are broadly similar in characteristics to known population parameters.
Formal education	79% of respondents indicated they had received a post-school qualification such as a certificate or diploma, a bachelor degree or postgraduate degree	479	In the ACT, 64% of residents were reported as having post-school qualifications in 2011. Survey respondents were biased towards the highly educated.
Income	The highest proportion of respondents (20%) reported an income between \$50 001 and \$80000, followed by 17% with an income between \$80 001 and \$110 000	435	In the ACT, the highest proportion of the population (14%) had an income between \$78 000 and \$103 999, whereas in NSW the highest proportion of the population (14%) had an income between \$20 800 and \$31 999. Survey respondents were biased towards those with a higher income.

4.6 Results

First we explore how acceptability of the three fuel management strategies varied when undertaken in different locations in the landscape and then how acceptability varied among respondents.

4.6.1 Type of fuel management strategy and location in which it is carried out

Prescribed burning, livestock grazing and mechanical thinning were all considered ‘acceptable’ fuel management strategies by most survey respondents (Table 4-3). All were considered slightly less acceptable when carried out in ‘natural’ landscapes (conservation areas and native forests), compared with farming landscapes, plantations or close to home; however these differences were not significant.

Mechanical thinning was perceived as less effective than prescribed burning and livestock grazing in reducing wildland fire risk, although all three strategies were rated effective by most respondents (Table 4-3).

All three strategies were more commonly considered sensible than risky, although prescribed burning was considered slightly less sensible than livestock grazing or mechanical thinning (Table 4-3).

The majority of respondents (87.7%, n = 472) indicated that it was ‘highly unacceptable’ not to undertake any fuel management, indicating overall strong support for use of fuel management strategies (Table 4-3).

Respondents’ views about the acceptability of all three strategies were strongly and consistently correlated across all locations in the landscape, with *P*-values for all associations being <0.00 (see Table Sup4 for supplementary material at the end of this chapter).

Table 4-3 Acceptability of prescribed burning, livestock grazing and mechanical thinning

Survey questions		Mean score (measured 1-7)	n
How acceptable is **prescribed burning….**[A]	…used for fuel management in general?	5.8	466
	…undertaken in conservation areas?	4.8	456
	… undertaken in farming areas?	5.4	455
	… undertaken in native forests?	4.6	461
	… undertaken in plantations?	5.4	451
	… undertaken close to my home?	5.3	463
How acceptable is **Livestock grazing….**[A]	…used for fuel management in general?	5.9	460
	…undertaken in conservation areas?	4.4	455
	… undertaken in farming areas?	6.3	459
	… undertaken in native forests?	4.5	455
	… undertaken in plantations?	5.7	453
	… undertaken close to my home?	5.8	457
How acceptable is **Mechanical thinning….**[A]	…used for fuel management in general?	5.7	461
	…undertaken in conservation areas?	4.9	458
	… undertaken in farming areas?	5.8	453
	… undertaken in native forests?	4.8	454
	… undertaken in plantations?	5.9	454
	… undertaken close to my home?	5.8	462
How **ineffective/effective** is….[B]	… Prescribed burning in general?	5.6	464
	…Livestock grazing in general?	5.2	452
	…Mechanical thinning in general are?	4.8	443
How **risky/sensible** is….[C]	…Prescribed burning in general?	4.7	468
	…Livestock grazing in general?	5.8	462
	…Mechanical thinning in general?	5.5	457
How acceptable is it….[A]	…**NOT** to carry out any fuel management at all?	1.7	472

[A] Measured on a scale from 1 (highly unacceptable) to 7 (highly acceptable)
[B] Measured on a scale from 1 (highly ineffective) to 7 (highly effective)
[C] Measured on a scale from 1(highly risky) to 7 (highly sensible)

4.6.2 Development of acceptability scales

We theorised that the fuel management acceptability questions would measure an underlying construct and could be combined into a single acceptability scale for each practice. Exploratory factor analysis was used on each fuel management strategy to examine the underlying structure of the data, using maximum likelihood and an oblique rotation (oblimin) as the items were related (Tabachnick and Fidell 2007).

Initial inspection of the correlation matrix for each fuel management practice revealed a correlation >0.8 between acceptability of conducting fuel management strategies in 'conservation areas' and 'native forests'; most other correlations were in the range 0.3–0.8. The 'conservation area' items for each fuel management practice were removed from subsequent factor analyses to address potential multicollinearity. Kaiser–Meyer–Oklin values exceeded the recommended value of 0.6 (Kaiser 1970) and *P*-values for Bartlett's test of sphericity (Bartlett 1954) were <0.00 for all three strategies, supporting the factorability of the correlation matrices (Table 4-4).

A Cronbach's alpha test was also used to measure the scales' reliability, obtaining scores of 0.88 for acceptability of prescribed burning, 0.87 for livestock grazing and 0.88 for mechanical thinning. These scores indicated a high level of internal consistency for each acceptability scale.

Although the item measuring how 'risky' or 'sensible' is each fuel management strategy has the potential to be problematic (due to the different terms used as scale ends and the different ways risk can be interpreted), survey respondents in this case have answered this item consistently with the other acceptability items, and therefore the item was included in the final acceptability scales.

The acceptability scales were calculated using the average score of the individual survey items that formed part of the scale. This simple arithmetic method was used in preference to generating a factor score as it enables replication of the scales in future studies.

The remainder of the results presented use these three acceptability scales and the single item scale 'how acceptable is it not to carry out any fuel management?' to explore variation in acceptability of fuel management strategies.

4.6.3 Associations with acceptability of fuel management strategies

Factors likely to influence acceptability of fuel management strategies were then examined.

4.6.3.1 Social trust

The groups most trusted to deliver information about fuel management were volunteer bushfire brigades, paid bushfire brigades and bushfire councils (Table 4-5). The least trusted sources of information were private forestry companies, followed by media outlets and education facilities (such as schools, technical and further education providers and universities).

Acceptability of the three fuel management strategies was not significantly correlated with trust in information delivered by media outlets, plantation managers or research institutions. Trust in information from nature reserve management agencies (ACT Park Conservation and Lands and NSW National Parks) and volunteer bushfire brigades was significantly correlated with acceptability of all strategies. Trust in other groups who deliver information about fuel management was significantly correlated with one or two fuel management strategies, but not all.

Table 4-4 Factor analysis and scale development
Extraction method: maximum likelihood. Rotation method: Oblimin with Kaiser normalisation

Scale name	Individual items forming the scale	Kaiser - Meyer -Oklin	Component eigenvalue	Variance explained
Acceptability of prescribed burning	How acceptable is prescribed burning[A]:	0.90	4.25	60.76
	Used for fuel management in general?			
	Undertaken in farming areas?			
	Undertaken in native forests?			
	Undertaken in plantations?			
	Undertaken close to my home?			
	How effective is prescribed burning in general?[B]			
	How sensible is prescribed burning in general?[C]			
Acceptability of livestock grazing	How acceptable is livestock grazing[A]:	0.89	4.28	61.16
	Used for fuel management in general?			
	Undertaken in farming areas?			
	Undertaken in native forests?			
	Undertaken in plantations?			
	Undertaken close to my home?			
	How effective is livestock grazing in general?[B]			
	How sensible is livestock grazing in general?[C]			
Acceptability of mechanical thinning	How acceptable is mechanical thinning[A]:	0.86	3.97	56.70
	Used for fuel management in general?			
	Undertaken in farming areas?			
	Undertaken in native forests?			
	Undertaken in plantations?			
	Undertaken close to my home?			
	How effective is mechanical thinning in general?[B]			
	How sensible is mechanical thinning in general?[C]			

[A] Measured on a scale from 1 (highly unacceptable) to 7 (highly acceptable)
[B] Measured on a scale from 1 (highly ineffective) to 7 (highly effective)
[C] Measured on a scale from 1 (highly risky) to 7 (highly sensible)

4.6.3.2 Previous experience

Most respondents (95.3%) had experienced a major wildland fire in the past, and had experienced varying effects of fire, most commonly personal anxiety, seeing colleagues and associates affected by the fire, and friends and family being affected (Table 4-5). Many (30.5%) indicated they experienced no negative effects (n=488). Past experience of wildland fire and acceptability of fuel management were not significantly associated. However, those who reported being personally affected as a result of a fire in the past were more likely to find all three fuel management strategies acceptable. Respondents who reported feeling anxiety during a wildland fire were slightly more likely to feel prescribed burning was unacceptable (Table 4-5).

4.6.3.3 Feelings of vulnerability

Most respondents felt moderately vulnerable to future wildland fires at their residence (mean score 3 out of 5, s.d. 1.2, n=484). Respondents living on rural properties were significantly more likely to feel vulnerable, followed by those living in rural towns or on city outskirts, with those in urban areas feeling least vulnerable (H=111.4, p<0.00, n=473).

Respondents who felt more vulnerable to wildland fire were more likely to find livestock grazing and mechanical thinning acceptable, and undertaking no fuel management unacceptable, than those who felt less vulnerable. Vulnerability was not correlated with acceptability of prescribed burning (Table 4-5).

4.6.3.4 Knowledge about fuel management strategies

Respondents felt they had a high level of knowledge about fuel management, with a mean score of 4.1 out of 5 being reported (s.d. 0.9, n=486). It is unknown, however, if this self-rated level of knowledge about fuel management differs from objectively measured levels of knowledge. Respondents with higher self-rated knowledge were more likely than those with lower self-rated knowledge to find all fuel management strategies acceptable, and undertaking no fuel management unacceptable (Table 4-5).

4.6.3.5 Importance of own actions in reducing wildland fire risk

The majority of respondents (59.6%, n=489) believed their own actions were very important in reducing wildland fire risk at their place of residence. Those who rated their actions as important were significantly more likely to believe all fuel management strategies were acceptable, and that undertaking no fuel management is unacceptable (Table 4-5).

4.6.3.6 Location of residence

Of respondents, 43.5% lived in an urban or suburban area, 33.7% on a rural property and 22.8% in a peri-urban area, rural town or rural residential area (n=478). Respondents living on rural properties were more likely to consider livestock grazing acceptable, whereas people living in urban areas were more likely to believe not undertaking any fuel management was acceptable. Residential location was not significantly associated with differences in views about prescribed burning or mechanical thinning (Table 4-5).

4.6.3.7 Socio-demographics

Male respondents, older and middle-aged respondents, employed respondents and those with low to medium incomes were significantly more likely than other respondents to feel prescribed burning was acceptable. Older and middle-aged respondents, with low to mid incomes were significantly more likely to feel mechanical thinning was acceptable. Acceptability of livestock grazing was not significantly associated with gender, age, employment status, education or income (Table 4-5).

Table 4-5 Associations between acceptability of fuel management and respondent characteristics

Survey question		**Mean score (Measured 1-5), SD, n**	**Bivariate analysis**			
			Prescribed burning	Livestock grazing	Mechanical thinning	No fuel management
			Spearman's rho			
			(r_s, p, n)	**(r_s, p, n)**	**(r_s, p, n)**	**(r_s, p, n)**
Level of **trust** in the information about fuel management delivered by ….[A]	Media outlets (for example, TV news, newspapers, radio)	3.1, 1.0, 445	0.04, 0.46, 388	0.03, 0.63, 389	0.02, 0.68, 384	-0.03, 0.53, 432
	Federal government	3.2, 1.1, 427	-0.10, 0.07, 371	**-0.13, 0.01, 383**	**-0.14, 0.01, 374**	0.07, 0.16, 416
	Territory Government agency – Parks Conservation and Lands	3.4, 1.1, 423	**-0.11, 0.04, 362**	**-0.16, 0.00, 375**	**-0.13, 0.02, 368**	0.04, 0.46, 413
	NSW State Government agency - Department of Primary Industry	3.3, 1.0, 408	-0.07, 0.21, 362	-0.06, 0.23, 368	-0.10, 0.06, 361	0.01, 0.90, 397
	NSW State Government agency – National Parks	3.3, 1.1, 416	**-0.15, 0.01, 366**	**-0.18, 0.00, 373**	**-0.13, 0.02, 361**	0.07, 0.16, 405
	NSW State forestry agency (e.g. plantation managers)	3.3, 1.1, 406	0.03, 0.64, 359	-0.02, 0.72, 365	-0.03, 0.57, 357	-0.06, 0.27, 395
	Private forestry companies	2.7, 1.1, 381	**0.15, 0.01, 339**	**0.11, 0.04, 345**	0.07, 0.24, 335	-0.06, 0.23, 371
	Urban firefighters	3.7, 1.0, 424	0.07, 0.21, 374	0.08, 0.13, 374	**0.12, 0.02, 369**	-0.08, 0.12, 413
	Bushfire councils	3.9, 1.0, 428	**0.10, 0.05, 376**	0.02, 0.69, 379	0.04, 0.46, 373	**-0.11, 0.03, 416**
	Paid bushfire brigades	4.0, 0.9, 418	**0.14, 0.01, 368**	0.10, 0.06, 372	**0.12, 0.02, 365**	**-0.20, 0.02, 407**
	Volunteer bushfire brigades	4.1, 0.9, 445	**0.20, 0.00, 387**	**0.20, 0.00, 372**	**0.19, 0.00, 382**	**-0.20, 0.00, 434**
	Community fire units	3.8, 0.9, 406	0.09, 0.10, 362	0.05, 0.31, 363	0.06, 0.24, 357	**-0.18*, 0.02, 395**
	Education facilities (e.g. schools, TAFE/CIT or universities)	3.1, 1.1, 387	**-0.12, 0.03, 346**	**-0.15**, 0.01, 350**	-0.00, 0.10, 339	0.05, 0.36, 376
	Research institutes (e.g. CSIRO, universities)	3.7, 1.1, 417	-0.06, 0.29, 366	-0.10, 0.06, 372	-0.04, 0.42, 362	0.03, 0.55, 405
	Friends and family	3.3, 1.0, 425	**0.15, 0.01, 375**	**0.13, 0.01, 382**	0.09, 0.09, 371	**-0.12, 0.02, 415**

Survey question		Mean score (Measured 1-5), SD, n	Bivariate analysis			
			Prescribed burning	Livestock grazing	Mechanical thinning	No fuel management
Vulnerability[A]	How vulnerable do you personally feel to the possible threat of future bushfires at your current residence?	3.0, 1.2, 484	0.08, 0.11, 414	**0.18, 0.00, 418**	**0.15, 0.00, 411**	**-0.10, 0.04, 465**
Knowledge[A]	How would you rate your current level of awareness and knowledge about fuel management?	4.1, 0.9, 486	**0.20**, 0.00, 415**	**0.27, 0.00, 418**	**0.16, 0.00, 411**	**-0.24, 0.00, 468**
Own actions[A]	How important do you personally feel your own actions around your property/place of residence are in reducing bushfire risk to you?	4.4, 1.0, 489	**0.21, 0.00, 417**	**0.25, 0.00, 420**	**0.20, 0.00, 413**	**-0.22, 0.00, 471**
Socio-demo	Age[A]		**0.14, 0.01, 407**	0.06, 0.24, 409	**0.14, 0.01, 404**	-0.05, 0.31, 459
	Income[A]		**-0.13, 0.01, 375**	-0.08, 0.13, 380	**-0.12, 0.02, 379**	0.01, 0.78, 422
			Kruskal–Wallis tests			
			(*H*, *p*, n)	**(*H*, *p*, n)**	**(*H*, *p*, n)**	**(*H*, *p*, n)**
	Gender[B]		**7.85, 0.01, 410**	1.56, 0.21, 412	0.03, 0.86, 407	0.22, 0.64, 464
	Education level[B,C]		1.16, 0.28, 410	3.37, 0.07, 412	2.29, 0.13, 408	0.02, 0.89, 463
	Employment status (employed, unemployed, retired)[B]		**6.36, 0.04, 380**	1.27, 0.53, 380	2.79, 0.25, 377	1.91, 0.39, 426
Location of residence[B]	Describe where you live: 1) an urban/suburban area; 2) peri-urban area, rural town/rural residential; or 3) on a rural property		1.87, 0.39, 408	**27.60, 0.00, 411**	3.47, 0.18, 405	**9.39, 0.01, 460**
		% experienced this, n=488				
Previous	Were you living (or visiting) the Canberra region during the bushfires in	95.3%	0.11, 0.74, 414	1.00, 0.32, 417	1.69, 0.19, 410	0.71, 0.40, 468

Survey question		Mean score (Measured 1-5), SD, n	Bivariate analysis			
			Prescribed burning	Livestock grazing	Mechanical thinning	No fuel management
experience[B]	January 2003, or have you experienced any other bushfires close to where you live/lived					
	Experienced personal impacts such as loss of friends/family, loss of or damage to assets, loss of pets/stock, health issues/injury, loss of power, firefighting.	25%	**12.12, 0.00, 418**	**15.02, 0.00, 420**	**7.37, 0.01, 414**	0.29, 0.59, 472
	Experienced personal anxiety	45.7%	**3.89, 0.05, 418**	2.11, 0.15, 420	0.73, 0.39, 414	1.55, 0.21, 472
	Friends or family were impacted: loss of or damage to assets, health issues/injury.	42.5%	0.14, 0.71, 418	2.44, 0.12, 420	0.61, 0.43, 414	0.40, 0.53, 472
	Colleagues, neighbours or associated were impacted.	45.5%	1.54, 0.22, 418	0.55, 0.46, 420	1.06, 0.30, 414	1.78, 0.18, 472

[A] Spearman's rho (rs) was used

[B] Kruskal–Wallis tests (H) were used

[C] Education was grouped into 1) year 12 or under and 2) further education, e.g. diploma, degree or higher degree.

4.6.4 Regression analysis

We developed three multiple regression models to further examine which variables best predicted acceptability of each fuel management strategy. The variables included were based on those that have been associated with acceptability of fuel management in previous studies, as well as results of our bivariate analysis. The variables included in the final models were respondents' self-rated level of knowledge about fuel management; trust in organisations directly related to fuel management (government agencies, bushfire brigades, forestry companies and education facilities); respondents' feelings of vulnerability to the threat of wildland fires; respondents' location of residence (urban, peri-urban/rural town or rural property); whether respondents had experienced a wildland fire in the past; and if they were affected personally by it; and importance of own actions in reducing wildland fire risk. Sociodemographic factors influencing acceptability of fuel management are generally inconsistent in the North American literature, so we chose to include only two socio-demographic variables – income and age–which were associated with more than one fuel management strategy in our bivariate analysis. The results of each regression are presented in Table 4-6

Preliminary analysis found no violations of the assumptions of normality, linearity, homoscedasticity or multicollinearity in the variables included in the three regression models, making them suitable for inclusion in the analysis. Variance inflation factor (VIF) values ranged from 1.10 to 2.05 and tolerances ranged from 0.49 to 0.91, well outside the thresholds considered indicative of likely multicollinearity (>10 for VIF values and , <0.10 for tolerance) (O'Brien 2007).

All three models explained a statistically significant amount of variance in acceptability of prescribed burning, livestock grazing and mechanical thinning (P <0.00), but the proportion of variation explained in each model was low, with R^2 values ranging from 0.12 to 0.17. Two factors predicted acceptability of all three fuel management strategies: trust in government agencies and trust in bushfire brigades. Trust in private forestry companies and being personally affected by a wildland fire predicted acceptability of prescribed burning and livestock grazing but not mechanical thinning. Income predicted acceptability of prescribed burning only, self-rated knowledge about fuel management predicted acceptability of livestock grazing only and trust in education facilities predicted acceptability of mechanical thinning only.

Table 4-6 Predictors of acceptability (of fuel management strategies)

Final model	**F**	R^2	**Sig.**	***B***	**Std Err *B***	***β***	***t***
Prescribed burning	**F(12,326) = 4.32**	**0.14**	**0.00**				
Constant			*.000*	*4.471*	*.655*		*6.822*
Trust in private forestry companies			.001	.256	.073	.206	3.513
Trust in bushfire brigades[A]			.005	.281	.100	.170	2.817
Whether respondent was personally impacted by a previous wildland fire			.008	.474	.177	.149	2.681
Respondents' income			.010	-.093	.036	-.147	-2.602
Trust in government agencies[B]			.041	-.200	.097	-.151	-2.054
Respondents' self-rated level of knowledge about fuel management			.146	.129	.089	.087	1.458
Trust in education facilities			.226	-.099	.081	-.080	-1.213
Respondents' location of residence			.302	-.098	.095	-.065	-1.033
Whether respondents experienced a previous major wildland fire event			.341	-.321	.337	-.051	-.953
Importance of own actions in reducing wildland fire risk			.489	.059	.085	.043	.693
Feelings of vulnerability to the threat of wildland fire			.969	.003	.067	.002	.039
Respondents' age			.987	.001	.033	.001	.016
Livestock grazing	**F(12,332) = 5.79**	**0.17**	**0.00**				
Constant			*.000*	*3.996*	*.543*		*7.359*
Trust in bushfire brigades[A]			.000	.314	.083	.223	3.799
Trust in government agencies[B]			.024	-.183	.081	-.162	-2.272
Trust in private forestry companies			.032	.130	.060	.123	2.158
Respondents' self-rated level of knowledge about fuel management			.045	.148	.073	.116	2.017
Whether respondent was personally impacted by a previous wildland fire			.045	.294	.146	.108	2.008
Respondents' location of residence			.051	.155	.079	.119	1.962
Respondents' income			.090	-.050	.030	-.093	-1.699
Respondents' age			.302	-.028	.027	-.060	-1.033
Trust in education facilities			.311	-.068	.067	-.065	-1.016
Feelings of vulnerability to the threat of wildland fire			.532	.035	.055	.037	.625
Importance of own actions in reducing wildland fire risk			.663	.031	.070	.026	.437
Whether respondents experienced a previous major wildland fire event			.994	.002	.279	.000	.008

Final model	**F**	***R^2***	**Sig.**	***B***	**Std Err *B***	***β***	***t***
Mechanical thinning	**F(12,322) = 3.66**	**0.12**	**0.00**				
Constant			*.000*	*4.096*	*.589*		*6.954*
Trust in government agencies[B]			.000	-.334	.087	-.286	-3.823
Trust in bushfire brigades[A]			.001	.298	.090	.204	3.319
Trust in education facilities			.029	.160	.073	.146	2.199
Respondents' income			.086	-.055	.032	-.099	-1.723
Whether respondent was personally impacted by a previous wildland fire			.162	.223	.159	.079	1.401
Respondents' location of residence			.194	-.111	.085	-.083	-1.302
Feelings of vulnerability to the threat of wildland fire			.238	.071	.060	.073	1.182
Trust in private forestry companies			.276	.071	.065	.065	1.092
Importance of own actions in reducing wildland fire risk			.277	.083	.076	.068	1.090
Whether respondents experienced a previous major wildland fire event			.491	.209	.303	.038	.689
Respondents' self-rated level of knowledge about fuel management			.574	.045	.080	.034	.563
Respondents' age			.759	.009	.029	.019	.307

[A] A combined scale of trust in paid bushfire brigades and volunteer bushfire brigades

[B] A combined scale of trust in the federal government, trust in the ACT government agency - Park Conservation and Lands and trust in the NSW State government agency - National Parks

4.7 Discussion

Understanding social acceptability of fuel management can help wildland fire decision makers recognise when existing policies and strategies are supported by the public, identify when proposed or existing strategies are likely to experience opposition and inform development of campaigns to increase public understanding of controversial strategies. It can also assist in the development of new fuel management policies and strategies that consider and acknowledge both social and cultural expectations.

Although a substantial body of literature examining social acceptability of fuel management has been carried out in North America, it was unknown if the findings were applicable to other regions such as Australia. In this discussion we present some of the key similarities and differences in findings between the regions, and provide a deeper understanding of the social aspects of fuel management in a region outside North America.

4.7.1 Does type of strategy or location in which it is carried out matter?

Although the majority of respondents considered prescribed burning, livestock grazing and mechanical thinning acceptable, they considered all three to be slightly more acceptable in landscapes dominated by human activity (farming areas, tree plantations and residential areas) than in those perceived to be natural (conservation areas and native forests). This is consistent with the findings of Gunderson and Watson (2007) that attachment to natural landscapes, regardless of whether they had been visited, was associated with lower acceptability of fuel management. Although the differences in acceptability found in our study were not significant, they still may suggest that when undertaking fuel management in landscapes perceived as being more natural, wildland fire managers should focus on communicating how the practice will affect the values of those natural places, how negative effects on those values will be avoided and how positive outcomes that enhance natural environments can result.

An often unsubstantiated view observed in general dialogue is that fuel management may be considered less acceptable if undertaken close to a person's home. Although a small number of studies have found that prescribed burning in particular is less acceptable close to residential areas (Winter et al. 2002; Brunson and Shindler 2004; Weisshaupt et al. 2005; Paveglio et al. 2010), this was not seen in the results of our study. Our results are more consistent with studies that have argued that this line of thought is overly simplistic and masks more complex factors that drive acceptability. It may be more appropriate to investigate people's interests, values, beliefs and behavioural motives behind lack of acceptance rather than assuming that those who do not accept a practice simply do not want it undertaken close to where they live (Wolsink 1994; Upreti 2004; Kempton et al. 2005; Devine-Wright 2005 & 2009).

4.7.2 Social trust

Shindler et al. (2002) identified lack of trust as a barrier to social acceptance of natural resource policies and actions, a common finding among social acceptability studies (e.g. Winter et al. 2002; Winter et al. 2004; Vogt et al. 2005; McCaffrey 2006; Toman et al. 2006; Vaske et al. 2007; Lijeblad et al. 2009; Toman et al. 2011). In this study, higher levels of trust in information delivered by organisations with direct responsibility for fuel management (e.g. bushfire brigades, land management agencies and forestry companies) had a significant association with higher acceptance of all types of fuel management strategies. This association was highlighted in our regression analysis, where higher trust in information delivered by government agencies and bushfire brigades was found to significantly predict acceptability of all three fuel management strategies. The same association was not found for other information sources that had no responsibility for fuel management, such as media outlets. Although we examined trust in information about fuel management delivered by different organisations, rather than trust in the organisations themselves, the results still suggest a need to build trust in organisations with direct responsibility for fuel management, rather than focusing largely on avenues such as the media to build acceptability of fuel management.

Trust in information delivered by private forestry companies was correlated with acceptability of prescribed burning and livestock grazing, but not mechanical thinning (also highlighted in our regression analysis). This is consistent with studies in North America reporting distrust of forestry companies undertaking thinning operations for fuel management purposes, particularly if a commercial value is placed on the thinned material (Winter et al. 2002; Nakamura 2004).

4.7.3 Targeting information dissemination to the right audience

In our study, the types of people least likely to find any fuel management strategy acceptable were women, higher income earners and younger people. Understanding why these groups find fuel management strategies less acceptable is an important step in developing information dissemination programs that are designed to reach and effectively communicate to these groups in particular. However it is unknown if these findings are relevant in other regions. McCaffrey et al.’s (2013) overview of recent literature examining social aspects of wildland fire management found that results for socio-demographic factors influencing acceptability of fuel management are inconsistent; suggesting that focusing on socio-demographic factors may be challenging, and perhaps less effective between regions.

People living in urban areas and rural towns were more likely than those living on rural properties to feel it is acceptable not to undertake fuel management, suggesting a need to focus messages to these groups; despite often not living adjacent to areas burned they may experience effects such as smoke from fuel reduction burns.

Our results suggest only a weak relationship between acceptability of fuel management and whether a respondent had previously experienced a major wildland fire unless the person was directly and personally affected in a negative way by that fire (e.g. through injury, illness or through loss of a pet or assets). This is highlighted in our regression results, where past experiences with wildland fire predict acceptability of prescribed burning but not livestock grazing or mechanical thinning, and negative personal experiences from past wildland fire predict acceptability of livestock grazing only. Results of previous studies examining associations between past experiences of wildland fires and acceptability of prescribed burning have been mixed. For example, Blanchard and Ryan (2004) found that past personal experiences of wildland fire increased acceptability of prescribed burning, whereas other studies did not find past experience with wildland fire a significant predictor of acceptability (e.g. Vogt et al. 2005; Winter et al. 2005).

Past experiences cannot be altered and as such do not provide good pathways for increasing acceptability of existing policies and strategies. Instead, focusing on areas that can be influenced as they relate to a person's current circumstances is likely to be more effective. We identified three areas in particular: knowledge about fuel management strategies, the importance of taking action to reduce wildland fire risk around the home and feelings of vulnerability to the threat of wildland fire.

Acceptability of each fuel management strategy was higher for those who felt they had good knowledge about fuel management in general, particularly for livestock grazing, which is highlighted in our regression results. This association between knowledge about fuel management strategies and acceptability for those strategies is consistent with multiple other studies examining acceptability of fuel management (e.g. McCaffrey 2002; Blanchard 2003; Shindler et al. 2003; Shindler and Toman 2003; McCaffrey 2004; Absher and Vaske 2007; McCaffrey 2006). However, simply providing information in the hope of increasing knowledge, and in turn acceptability, is not always effective. People receive information differently depending on their background knowledge and circumstances, and some ways of delivering information are more effective than others, so it is important to use different messages and media to reach as many people as possible (McCaffrey 2004; Toman et al. 2006). Understanding people's familiarity and specific knowledge or interest in fuel management is an important step in effectively developing targeted information programs (McCaffrey et al. 2008). A key challenge in increasing knowledge in the study region is that many people already feel they have good knowledge about fuel management. This confidence in self-rated knowledge may reduce the interest and willingness of residents to accept new information or seek more information. Paradoxically, increasing knowledge about fuel management may first require convincing people they still have new things to learn.

The importance people placed on their own actions around their homes in reducing wildland fire risk was strongly correlated with acceptability of all three fuel management strategies, however importance of own actions in reducing wildland fire risk did not significantly predict acceptability of any of the three fuel management strategies in our regression models. This suggests a need to further explore how individuals' own actions in reducing wildland fire risk is related to acceptability of fuel management strategies in future research. Although this particular association between homeowners actions and acceptability of fuel management was not found in previous literature, there are some similarities with North American studies that have found that in areas with high wildland fire risk, homeowners tend to feel responsible for reducing fire risk on their own property, but that it is the responsibility of the government agencies to educate them about that risk and how to mitigate it, and that these agencies are responsible for reducing risk on public lands (e.g. Winter and Fried 2000; Weisshaupt et al. 2007; Vining and Merrick 2008). Campaigns to increase acceptability of fuel management could inform people about the potential hazards on their properties and how they can be mitigated, while showing that they are also reducing wildland fire risk on public lands. This may help engender increased knowledge of the risks being addressed through fuel management, which in turn increases acceptability of fuel management strategies.

Although we found a significant bivariate relationship between acceptability of livestock grazing and mechanical thinning and how vulnerable a person feels to the threat of wildland fires at their current residence, our regression results suggest that feelings of vulnerability do not predict acceptability of any of the three fuel management strategies. Previous studies examining acceptability of fuel management have focused on risk perception rather than feelings of vulnerability (e.g. Carroll et al. 2004; Weible et al. 2005; McCaffrey et al. 2013); therefore it is difficult to assess whether the findings are similar. We chose to measure vulnerability, as it allows individuals to assess consequences to them personally if a wildland fire occurs. However, given that risk and vulnerability are closely related, we can reasonably expect that the associations would be similar. The lack of significance of vulnerability perceptions in predicting acceptability in the regression, despite a significant bivariate association, suggests a need to better understand the linkages between feelings of vulnerability to wildland fire and acceptance of fuel reduction strategies. This could better identify whether acceptance of these strategies can, at least in part, be increased through helping people understand their vulnerability to wildland fire risk. Future studies should better examine the multiple factors influencing perceptions of vulnerability, to better assess how these may link to acceptance of fuel management: for example, how perceptions of the risk of potential damage to or loss of assets influences health and safety, and how emotional distress caused by wildland fire influences feelings of vulnerability.

4.8 Conclusion

Prescribed burning, livestock grazing and mechanical thinning were all considered acceptable by the majority of respondents in our study. Acceptability was not significantly different between the fuel management strategies, or between the different locations in which they are carried out, although all were considered slightly less acceptable in areas considered 'natural' (conservation areas and native forests), compared with landscapes dominated by human activity, such as farming areas, plantations and residential areas.

Factors such as knowledge about fuel management and trust in information sources were better predictors of a person's level of overall acceptance of fuel management strategies than type of strategy or where it takes place. The importance a person placed on their own actions in reducing wildland fire risk at their place of residence, feelings of vulnerability to the threat of wildland fire, past experiences with wildland fire and some sociodemographic factors such as gender, age, employment status, income and location of residence were also associated with acceptability of fuel management, but can be more difficult to influence than knowledge and social trust.

The majority of findings in this Australian case study were consistent with findings from North American studies, in particular the importance of trust and increased knowledge in building acceptability of fuel management strategies, which are conclusions consistently found in numerous North American studies. There was one exception: the high acceptability of prescribed burning close to people's homes in our study is inconsistent with some studies in North America, but not all.

We recommend public information campaigns aiming to increase acceptability of existing fuel management policies and strategies in the Australian context focus on increasing social trust in the organisations that are directly responsible for fuel management, increasing knowledge about fuel management strategies and exploring ways to increase home owners' willingness to take personal action around their homes to reduce wildland fire risk. Further research aimed at gaining a deeper understanding about acceptability of fuel management can also assist in developing more appropriate fuel management policies and strategies that better incorporate social expectations into the future.

4.9 Acknowledgements

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4.11 Supplementary material

Table Sup4. Associations between the fuel management strategies and the locations in which they are carried out

Acceptability of:		Correlation with acceptability of…																	
		Prescribed burning in…						**Livestock grazing in…**						**Vegetation thinning in…**					
		General	Conservation areas	Farm areas	Native forests	Plantations	Close to home	General	Conservation areas	Farm areas	Native forests	Plantations	Close to home	General	Conservation areas	Farm areas	Native forests	Plantations	Close to home
Prescribed burning in general	r_s	1.00	0.67**	0.62**	0.63**	0.57**	0.69**	0.55**	0.45**	0.41**	0.48**	0.34**	0.50**	0.54**	0.45**	0.36**	0.40**	0.35**	0.50**
	P		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	466	451	450	453	446	456	453	447	453	447	446	450	453	449	447	446	447	453
Prescribed burning in conservation areas	r_s	0.67**	1.00	0.58**	0.83**	0.54**	0.57**	0.45**	0.60**	0.29**	0.60**	0.35**	0.38**	0.43**	0.59**	0.29**	0.55**	0.31**	0.42**
	P	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	451	456	447	448	440	449	443	444	447	444	440	442	445	445	441	441	440	445
Prescribed burning in farming areas	r_s	0.62**	0.58**	1.00	0.56**	0.66**	0.65**	0.36**	0.34**	0.43**	0.38**	0.46**	0.46**	0.36**	0.31**	0.45**	0.32**	0.42**	0.41**
	P	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	450	447	455	447	441	450	446	444	448	444	443	444	445	444	443	439	440	444
Prescribed burning in native forests	r_s	0.63**	0.83**	0.56**	1.00	0.59**	0.60**	0.42**	0.52**	0.34**	0.60**	0.39**	0.38**	0.45**	0.60**	0.32**	0.62**	0.34**	0.46**
	P	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	453	448	447	461	445	454	447	446	448	446	444	447	449	446	443	446	444	448
Prescribed burning in plantations	r_s	0.57**	0.54**	0.66**	0.59**	1.00	0.62**	0.34**	0.37**	0.39**	0.40**	0.53**	0.40**	0.40**	0.37**	0.34**	0.40**	0.47**	0.39**
	P	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	446	440	441	445	451	447	440	438	443	438	438	441	443	441	440	439	441	441
Prescribed burning close to home	r_s	0.69**	0.57**	0.65**	0.60**	0.62**	1.00	0.40**	0.34**	0.38**	0.35**	0.40**	0.50**	0.45**	0.38**	0.37**	0.35**	0.35**	0.52**
	P	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	456	449	450	454	447	463	451	447	452	448	447	450	451	448	446	446	445	451

Acceptability of:		Correlation with acceptability of…																	
		Prescribed burning in…						**Livestock grazing in…**						**Vegetation thinning in…**					
		General	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home	General	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home	General	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home
Livestock grazing in general	r_s	0.55**	0.45**	0.36**	0.42**	0.34**	0.40**	1.00	0.64**	0.53**	0.63**	0.52**	0.64**	0.55**	0.44**	0.40**	0.43**	0.41**	0.48**
	P	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	453	443	446	447	440	451	460	446	454	448	447	452	452	447	446	444	445	452
Livestock grazing in conservation areas	r_s	0.45**	0.60**	0.34**	0.52**	0.37**	0.34**	0.64**	1.00	0.29**	0.81**	0.39**	0.48**	0.41**	0.60**	0.26**	0.55**	0.25**	0.38**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	447	444	444	446	438	447	446	455	450	448	446	445	445	446	442	442	440	444
Livestock grazing in farming areas	r_s	0.41**	0.29**	0.43**	0.33**	0.39**	0.38**	0.53**	0.29**	1.00	0.36**	0.54**	0.62**	0.39**	0.31**	0.53**	0.33**	0.50**	0.51**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	453	447	448	448	443	452	454	450	459	451	450	453	452	449	449	446	447	452
Livestock grazing in native forests	r_s	0.48**	0.60**	0.38**	0.60**	0.40**	0.35**	0.63**	0.81**	0.36**	1.00	0.57**	0.53**	0.47**	0.62**	0.35**	0.67**	0.37**	0.47**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	447	444	444	446	438	448	448	448	451	455	448	447	447	445	444	444	443	446
Livestock grazing in plantations	r_s	0.39**	0.35**	0.46**	0.39**	0.53**	0.40**	0.52**	0.39**	0.54**	0.57**	1.00	0.61**	0.42**	0.34**	0.48**	0.40**	0.61**	0.49**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n	446	440	443	444	438	447	447	446	450	448	453	445	446	444	443	440	442	445
Livestock grazing close to home	r_s	0.50**	0.38**	0.46**	0.38**	0.40**	0.50**	0.64**	0.48**	0.62**	0.53**	0.61**	1.00	0.45**	0.33**	0.44**	0.33**	0.41**	0.60**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
	n	450	442	444	447	441	450	452	445	453	447	445	457	448	444	444	442	444	449
Vegetation thinning in general	r_s	0.54**	0.43**	0.36**	0.45**	0.40**	0.45**	0.55**	0.41**	0.39**	0.47**	0.42**	0.45**	1.00	0.64**	0.67**	0.60**	0.60**	0.71**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00

Acceptability of:		Correlation with acceptability of…																	
		Prescribed burning in…						Livestock grazing in…						Vegetation thinning in…					
		Gen-eral	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home	Gen-eral	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home	Gen-eral	Conser-vation areas	Farm areas	Native forests	Planta-tions	Close to home
	n	453	445	445	449	443	451	452	445	452	447	446	448	461	455	453	452	454	458
Vegetation thinning in conservation areas	r_s	0.45**	0.59**	0.31**	0.60**	0.37**	0.38**	0.44**	0.60**	0.31**	0.62**	0.34**	0.33**	0.64**	1.00	0.49**	0.86**	0.50**	0.57**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	n	449	445	444	446	441	448	447	446	449	445	444	444	455	458	449	450	449	453
Vegetation thinning in farming areas	r_s	0.36**	0.29**	0.45**	0.32**	0.34**	0.37**	0.40**	0.26**	0.53**	0.35**	0.48**	0.44**	0.67**	0.49**	1.00	0.52**	0.73**	0.67**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
	n	447	441	443	443	440	446	446	442	449	444	443	444	453	449	453	447	449	452
Vegetation thinning in native forests	r_s	0.40**	0.55**	0.32**	0.62**	0.40**	0.35**	0.43**	0.55**	0.33**	0.67**	0.40**	0.33**	0.60**	0.86**	0.52**	1.00	0.55**	0.61**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	n	446	441	439	446	439	446	444	442	446	444	440	442	452	450	447	454	447	450
Vegetation thinning in plantations	r_s	0.35**	0.31**	0.42**	0.34**	0.47**	0.35**	0.41**	0.25**	0.50**	0.37**	0.61**	0.41**	0.60**	0.50**	0.73**	0.55**	1.00	0.67**
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	n	447	440	440	444	441	445	445	440	447	443	442	444	454	449	449	447	454	453
Vegetation thinning close to home	r_s	0.50**	0.42**	0.41**	0.46**	0.39**	0.52**	0.48**	0.38**	0.51**	0.47**	0.49**	0.60**	0.71**	0.57**	0.67**	0.61**	0.67**	1.00
	P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	n	453	445	444	448	441	451	452	444	452	446	445	449	458	453	452	450	453	462

5 Exploring the ‘issue-attention cycle’: Does length of time since wildfire impact predict social acceptability of prescribed burning?

5.1 Foreword

Public attention to wildfire risk reduction strategies vary over time, and some theories suggest that as a consequence, acceptability of management interventions such as fuel management will decline as the length of time since experiencing a wildfire event increases. This theory was not explored in survey 1 due to funding and time constraints limiting the survey to only one region where most respondents would have experienced a similar length of time since last personally experiencing wildfire. However, I was subsequently presented with the opportunity to include questions related to my research in the Australia-wide Regional Wellbeing Survey, enabling exploration of this theory across different regions with differing wildfire experiences.

Using both qualitative interviews from the ACT region case study and data from survey 2, the paper presented in this chapter (under review by the journal *Environmental Management* at the time of thesis submission) examines whether the length of time since being personally impacted by a wildfire is associated with acceptability of prescribed burning, using Downs’ (1972) ‘issue-attention cycle’ model. In this paper a mixed method approach was used. This is different to the other papers presented in this thesis, where qualitative interviews served largely to inform question development for the quantitative surveys, and were not also drawn on in analysis as they are in this paper.

This chapter contributes to answering three of my research questions:

(i) With a focus on prescribed burning and by drawing on a nationwide dataset (different to that used in Chapters 3 and 4), I continue to answer the question *how acceptable is the use of different fuel management strategies in Australia?*

(ii) Exploring the common theory that the length of time since experiencing a wildfire is associated with acceptability of fuel management, I continue to address the question *to what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?* using the ‘issue-attention cycle’. There is limited past research examining this specific theory, and it is an important theory to address from the perspective of identifying communication needs.

(iii) If length of time since experiencing wildfire is associated with acceptability of fuel management, there are important implications for communicating about fuel management: wildfire managers may need to increase the amount invested in sustaining public attention as time increases since wildfire to ensure support for long-term implementation of prescribed burning. This chapter further addresses my research question *what are the implications of better understanding acceptability for communication?* by examining whether investment in communication needs to change over time in relation to time since wildfire experience, or whether investment can be targeted in other ways to best support long-term acceptance of fuel management strategies.

In this paper, the term ‘wildfire’ is used to suit the terminology used in the journal.

This paper was primarily written by me, with input and review by my co-author Associate Professor Jacki Schirmer. With the exception of minor formatting edits, the text presented in this chapter is identical to that published in 2020 in *Environmental Management*:

Mylek, M.R., and J. Schirmer. 2020. Exploring the ‘issue-attention cycle’: Does length of time since wildfire impact predict social acceptability of prescribed burning? *Environmental Management,* 65:433-477. DOI: 10.1007/s00267-019-01251-x

5.2 Abstract

Social acceptability of environmental management actions, such as prescribed burning used to reduce wildfire risk, is critical to achieving positive outcomes. However, environmental managers often need to implement strategies over a long time period, and sustaining long-term community support can be challenging. Public attention to environmental issues is argued to vary over time, with acceptability of management interventions theorized to decrease with time since experiencing an environmental problem. However, it is unknown whether a person needs to personally experience the problem to maintain support, or if hearing about it in the media is sufficient. In this paper we explore whether acceptability of prescribed burning used to reduce wildfire risk declines with length of time since personally experiencing a wildfire. In a sample of 4390 Australians, acceptability of prescribed burning was not predicted by length of time since personally experiencing a wildfire, or perceptions of wildfire risk. Significant predictors included perceptions of local fuel loads, and of positive and negative impacts of prescribed burning, suggesting addressing these issues may be more effective in maintaining long-term support for wildfire management policies than investing in increasing attention to wildfire risk. This suggests environmental managers can design communication strategies to maintain support for environmental actions even in the absence of an individual personally experiencing the problem the action is designed to address.

5.3 Acknowledgements

Data from the Regional Wellbeing Survey (RWS) were used in this publication. The RWS was initiated and is managed by the University of Canberra and is funded by a number of organizations. The qualitative interviews were funded by the Cooperative Research Centre for Forestry, Hobart. The contributions of interviewees and survey participants are greatly appreciated. We appreciate the valuable suggestions and input from the reviewers of this paper.

5.4 Introduction

Achieving positive environmental outcomes or reduced risk of environmental damage often requires management strategies to be implemented over long time periods, for example implementing wildfire risk reduction policies and strategies in changing communities and landscapes (Gordon et al. 2013), environmental remediation and ecological restoration (Burger 2000), long-term environmental monitoring programs (Christensen et al. 2011) and environmental watering (Conallin et al. 2018). Maintaining public support for environmental strategies over long time period is therefore important for environmental managers: without long-term support they may be unable to implement actions over the time periods necessary to make a meaningful difference. However, maintaining public support over the long term can be challenging.

The issue-attention cycle theory (Downs 1972) proposes that if people haven't experienced a problem or issue recently, they may not recognize its seriousness and will therefore be less willing to support action to prevent it, suggesting experiencing a problem may provide opportunities to increase support for implementing new policies and actions (Mockrin et al. 2018). This has clear relevance to environmental management: if a person hasn't experienced the environmental problem an action is designed to address, or only experienced it a long time ago, their support for investing in action to prevent the problem may decline over time. However, it is unknown whether a person needs to personally experience the problem, or whether sufficient attention to the problem, and hence support for action to prevent it or address it, can be sustained through media coverage of the problem when it occurs in other regions. If this is the case, ongoing awareness of environmental problems occurring in other regions can be used as a strategy to sustain support for environmental management action.

Investment in actions to reduce risk of catastrophic wildfire is a useful example of the issue of maintaining support for long-term environmental management action. Wildfires can have significant impacts on environmental, social and economic values. Prescribed burning is a management strategy commonly used to alter fuel loads in the landscape to reduce wildfire risk, which is most effective when implemented over long time periods, but is often met with social controversy (Carroll and Bright 2010; Altangerel and Kull 2013). Questions are often raised about whether environmental, physical and social costs associated with prescribed burning outweigh benefits provided by prescribed burning in reducing fuel hazards in a landscape (Whittaker and Mercer 2004; McCaffrey et al. 2008). Understanding the predictors of social acceptability of prescribed burning in a given community is an important step in successfully implementing wildfire risk management activities in ways that address public concerns and expectations, and that acknowledge environmental and social values (McCaffrey et al. 2008; Carroll and Bright 2010; McCaffrey et al. 2013; Toman et al. 2014). Social acceptance of prescribed burning is influenced by multiple factors including prior knowledge about the practice and about bushfire risk in general, social trust, personal experiences, beliefs and values, perceived effectiveness of prescribed burning, perceived benefits and costs of prescribed burning and contextual circumstances (e.g. Kneeshaw et al. 2004; Whittaker and Mercer 2004; Bell and Oliveras 2006; Toman et al. 2006; Carroll et al. 2007; Lijeblad et al. 2009; McCaffrey et al. 2013; Toman et al. 2014; Mylek and Schirmer 2016; Dupéy and Smith 2018). The majority of studies examining acceptability of prescribed burning have been undertaken in North America, with some also emerging in Australia (Mylek and Schirmer 2016). While some literature exists in other countries examining the human dimensions of wildfire, they tend to focus on the views of stakeholders such as small forest landholders, rather than on community attitudes (e.g. Valente et al. 2015, CalviñoCancela and Cañizo-Novelle 2018).

It is possible that acceptance also depends on the interaction between a person's experience of wildfire in their local physical environment, and time since this experience. Some argue that the occurrence of a major wildfire in a person's local environment triggers renewed or heightened interest in reducing wildfire risk, including managing fuels in the landscape using prescribed burning (Gill 2008; Lapsley 2015; Brown 2017). However, this interest has been argued by some wildfire managers to diminish over time, ultimately resulting in reduced interest in managing wildfire risk and lowered public support for prescribed burning. If length of time since experiencing wildfire influences acceptability of prescribed burning, there are important implications for policy and program implementation. Fuel reduction interventions are often needed when there has been a long time since fire, the point at which there are often higher fuel loads, and prescribed burning is most effective when conducted consistently over long time horizons (McCormick 2002), ideally requiring consistent public support to be implemented effectively over sustained periods of time (Brunson and Shindler 2004). Given this, the question becomes: do wildfire managers need to invest in sustaining public attention sufficiently to ensure support for long-term implementation of prescribed burning?

Despite being proposed as a potential factor influencing support for prescribed burning, no empirical studies have examined whether support for prescribed burning varies with time since personally experiencing a wildfire. Using Downs' (1972) "issue-attention cycle" model (detailed subsequently), we examine whether increased time since being directly affected by a wildfire is associated with reduced acceptability of prescribed burning in Australia, using data from a sample of 4390 people who completed the annual Regional Wellbeing Survey. We first describe the issue-attention cycle and its use to explore public attention to environmental issues. We consider arguments for and against the applicability of the model to prescribed burning in the context of large-scale media coverage of wildfires and implications of this for issue attention. We then describe the methods used to explore this theory in our study, present our results, and discuss implications of our findings for wildfire managers and wildfire management policy.

5.4.1 The issue-attention cycle

The premise behind Downs' (1972) issue-attention cycle is that an event, or problem (e.g. wildfire) can suddenly bring an issue (e.g. the need to reduce wildfire risk) to the forefront of public attention, where it remains for a short period of time. However, public attention does not remain on the issue; even if the issue is largely unresolved, attention gradually diminishes. The issue-attention cycle is argued to be a result of both the nature of some issues, and of how the media interacts with the public.

Downs (1972) argued that environmental issues naturally go through issue-attention cycles because they have, to some extent, three common characteristics, each with potential relevance to wildfire and prescribed burning. First, the problem is not experienced equally throughout a population, and not enough people are impacted directly by the problem to maintain issue-attention. Wildfire is typically directly experienced by only a small proportion of the population, meaning wildfire risk reduction strategies may be subject to rapid reduction in attention. Second, the afflictions caused by the problem can provide a benefit to parts (but not all) of the population. Wildfire risk reduction attributed to prescribed burning has potential to benefit those more at risk of being directly impacted by a wildfire, but not all parts of the population are likely to encounter experiencing a wildfire themselves. For some, the perceived costs associated with prescribed burning (e.g. smoke, visibility, aesthetic issues) potentially outweigh the perceived benefits to others. Third, attention can fade with time if the problem lacks exciting qualities, or no longer has them. Wildfires have exciting qualities during and soon after occurring, often associated with heightened media attention. However over time the news media often stops reporting on the consequences of or recovery from a specific wildfire; once the impacts are not as evident or easily seen, excitement —and therefore attention—can fade. These three characteristics were described by Downs (1972) as being expressed through the five (not always linear) stages of attention outlined in Table 5-1, which also identifies potential applicability of each stage to prescribed burning.

Table 5-1 The issue-attention cycle

Stage	Theory (Downs 1972)	Applicability to wildfire management
Pre-problem stage	An undesirable social condition exists, but has not yet captured public attention (although some groups may already be alarmed)	Wildfire risk exists, and while land managers and interest groups are likely already alarmed, it is not yet capturing public's interest.
Alarmed discovery and euphoric enthusiasm	As a result of a dramatic event the public is suddenly aware and alarmed about a problem, and the issue is exciting. This is accompanied by euphoric enthusiasm to 'solve' the problem within relatively short timeframes.	As a result of a dramatic wildfire event, which would usually be accompanied by graphical reporting of wildfires in the media, the public is suddenly aware and alarmed about wildfire risk despite only a small proportion being directly affected by the wildfire being reported on. This alarmed state may be accompanied by enthusiasm to reduce wildfire risk. It is at this point prescribed burning would theoretically receive most support.
Realising the cost of significant progress	A gradual realisation of the cost of solving a problem, not only monetary costs but also potential sacrifices by the public, or loss of benefits.	The public starts to realise the monetary and personal cost of reducing wildfire risk (e.g. visual impacts of prescribed burning, smoke impacts, potential for road closures and perceived potential for escaped burns). At this stage, the media has also likely stopped reporting as intensely about wildfires, and the excitement fades.
Gradual decline of intense public interest	There is a gradual decline in the intensity of public interest. At this time, another issue is usually entering stage 2, drawing public attention.	As time goes on, more people realise there is a cost to reducing wildfire risk. As a result, the public desire for prescribed burning diminishes.
The post problem stage	The issue has been replaced by another issue, but now has a different relationship to public attention than at stage one. New institutions, policies etc may have been implemented as a	The need for prescribed burning has been replaced as the focus of public attention, and so moves into a time of lesser attention or spasmodic recurrences of interest. However when another wildfire occurs attracting media attention, or a region experiences a high

	result of stage 2, and issues that once captured public attention can easily recapture attention.	wildfire risk season, public interest in prescribed burning can increase again. Additionally, institutions, policies or practices may have been put in place during stage 2, and their influence will remain over time.

The issue-attention cycle has been used to examine changes in public attention to various issues, from international terrorism (Petersen 2009) to bushfires (Whittaker and Mercer 2004). These studies suggest understanding issue-attention provides insights into how long people are likely to remain interested enough in any given issue to sustain support and drive meaningful change (McComas and Shanahan 1999; Daw et al. 2013).

Some have critiqued the linear nature of Downs' (1972) model, arguing it ignores the dynamics of social interactions, the unique nature of some events and the reinforcing effect of media coverage. While not disputing that interest in an issue is episodic following significant events, critics argue that the stages of the issue-attention cycle are not sequential but can occur simultaneously (Peters and Hogwood 1985; Hilgartner and Bosk 1988; Hansen 1991; McComas and Shanahan 1999; Daw et al. 2013).

Multiple studies have identified diminishing public attention to natural hazard issues over time, even when experiencing that hazard initially results in changed behaviour or support for mitigation measures (Sims and Buamann 1983; Mileti 1980). However, studies examining how experiencing natural hazards influences perceptions of risk, and support for mitigation activities, have varying and inconsistent conclusions (McCaffrey 2004). Risk perception and support for prescribed burning has been found to be higher amongst those who have personally experienced a wildfire (Blanchard and Ryan 2004, 2007; Flint 2007), albeit in some cases only slightly (Mylek and Schirmer 2016). However these studies did not examine how long ago the personal experience of wildfire occurred. Gardner and Cortner (1985) found perceptions of wildfire risk increased with time since wildfire, but did not examine support for wildfire risk mitigation.

If, consistent with the issue-attention cycle, a person's willingness to accept prescribed burning increases after being personally affected by wildfire, but then reduces over time, this presents important challenges for wildfire managers. Whereas some argue that implementing new policies

or strategies in stage two can adequately solve the problem (Whittaker and Mercer 2004), this is not the case for prescribed burning. Managing wildfire risk using prescribed burning requires long-term attention, with burning occurring at regular intervals over long periods. If low support for prescribed burning results in reduced funding and hence less prescribed burning at some points, this can limit effectiveness of prescribed burning as a strategy for reducing wildfire risk.

It is also possible that length of time since experiencing wildfire has no linear relationship with acceptability of prescribed burning, or any relationship. In an increasingly connected world (Peters et al. 2008) with new modes of communication such as social media and increased reach and visual impact of traditional media compared to when Downs developed the model (Yell 2010, Lymperopoulos and Loannou 2016), there is an increasing reinforcing effect of media coverage (McComas and Shanahan 1999). Impacts of wildfires are now 'experienced' by many on a regular basis, even when not living near or affected by those wildfires. While the role of media in the attention cycle has been examined in multiple studies (Ungar 1992; McComas and Shanahan 1999, Shih et al. 2008, Daw et al. 2013), they have not examined whether media attention can compensate for the effect of increasing time since personally experiencing wildfire. If regular media reporting maintains attention over time across large geographic regions, this may reduce the need for wildfire managers to invest in increasing attention as time since fire in a given region increases.

Australia is a country where the reinforcing effect of the media is likely to be high, with wildfire impacts graphically presented in the media on a regular basis (Hughes et al. 2007, Gill 2009, North and Bainbridge 2010), and a documented intensification of media coverage in recent decades (Yell 2010). This makes it a useful region to identify whether increasing time since being personally affected by wildfire is associated with reduced acceptability of prescribed burning, or if the reinforcing effect of media is sufficient to maintain support for prescribed burning amongst those not directly or recently personally affected by a wildfire.

5.5 Methods

Qualitative interviews with wildfire experts and members of the general public, and quantitative data collected via a survey of Australian residents, were used.

5.5.1 Qualitative interviews

Qualitative interviews were conducted with ten informed experts and 14 members of the general public, to explore acceptability of prescribed burning and fuel management in general. At the time of interview, all resided or worked in the Australian Capital Territory, for practical reasons (proximity to the researcher for face to face interviews) but most had lived or worked elsewhere in Australia previously. A purposive sampling strategy was used, with the objective of recruiting participants representing the diversity of views likely to exist about prescribed burning (Judd et al. 1991).

Informed experts were selected based on their knowledge of wildfire management. Contact details were obtained through the public domain or via recommendations from other experts. General public interviewees were selected to ensure a diversity of gender, age, location of residence, profession and interests. Emails were initially sent to the researchers' friends, colleagues and family, who were asked to forward the invitation to others outside the researchers' social, work or family circle. Recipients were asked to initiate contact if they wished to participate in the study. They were then asked to provide details about themselves, and a diversity of interviewees was selected for interview from the pool of potential participants (Table 5-2).

Table 5-2 Purposive sampling selection elements

Selection element		Number of interviewees
Informed experts involved in wildfire management		
Scientists	Focusing on wildfire behaviour, ecology and management	4
Land managers	Wildfire managers & emergency wildfire responders	3
	Land manager	1
Policy	Forest and environment governance and policy	1
	Environment, health and safety regulation and governance	1
General public		
Gender	Female	4
	Male	10
Age	25 and under	2
	26-35	2
	36-45	5
	46-55	4
	Over 55	1
Location of residence	Urban	7
	Peri-urban[a]	5
	Rural area	2

[a] Interviewees resided in suburbs located on the outskirts of Canberra

All interview participants had in some way experienced a wildfire in the past, with nine informed experts having direct involvement with wildfires (wildfire risk management, wildfire suppression or research), and 13 of the general public describing how their household had been affected by a wildfire in the past (such as loss of assets, being evacuated or being on standby for evacuation, extinguishing burning debris falling onto their property, or having a family member involved in fire suppression). All interview participants had been exposed to wildfire reporting in the media. Additionally, nine informed experts and 12 members of the public lived in or near Canberra during the 2003 Canberra wildfires, a large wildfire event in January 2003 resulting in four deaths, over 500 homes destroyed, and a significant proportion of the Territory’s National parks, pastures and production forests damaged or destroyed (McLeod 2003).

Using semi-structured interviews, informed experts were asked their views about appropriate ways to reduce wildfire risk, community reactions they had observed to prescribed burning, and factors they felt influenced perceptions about and acceptability of prescribed burning to reduce wildfire risk. In this paper, we focus on answers to the question “What community reactions have you observed with prescribed burning?”. Community members were asked about their experiences with, knowledge of, interest in, understanding of and views about wildfires, wildfire management and prescribed burning. In this paper we focus in particular on responses to the question “Has experiencing a major wildfire changed your feelings or views about fuel management in general?”.

Interviews were audio recorded. Descriptive codes were used to describe the cases, before responses were analyzed more interpretively into topics and themes using analytical (or pattern) coding (Miles and Huberman 1994, Richards 2005). Responses relating to changes in attitudes towards fuel management after experiencing wildfire were collated and categorized based on (i) whether they discussed attitudes in relation to length of time since experiencing a wildfire and (ii) the five stages of the issue-attention cycle.

5.5.2 Quantitative survey

Data from the 2016 Regional Wellbeing Survey (Wave 4) were analysed. The Regional Wellbeing Survey is an annual survey of Australian adult residents, which includes multiple topics (Schirmer et al. 2016). Respondents could complete the survey online or on paper, and were recruited using multiple methods. Flyers inviting participations were sent to (i) all postboxes in intensively sampled regions and (ii) randomly selected addresses in less intensively sampled regions. Addresses were obtained from a publicly available mailing database. Email, social media and traditional media promotion were used to increase awareness of the survey.

Table 5-3 describes survey items relevant to this paper. We examined (i) the relationship between length of time since being affected by wildfire and acceptability of prescribed burning, and (ii) relative strength of association of length of time compared to other factors known to influence acceptability of prescribed burning, specifically:

- Severity of impact: Severity of impact has been identified as a stronger predictor of acceptability of prescribed burning than having experienced a wildfire (Mylek and Schirmer 2016).
- Risk perception: Multiple studies have identified that perceived wildfire risk influences acceptability; to support actions to address a problem, people first need to perceive there is a problem (Bamberg and Rolle 2003; Weible et al. 2005; Gunderson and Watson 2007; Keys et al. 2010; McCaffrey et al. 2013, Mylek and Schirmer 2016).
- Perceived effectiveness: The perceived effectiveness of a practice (in this case, effectiveness of prescribed burning in achieving reduced wildfire risk) can influence social acceptance of that practice (Whittaker and Mercer 2004, Eriksson et al. 2008)
- Perceived benefits and costs: The perceived benefits and costs of prescribed burning can influence its social acceptability, including perceived impacts (positive or negative) on vegetation, native animals and human health, as well as perceived risk of prescribed burns escaping containment boundaries (Vaske et al 2007; Vinning and Merrick 2008)

Table 5-3 Description of survey items

Concept	Survey question	Survey response options
Acceptability of prescribed burning	How acceptable do you find the following activities in your LOCAL area? - Controlled burning[a] to reduce bushfire risk	1 "Not at all acceptable” to 7 "Very acceptable"
Severity of wildfire impact in the last 10 years	Has your household been directly affected by any of the following in the last 10 years? Bushfires	1 "Not at all affected” to 7 "Severely affected” This was subsequently transformed into a dichotomous variable for analysis: “Yes” included responses of 2-7 and “No” included responses of ‘not at all affected’
Time since being affected by a wildfire	*For those who answered 2-7 on the scale of how they were affected by bushfire in the above question, they were then asked:* What year did the bushfire occur?	2006-2010; 2011; 2012; 2013; 2014; 2015; 2016. Responses were transformed into a scale from 0 (experienced a wildfire in 2016, the year of the survey) to 6 (experienced a wildfire between 2006-2010)
Perceptions about wildfire risk	There is a high risk of bushfire[1] near where I live	1 "Strongly disagree” to 7 "Strongly agree”
Worries about wildfire impact	I worry about the potential impacts of bushfires on my property or business	1 "Strongly disagree” to 7 "Strongly agree”
Perceptions about fuel load	Fuel loads are too high in forests/woodlands in my local region	1 "Strongly disagree” to 7 "Strongly agree”
Perceptions about prescribed burning effects on vegetation	Controlled burning is good for forest/vegetation health	1 "Strongly disagree” to 7 "Strongly agree”
Perceptions about prescribed burning impacts on animals	Controlled burning harms animal and bird populations	1 "Strongly disagree” to 7 "Strongly agree”
Concern about prescribed burns escaping	There is a high risk of burns getting out of control in my region	1 "Strongly disagree” to 7 "Strongly agree”
Health concerns due to smoke from prescribed burns	I worry about the health effects of smoke from controlled burning	1 "Strongly disagree” to 7 "Strongly agree”
Perceptions about ability to undertake prescribed burning	It's difficult to get enough controlled burning done in this region	1 "Strongly disagree” to 7 "Strongly agree”
Age	How old are you?	Respondents could select from the following categories: "under 18 years"; "19 years"; five year categories from “20-24 years” to “85-89 year”; “90 years or older”. Respondents under 18 years were

Concept	Survey question	Survey response options
		excluded from the analysis.
Gender	Do you identify as…	"Female"; "Male"
Geographic location (State/Territory)	Where do you live? State/Territory you live in:	"ACT"; "NSW"; "Victoria"; "South Australia"; "Western Australia"; "Queensland"; "Tasmania"; or "Northern Territory" [b]
Residential location	Is the place where you live most or all of the time...	"In a town, suburb or village" or "On a rural property"
Geographic remoteness	Created variable from: Where do you live? [c]	"Major cities of Australia" or "Not a major city of Australia"
Farmer status	Created variable from: Are you involved in farming or work related to agriculture?	A "Farmer" is someone that indicated they own a farm, manage a farm or assist in management of a farm.

[a] The terms 'controlled burning' and 'bushfires' were used in the survey instead of 'prescribed burning' and 'wildfire', because they are the terms commonly used by non-experts in Australia. These terms are used in this paper when referring to specific survey items.
[b] Only Victoria was used in our analysis to account for the deliberate overrepresentation of that state.
[c] Respondents were asked to write the location where they live. This was recoded into a remoteness scale ("Major cities of Australia"; "Inner regional Australia"; "Outer regional Australia"; "Remote Australia"; and "Very remote Australia"). In this survey we used the categories 'major cities' and 'not major cities'.

Analysis also included potential demographic confounders to control for known sample biases and factors identified in past studies to influence acceptability of prescribed burning (McCaffrey et al. 2013; Mylek and Schirmer 2016) (described in 5.5.3 and 5.5.4).

5.5.3 Sample

In total 10,395 Regional Wellbeing Survey participants were asked all questions analysed in this paper; other survey participants were not asked some or all of the questions examined and so did not form part of the potential sample. Survey data were assessed for both missing data and to identify whether 'don't know' responses should be considered part of the valid sample, recognizing that bias can be introduced into analyses through exclusion of 'don't know' responses (Brooks 2004) and can also result from missing responses (Raghunathan 2004).

Only a small proportion of respondents (3.5%) answered 'don't know' to acceptability of prescribed burning; across other variables an average of 8.7% answered 'don't know' and there was high intersection of those who answered 'don't know' to the dependent and independent variables. There were differences in the characteristics of respondents who answered 'don't know' compared to those who answered in the middle of the acceptability scale, suggesting recoding from 'don't know' to 'neither agree/disagree' was not appropriate. Consequently, 'don't know' responses were excluded from analysis rather than re-coded as a 'neither agree/disagree' response. As described further below, we then included as control variables those characteristics of respondents known to predict 'don't know' responses (gender and age), to identify if our results still held after controlling for the effects of variation likely to have been introduced into the sample due to the removal of don't know responses.

After removing 'don't know' responses a total of 11.9% was missing from the dependent variable, an average of 11.3% from independent variables, and Little's MCAR test identified that data were not missing completely at random (X^2=1098.6, p=0.00). We elected to use listwise deletion of missing data, as even after its removal we had a large sample size (n=4390) enabling reasonable statistical power for analysis, and the non-normal distribution of key variables meant that many standard imputation techniques risked achieving increased rather than reduced bias if missing data imputation was used (Stern et al. 2009).

To ensure potential confounding effects of bias resulting from missing data (both removal of 'don't know' responses and missing responses) were addressed, given the relatively large proportion of responses removed through listwise deletion, we examined demographic variation in survey responses, and included demographic variables that predicted 'don't know' and missing responses as control factors in regression analysis. The demographic variables included were those deliberately over-sampled in the Regional Wellbeing Survey (farmers, people living outside large cities and those living in the state of Victoria), and those identified in Schirmer et al. (2016) as being unintentionally over-sampled (older respondents and female respondents), and more likely to answer 'don't know' or not to respond (younger respondents and female respondents).

The final valid sample after removal of 'don't know' and missing responses was 4390 respondents.

5.5.4 Survey data analysis

We used Spearman's rho (r_s) to identify correlations between variables where one or both were ordinal, and Kruskal–Wallis tests (H) to identify differences between ordinal or continuous variables for two or more independent groups.

Hierarchical multiple regression was used to assess the effect of time since wildfire and other factors on the dependent variable. The variables were entered in three steps:

1. Model 1 – demographic control variables: age, gender, geographic remoteness, residential location, farmer status, and whether the respondent lived in the state of Victoria or not.
2. Model 2 - factors known to influence acceptability: Perceptions about wildfire risk, worry about wildfire impacts, the severity of the wildfire impact in the last 10 years, perceptions about fuel loads, perceptions about prescribed burning effects on vegetation, perceptions about prescribed burning impacts on animals, concerns about prescribed burns escaping, health concerns from prescribed burns and perceptions about the ability to undertake prescribed burns.
3. Model 3 - Time since being affected by a wildfire.

VIF values ranged from 1.01 to 2.37 and tolerances ranged from 0.42 to 0.99. These values are outside the thresholds that are likely to indicate multicollinearity (>10 for VIF values and <0.10 for tolerance) (O'brien 2007).

Analysis was conducted using the Statistical Package for Social Sciences (SPSS) Version 25 and Microsoft Excel.

5.6 Results

5.6.1 Qualitative interviews

Of the ten experts, five had views about how experiencing a wildfire influences acceptability of wildfire management, including prescribed burning, and the role of time since experiencing a wildfire event. All community members discussed how their views had, or had not, changed over time. In analysis, four key themes emerged: (i) a view that attitudes changed dramatically after experience of wildfire; (ii) a view that wildfires receive high attention even when not occurring locally; and contrasting views from wildfire experts and residents about how views changed with time since fire, with (iii) wildfire experts feeling attention and support declined over time, while (iv) community members felt their support did not change (even if attention did).

The first key theme was consistent with stage 2 of the 'issue-attention' cycle: Alarmed discovery and euphoric enthusiasm. Several interviewees observed that awareness and 'alarm' about wildfire increased after a wildfire event, and felt support for prescribed burning increased at the same time:

> *"There was a dramatic change in attitudes immediately after the 2003 fires compared to before the fires."* Land manager

While some spoke about increased support resulting from personal experience of wildfire, others felt attention to wildfires and support for prescribed burning also resulted more generally from widespread media coverage of wildfires occurring across Australia:

> *"I think people are a lot more aware now. And I think that has a lot to do with the fact of modern media, it's in your face all the time, whether it's the 2003 fires, or a summary of 2003 or the Victorian fires, it's there on the news, on the radio… it's just put it back into people's mind that you do have to do fuel management."* Wildfire manager 1

When describing the effect of time since fire on community support, there were clear differences in the perceptions of informed experts and community members. Informed experts typically felt support for prescribed burning dropped with time since fire, consistent with stage 4 of the 'issue-attention' cycle:

"We need to keep it in the forefront of people's mind. We're seven years after the fires - we're still pretty well accepted, but it is noticeable that it's [support for prescribed burning] starting to drop off a little bit." Wildfire manager 1

"After the [2003] fires the acceptance of fuel management was more intense. It is still stronger than before the fires but it is decreasing. People forget, priorities change, attitudes change." Land manager

However only four community members felt their personal views about fuel management changed after experiencing the 2003 Canberra wildfires, while 10 did not. This is possibly because all but one community member indicated general support for prescribed burning both before and after the wildfires, with the remaining community member indicating they did not feel strongly one way or the other. Of the four who felt their personal views about fuel management had changed, two felt more fuel management was needed after experiencing a wildfire, and two felt they were reminded of the importance of fuel management in wildfire risk reduction, but did not state that their support for prescribed burning increased:

"I wasn't sort of aware of what it [a wildfire] was like before the fire, but it was pretty nasty. I think we probably need more fuel management now". Community member 1

"I think the 2003 bushfires did in a way make me more mindful of the importance of fuel modification" Community member 2

"Before the fires I never really gave it [fuel management] much thought. Fires always happened somewhere else. When the fires happened here, yeah it did change my opinion". Community member 3

Of the ten that indicated their personal beliefs did not change after experiencing the 2003 Canberra wildfires, seven felt this was because they had already experienced or were familiar with wildfires and/or fuel management.

"I already felt that way prior to [the fires]. It basically confirmed the practices that I grew up with." Community member 4

"I don't think it really did. Through my degree and taking an interest in land management and rural issues and things like that, it's always been a part of land management and I think

it is natural and something that needs to be done. It's not a controversial subject for me personally." Community member 5

Overall, the interviews identified diverse views about whether personal experience changed awareness of wildfire risk and support for fuel management, suggesting a need to assess this across a larger sample.

5.6.2 Survey

Most survey respondents felt prescribed burning was acceptable (80.4%), that there was a high risk of wildfires near where they lived (61.8%), that it was difficult to get enough controlled burning done in their local region (56.0%), and that prescribed burning was good for forest/vegetation health (75.1%) (Table 5-4). Note that this is not necessarily representative of the Australian population: key groups over-represented in the sample (farmers, older people, and those living on rural properties) were significantly more likely to find prescribed burning acceptable (Table 5-5).

Table 5-4 Acceptability of and perceptions about prescribed burning (n=4390)

Survey item	**% selected 1, 2 or 3**	**% selected 4**	**% selected 5, 6 or 7**
How acceptable do you find the following activities in your LOCAL area? - Controlled burning to reduce bushfire risk[a]	10.8	8.8	80.4
There is a high risk of bushfire near where I live[b]	26.4	11.8	61.8
I worry about the potential impacts of bushfires on my property or business[b]	38.9	12.4	48.7
Fuel loads are too high in forests/woodlands in my local region[b]	32.9	17.0	50.0
Controlled burning is good for forest/vegetation health[b]	11.8	13.1	75.1
Controlled burning harms animal and bird populations[b]	38.5	21.3	40.2
There is a high risk of burns getting out of control in my region[b]	42.0	18.3	39.7
I worry about the health effects of smoke from controlled burning[b]	49.4	16.3	34.3
It's difficult to get enough controlled burning done in this region[b]	25.5	18.5	56.0

[a] Response options: 1 "Not at all acceptable" to 7 "Very acceptable"; 4 "neither unacceptable or acceptable"

The terms 'controlled burning' and 'bushfires' were used in the survey instead of 'prescribed burning' and 'wildfire', because they are the terms commonly used by non-experts in Australia

[b] Response options: 1 "Strongly disagree" to 7 "Strongly agree"; 4 "neither disagree or agree"

Fewer felt worried about the potential impacts of wildfires on their property or business (48.7%), or that fuel loads were too high in their local region (50.0%). Less than half felt prescribed burning had negative impacts, such as harming animals/birds (40.2%), health impacts from smoke (34.3%) or a high risk of getting out of control (34.3%).

In total, 37.4% had been directly affected by a wildfire in the last ten years (n=4390), including 11.9% who indicated being very severely affected (n=1643), and 19.8% experiencing very little impact. Of all respondents, 4.6% were affected by wildfire in 2016, the year of the survey, 13.4% one to two years prior to the survey, 7.2% three to five years prior, 12.3% six to ten years prior, and 62.9% had not been affected by wildfire in the last 10 years (n=4390).

While acceptability of prescribed burning varied somewhat with time since fire (Figure 5-1), these differences were not significant (p=0.89, r_s=-0.00). There was also no significant bivariate correlation between acceptability and being affected by a wildfire at any point in the last 10 years (p =0.55, r_s =0.35). However, self-rated severity of the wildfire impact was positively correlated with acceptability (p<0.01, r_s=0.07) (Table 5-5), irrespective of time since fire.

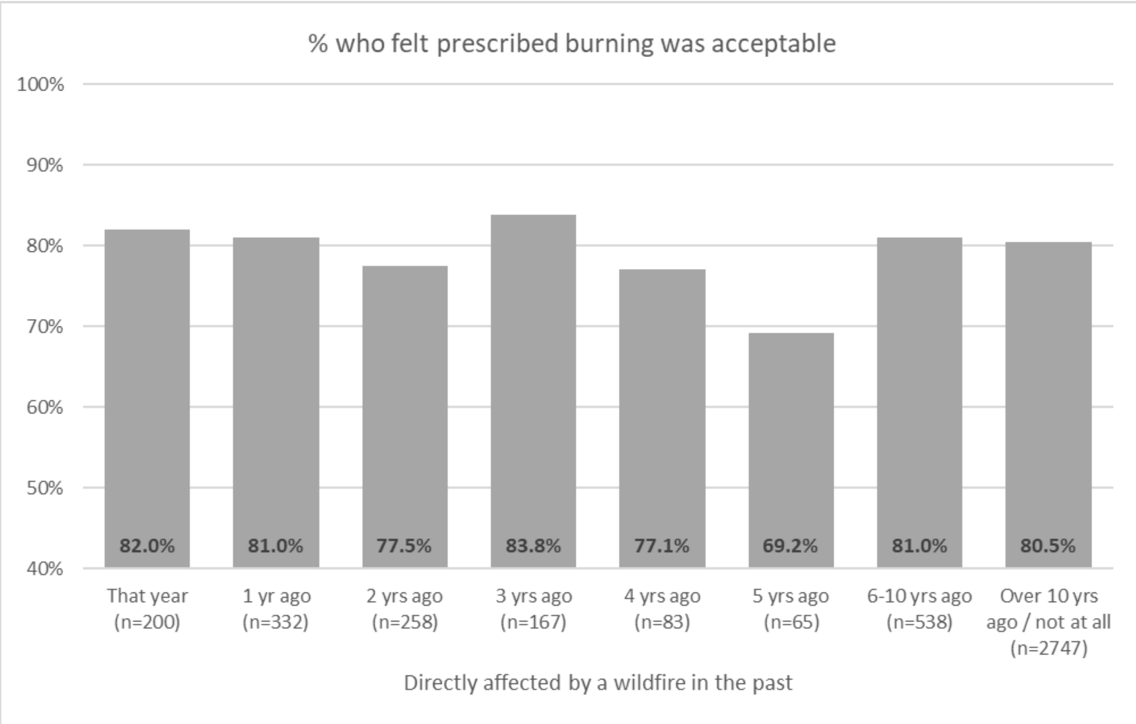

Figure 5-1 Acceptability of prescribed burning with time since being directly affected by wildfire.

Multiple factors other than personal experience of wildfire and time since that experience were significantly associated with acceptability of prescribed burning (Table 5-5). Survey participants were significantly more likely to find prescribed burning acceptable if they (i) felt that there was a high wildfire risk near where they lived, (ii) worried about wildfire impacts on their property or business, (iii) felt there were high fuel loads in their region, (iv) believed prescribed burning was good for vegetation health, or (v) believed that it was difficult to get enough prescribed burning done in their region. They were significantly less likely to find prescribed burning acceptable if they (i) felt prescribed burning harms animals and birds, (ii) were concerned about the health impacts caused by smoke from prescribed burns, or (iii) were concerned about prescribed burns escaping.

Table 5-5 Bivariate analysis of association between acceptability of prescribed burning and factors hypothesized to influence acceptability

		Acceptability of prescribed burning (n=4390)
Time since wildfire impact	r_s, p	-0.00, 0.89
Impacted by a wildfire in the last 10 years (yes/no)	H, p	0.35, 0.55
Severity of wildfire impact in the last 10 years[a]	r_s, p	0.07**, 0.00
Perceptions about wildfire risk	r_s, p	0.13**, 0.00
Worry about wildfire impacts	r_s, p	0.10**, 0.00
Perception about fuel loads	r_s, p	0.27**, 0.00
Perceptions about prescribed burning effects on vegetation	r_s, p	0.55**, 0.00
Perceptions about prescribed burning impacts on animals	r_s, p	-0.31**, 0.00
Concern about prescribed burns escaping	r_s, p	-0.23**, 0.00
Health concerns due to smoke from prescribed burns	r_s, p	-0.25**, 0.00
Perceptions about ability to undertake prescribed burning	r_s, p	0.26**, 0.00
Lives in a major city or outside major cities	H, p	0.01, 0.92
Lives on a rural property or not	H, p	13.09**, 0.00
Is a farmer or is not a farmer	H, p	28.32**, 0.00
Age	r_s, p	-0.02*, 0.24
Gender	H, p	1.91, 0.17

[a] Includes only those who were directly affected by a wildfire in the past 10 years, n=1643.
**Correlation is significant at the 0.01 level. *Correlation is significant at the 0.05 level.

5.6.3 Regression modelling

When hierarchical regression modelling was performed, all three models explained a statistically significant amount of variance in acceptability of prescribed burning ($p \leq 0.00$). The proportion of variation explained in the first step of the model (step 1) was very low (R_2= 0.02). This step included demographic variables (age, gender, farming, residential location) to control for known sample bias, and was not expected to strongly predict acceptability. The addition of step 2 variables (severity of wildfire impact, wildfire risk perception, perceptions about fuel load and perceived benefits and costs of prescribed burning) increased the R_2 value to 0.37, with a significant F change (0.00). The addition of time since being directly affected by a wildfire in the third step did not significantly change the R_2 value, remaining at 0.37, with an insignificant F change (0.39). Time since being affected by a wildfire did not predict acceptability of prescribed burning in the final model (Table 5-6).

Factors that did predict acceptability of prescribed burning were perceptions about fuel loads, perceptions about prescribed burning effects on (i) vegetation (ii) animals and (iii) human health, concerns about prescribed burns escaping, and perceptions about the ability to undertake prescribed burns. Age, gender, and whether a respondent lived in Victoria or not also predicted acceptability of prescribed burning in the final model.

Table 5-6 Regression model examining acceptability of prescribed burning

Step 1	***R^2***	**Sig.**	**FΔ**	**Sig.FΔ**	***B***	**Std Err *B***	***β***	***t***
F(6, 4383) = 13.46	**.02**	**.00**	**13.46**	**.00**				
Constant		*.00*			*6.10*	*.09*		*67.32*
Age		.00			-.04	.01	-.06	-3.95
Gender		.16			.07	.05	.02	1.41
Lives in major city/outside major city		.39			.10	.11	.01	.86
Lived on rural property/in rural town		.51			-.04	.06	-.01	-.66
Is a farmer/not a farmer		.00			.29	.07	.08	4.26
Victoria resident		.00			-.32	.05	-.09	-6.05
Step 2	***R^2***	**Sig.**	**FΔ**	**Sig.FΔ**	***B***	**Std Err *B***	***β***	***t***
F(15,4374) = 171.33	**.37**	**.00**	**271.60**	**.00**				
Constant		*.00*			*3.81*	*.13*		*28.86*
Age		.04			-.02	.01	-.03	-2.04
Gender		.01			-.12	.04	-.04	-2.82
Lives in major city/outside major city		.38			.08	.09	.01	.89
Lived on rural property/in rural town		.95			-.00	.05	-.00	-.06
Is a farmer/not a farmer		.99			.00	.06	.00	-.01
Victoria resident		.00			-.22	.04	-.06	-4.10
Severity of wildfire impact		.81			-.00	.01	-.00	-.25
Perceptions about wildfire risk		.72			.01	.01	.01	.36
Worry about wildfire impacts		.38			.01	.01	.02	.87
Perception about fuel loads		.00			.09	.01	.11	6.10
Perception about PB[a] effect on veg		.00			.41	.01	.43	30.27
Perception about PB impact on animals		.00			-.05	.01	-.05	-3.66
Concern about PB escaping		.00			-.12	.01	-.15	-9.80
Health concerns due to smoke from PB		.00			-.06	.01	-.07	-5.33
Perception about ability to do PB		.00			.08	.01	.10	6.69
Step 3	***R^2***	**Sig.**	**FΔ**	**Sig.FΔ**	***B***	**Std Err *B***	***β***	***t***
F(16,4373) = 160.66	**.37**	**.00**	**.73**	**.39**				
Constant		*.00*			*3.89*	*.16*		*24.03*
Age		.00			-.02	.01	-.03	-1.96
Gender		.01			-.12	.04	-.04	-2.81
Lives in major city/outside major city		.36			.08	.09	.01	.91
Lived on rural property/in rural town		.94			-.00	.05	-.00	-.08
Is a farmer/not a farmer		.97			.00	.06	.00	.04
Victoria resident		.00			-.21	.04	-.06	-4.84
Severity of wildfire impact		.45			-.01	.02	-.01	-.76
Perceptions about wildfire risk		.74			.01	.01	.01	.33
Worry about wildfire impacts		.38			.01	.01	.02	.87
Perception about fuel loads		.00			.09	.01	.11	6.62
Perception about PB effect on veg		.00			.41	.01	.43	30.28
Perception about PB impact on animals		.00			-.05	.01	-.05	-3.64
Concern about PB escaping		.00			-.12	.01	-.15	-9.81
Health concerns due to smoke from PB		.00			-.06	.01	-.07	-5.35
Perception about ability to do PB		.00			.08	.01	.10	6.67
Time since wildfire impact		.39			-.01	.01	-.02	-.86

[a] PB = Prescribed burning

5.7 Discussion

In our study, being affected by a wildfire and the length of time since being affected by a wildfire were not related to acceptability of prescribed burning, and did not predict acceptability of prescribed burning when other factors were controlled for. The level of impact experienced was associated with acceptability of prescribed burning in bivariate analyses, consistent with other studies (Mylek and Schirmer 2016), however this association did not hold after controlling for other factors in regression modelling. This suggests there are complex causal relationships. For example, it is possible experiencing impacts from wildfires may lead to changed views about some factors that did predict acceptability, such as about the positive and negative outcomes of prescribed burning.

While half of the informed experts interviewed felt that increased time since experiencing a wildfire reduced acceptability of prescribed burning, our results did not support this. It is possible that wildfire managers observe a drop in attention from key sources they interact with (e.g., highly interested stakeholders) that is not necessarily reflected in views of the general public, or that social tensions between groups who disagree about the use of wildfire risk reductions strategies temporarily dissolve immediately following a wildfire (Collins and Bolin 2009), suggesting steps in the issue-attention cycle can be experienced unequally throughout a population (McComas and Shanahan 1999; Daw et al. 2013). However, this theory was not explored in our study. There is a need to better understand whether there are specific groups in the population who communicate more directly with environmental managers, and whether these groups exhibit different issue-attention compared to others in the general public, who might maintain support for environmental management actions over longer periods of time.

Our findings suggest that direct personal experience of events such as wildfire in a person's immediate physical environment is not necessary for long-term acceptability of management actions such as prescribed burning, as many who had not been directly affected by a wildfire felt prescribed burning was highly acceptable. The length of time since personal experience of wildfire did not predict acceptability of prescribed burning, suggesting a significant wildfire in a different region or even a different country being reported in the media may be sufficient to maintain attention and support for prescribed burning over a period of time, rather than requiring personal experience or recent exposure to that wildfire. The impacts of a wildfire in one part of a country can now be easily communicated with people nationally and internationally (Mangold and Foulds 2009), with sensational images of wildfire devastation presented in all parts of the media on a regular basis (North and Bainbridge 2010; Yell 2010). In the context of this Australian study wildfires tend to receive high media attention. This high media attention on wildfires and their impacts can also be seen in other regions of the world, particularly in North America (McCaffrey et al. 2011, Wang et al. 2016, Boulianne et al. 2018). However, we did not ask respondents for detailed information about awareness of wildfires occurring in their region that did not affect their household, or the extent to which they had seen wildfires reported in the media. There is a need to investigate these factors further, and identify the extent of media attention required to achieve attention to and support for prescribed burning, ideally including regions in which wildfire is a less common focus of media attention.

While there is scope to further examine the issue attention cycle, there is also clear evidence that other factors influence acceptability of prescribed burning irrespective of personal experiences with wildfire or length of time since that experience. Perceptions about fuel loads, ability to undertake prescribed burns, effects of prescribed burning on vegetation and on animals, risk of prescribed burns escaping and health concerns related to smoke from prescribed burns are stronger predictors of acceptability of prescribed burning than time since fire. These findings are consistent with existing literature about factors influencing acceptability of prescribed burning and natural resource management practices in Australia and North America (e.g. Manfredo et al. 1990, Winter et al. 2002, Vaske et al. 2007, Eriksson et al. 2008, Vining and Merrick 2008, McCaffrey et al. 2013, Ryan et al. 2013, Everett et al. 2016, Mylek and Schirmer 2016). In Winter et al.'s (2002) study, support for prescribed burning was similar across diverse regions of the United States, with lower support consistently related to negative perceived outcomes of the strategy, in particular if it resulted in escaped fires, resulted in excessive smoke, or reduced the aesthetic quality of the surrounding landscape.

Perceptions of local wildfire risk and level of worry about potential wildfire impacts were not predictors of acceptability of prescribed burning in regression modelling, despite a strong bivariate correlation between these variables, and existing literature from both North America and Australia suggesting these factors influence acceptability of wildfire risk mitigation activities (Weible et al. 2005, Champ et al. 2013, McCaffrey et al. 2013, Mylek and Schirmer 2016). However some studies in North America have found that while perceptions of wildfire risk are often high, concern about the potential impacts from wildfires can be low (McCaffrey et al. 2011, Gordon et al. 2012). It is possible that the relationship between acceptability of prescribed burning and perceptions about wildfire risk is moderated by perceptions about the benefits and costs of prescribed burning, rather than by issue attention as is hypothesized in the issue-attention cycle model. This finding may reflect a cultural adaptation to wildfire hazard in a country such as Australia that has a long history of destructive wildfires, resulting in overall acceptance of new policies, risk mitigation activities and the acceptance of shared costs associated with prescribed burning (Laska 1990, Mockrin et al. 2018), as well as reasonably high public awareness about wildfire risk and prescribed burning in Australia (Mylek and Schirmer 2019). This suggests that past investment in raising awareness of wildfire risk even in areas that haven't personally experienced wildfires has created sufficient issue attention to enable support for prescribed burning if it is implemented in a way that is considered acceptable. Communication that supports more complex levels of thinking about prescribed burning has been linked to more moderate, sustainable and resilient levels of acceptability (Mylek and Schirmer 2019), which may be less prone to change based on mood or emotions (Petty and Cacioppo 1984), such as emotions based on personal experiences of a wildfire or the length of time since those experiences. In regions where awareness of the possibility of wildfires occurring is and remains high over time, communication efforts may consequently be most effective in influencing acceptability of prescribed burning if they focus on building understanding about fuel loads, and the benefits and costs of prescribed burning, rather than focusing further effort on increasing awareness of wildfire risk in an attempt to sustain support as time since a wildfire increases.

Experiencing environmental problems such wildfire disasters can provide a focusing event that inspires reflection on management actions (Mockrin et al. 2018). However, focusing on these events does not always result in policy change associated with mitigating those environmental problems (Crow et al. 2017). In our study support for prescribed burning is not strongly—if at all—predicted by time since personal experience once other issues are taken into account, suggesting that rather than seeking to reinforce the nature of the problem when a wildfire occurs, long-term stable support for action may require more focus on addressing concerns about the benefits and costs of undertaking an environmental management action, as well as communicating in ways that support more complex levels of thinking

5.7.1 Limitations

We did not ask questions about the extent to which individuals accessed media reporting about wildfires or prescribed burning, whether wildfires were experienced in the local region without being personally impacted, or the effect of seeing others impacted by wildfires. This limits the understanding about the relationship between acceptability of prescribed burning and personally experiencing a wildfire versus the potential reinforcing effect of the media in the issue-attention cycle, and should be examined in future studies. Additionally, the timeframe after experiencing a wildfire was limited to ten years in the survey question, and may need to be longer to properly assess the issue-attention cycle model.

Many of our results are consistent with previous literature, suggesting at least some generalisability in countries where there is generally high wildfire experience and exposure in the media. However it is unknown if the results are generalizable to other countries or contexts where wildfires do not occur as often as they do in Australia, and where wildfires may not be as continuously reported in the media.

5.8 Conclusion

Personally experiencing wildfire, and the length of time since being affected by that wildfire did not predict acceptability of prescribed burning in our study, suggesting the issue-attention cycle is not a simple predictor of acceptability of environmental actions. A more holistic measure is needed that better identifies how issue-attention is generated and sustained, for example through recognition of the reinforcing effect of the media versus personal experience, as well how the level of risk awareness interacts with issue attention.

Stronger predictors of acceptability of prescribed burning included perceptions about fuel loads and the ability to undertake prescribed burns, perceptions about the effects of prescribed burning on vegetation and animals, concerns about prescribed burns escaping containment lines and health concerns related to smoke from prescribed burns. This suggests that, in the case study region of Australia where wildfire awareness is already high, effective investment to build support for prescribed burning requires addressing concerns about the benefits and costs of undertaking prescribed burning more than raising awareness of risks or focusing on strategies to sustain public attention in wildfire risk mitigation strategies such as prescribed burning.

5.9 References

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6 Thinking about fuel management: The potential of Integrative Complexity Theory to inform design of communication about fuel management used to reduce wildfire risk

6.1 Foreword

In this chapter I begin to address a gap in literature identified in the introductory chapter – that existing studies have not typically linked what people think about fuel management (the focus of Chapters 3, 4 and 5) with how people think about it. In this chapter I look at how people think about fuel management, and how understanding this, combined with what people think, can assist in development of communication strategies about fuel management.

This was explored using Integrative Complexity Theory (ICT), which has emerged as a powerful approach to understanding how people think about complex and controversial issues. As ICT has been used more to understand the structure of a person's thinking, but not to explicitly inform design of communication strategies, I also drew on two other information processing theories more commonly used to inform design of communication: Heuristic-Systematic Model and Elaboration Likelihood Model.

The paper presented in this chapter was published in *Society and Natural Resources* in 2019, and focusses on understanding the integrative complexity (the way in which people structure their thoughts to form their views) of thinking about prescribed burning, mechanical thinning and livestock grazing. It then draws on the findings to explore how understanding complexity of thinking can inform design of communication about fuel management. The paper presents results from survey 1 distributed in and around the ACT, and used Carroll and Bright's (2009 & 2010) method of measuring integrative complexity using quantitative survey data.

This chapter contributes to addressing two of my research questions:

(i) By exploring the relationship between integrative complexity and acceptability of prescribed burning, mechanical thinning and livestock grazing, I begin to address my third research question *how is acceptability influenced by the way people structure their thinking about fuel management?*

(ii) Using ICT as well as drawing on other relevant information processing theories, I continue addressing research question 4 *what are the implications of better understanding acceptability for communication?* In this paper, this is done through identifying the potential implications for effective communication design of how information is processed to form views about acceptability.

American spelling is used in this Chapter to suit the requirements of the publishing journal.

This paper was primarily written by me, with input and review by my co-author Associate Professor Jacki Schirmer. With the exception of minor formatting edits, the text presented in this chapter is identical to that published in 2019 in *Society and Natural Resources*:

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6.2 Abstract

Multiple studies have examined ‘what’ people think about fuel management (perceptions); fewer have examined ‘how’ people think about it (structure of thoughts). In an Australian study, we used Integrative Complexity Theory (ICT) to explore the relationship between how complexly people thought about, and how acceptable they found, three fuel management strategies: prescribed burning, mechanical thinning and livestock grazing. Integrative complexity (IC) was associated with the direction of acceptability of the most familiar practice - prescribed burning, but trust in organizations was associated with acceptability of all strategies. IC was associated with the extremity of acceptability, with higher IC associated with more moderate attitudes. Our findings support the argument that targeting communication to (i) match current IC and (ii) encourage growth in complexity of thinking has potential to encourage more moderate and stable attitudes about fuel management.

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6.3 Introduction

Wildfire management is complex, and debate about fuel management strategies used to reduce wildfire risk is relatively common worldwide, with multiple studies identifying polarized views are often held about these strategies (Brunson and Evans 2005; Carroll and Bright 2010; Altangerel and Kull 2013). Understanding public perceptions about fuel management can assist wildfire managers to address concerns and better enable constructive public dialog about management strategies (Winter et al. 2004; Brunson and Evans 2005; McCaffrey et al. 2008; Carroll and Bright 2010). Factors known to influence perceptions of fuel management include social trust (Winter et al. 2004; Toman et al. 2011; Mylek and Schirmer 2016), prior knowledge about fuel management and wildfire risk (McCaffrey et al. 2013), personal experiences of wildfire (Blanchard and Ryan 2007), values and beliefs about wildfire management (Czaja et al. 2016), perceived costs and benefits of fuel management (McCaffrey et al. 2008), contextual circumstances (Vining and Merrick 2008) and socio-demographic characteristics (McCaffrey et al. 2013).

Understanding perceptions about fuel management (what people think) and the characteristics of people holding particular views is useful. To design effective communication about fuel management strategies that reduces polarization, it is also useful to understand how people process and structure often complex arguments about the use of different strategies to form these perceptions (how people think) (Bright and Barro 2000; Carroll and Bright 2009 & 2010; Burtz and Bright 2014; Czaja et al. 2016).

Integrative Complexity Theory (ICT), detailed subsequently, is one way to understand how people think. ICT argues that people with higher integrative complexity (IC) have less extreme attitudes about an issue due to better understanding differing and complex arguments about it, resulting in the less polarization of attitudes and reduced social conflict (Suedfeld and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000). Understanding IC about fuel management has potential to help wildfire managers identify likely public responses to its use (Suedfeld et al. 1977; Raphael 1982; Carroll and Bright 2009; Czaja et al. 2016), and to inform design of communication that is targeted to the level of complexity at which a person is thinking, improving their ability to process that information (Bright and Barro 2000; Carroll and Bright 2009; Czaja et al. 2016). A person presented with information more complex than the level at which they are thinking can experience information saturation, resulting in poor information processing (Schroder et al. 1967; Petty and Cacioppo 1984; Hunsberger et al. 1992). There may also be potential to design communication to build complexity of thinking (e.g. Hunsberger et al. 1992), with the resulting higher IC argued to result in less extreme attitudes and reduced social conflict (Carroll and Bright 2010).

While ICT has been used to understand complexity of thinking about fuel and wildfire management, detailed subsequently (Burtz and Bright 2007; Carroll and Bright 2009 & 2010; Burtz and Bright 2014; Czaja et al. 2016), there has been limited examination of how IC differs between fuel management strategies, how strongly IC is associated with acceptability of these strategies compared to other factors known to influence acceptability of fuel management, or of implications for communication about fuel management.

In this paper, we explore the association between IC and acceptability of prescribed burning, mechanical thinning and livestock grazing, each of which is used to differing degrees in the study region of the Australian Capital Territory, Australia. In the study region prescribed burning is used extensively, with large amounts of information available about it and regular media attention to its use. Mechanical thinning (the use of machinery to remove or alter the structure of fuels in a landscape) and livestock grazing are less commonly used, with less public discussion about, and a lower familiarity with, their use as fuel management strategies (Ximenes et al. 2017).

Our objectives are to better understand (i) how this association varies across fuel management practices residents are more and less familiar with, and (ii) the extent to which IC versus other factors are associated with direction and extremity of acceptability of these practices. We first review ICT, and situate it within a broader theory on information processing and attitude formation, using this review to identify key hypotheses about how IC may vary across more and less familiar strategies, and the likely associations between IC and acceptability of these strategies. The Australian case study, methods, and findings are then presented. Our discussion examines the implications of the findings for designing communication strategies that consider how a person thinks, as well as what they think, with the goal of building more moderate, resilient and stable attitudes.

6.4 Information processing and attitude formation

Multiple studies examine how to increase knowledge or reduce misperceptions of wildfire management, often with the objective of increasing support for management practices. These often focus on how best to deliver information to reach a diversity of people using tailored messages and mediums (e.g. Toman et al. 2006; McCaffrey 2004a, 2004b; McCaffrey et al. 2008; Valez et al. 2017). However, few studies have considered how best to tailor the complexity of information presented, or whether increasing support is the only or the optimal approach to reducing risk of social conflict about fuel management.

ICT offers a differing perspective for structuring communication about fuel management. This theory suggests a need to encourage complex thinking that considers rather than dismisses different views, with the objective of promoting more moderate and stable attitudes, and of reducing extreme views formed based on simpler information processing (Bright and Barro 2000; Carroll and Bright 2009 & 2010). From this perspective, the focus of communication about wildfire management shifts from increasing support to building complexity of thinking (Hunsberger et al. 1992; Carroll and Bright 2010; Czaja et al. 2016).

Information processing theories examine how people receive and process information. Within these, ICT examines how complexly a person thinks about an issue, focusing on the structure of thoughts (how a person conceptualizes an issue and how the differing information is integrated) rather than the content (Tetlock 1989). IC is measured based on the different arguments people consider about an issue (differentiation) and how this information is incorporated (integration). Someone who acknowledges one aspect of an issue (indicating limited consideration of alternative arguments) has low/no differentiation compared to someone who acknowledges multiple aspects (considering competing interests and views). Integration occurs when a person recognizes complex connections between different aspects of an issue and tradeoffs between these aspects. IC is measured by assessing the levels of both differentiation and integration (Tetlock 1989; Suedfeld et al. 1996; Carroll and Bright 2010). ICT was initially used to explore political preferences and actions during international crises (e.g. Raphael 1982; Tetlock 1989), and subsequently applied to broader topics including capital punishment (de Vries and Walker 1987), nuclear weapon use (Kristiansen and Matheson 1990), abortion (Dillon 1993), slavery (Tetlock et al. 1994), plant and wildlife protection (Bright and Barro 2000), and wildfire management (Burtz and Bright 2007; Carroll and Bright 2009 & 2010; Burtz and Bright 2014; Czaja et al. 2016).

ICT has similarities with other information processing theories, particularly the Heuristic-Systematic Model (HSM) and Elaboration Likelihood Model (ELM). These argue that people who process information heuristically (‘peripheral route’) use the least cognitive effort possible to process information, relying more on factors such as perceived credibility of information sources and personal mood to form attitudes about an issue. Those who process information via more systematic processing (‘central route’) use greater cognitive effort, and are able to think critically and arrive at a reasoned, evidence-based attitude about a topic which is more resilient to change (Chen et al. 1999; Chaiken 1980; Petty and Cacioppo 1984; Petty 1986; Eagly and Chaiken 1993). Low IC is consistent with use of heuristic processing and high IC with systematic processing.

Theories such as HSM and ELM are typically used to examine how information processing mediates attitude change in response to persuasive (one sided) messaging, with systematic processing often associated with attitude change consistent with this messaging. However the extremity of attitudes is not typically examined (Chaiken 1980; Petty and Cacioppo 1984; Petty 1986; Eagly and Chaiken 1993).

Multiple studies have found attitude direction (support or opposition) is often not related to IC, but attitude extremity is, with more extreme attitudes (positive or negative) associated with lower IC, and more moderate attitudes with higher IC (de Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000). This is consistent with Schroder et al.’s (1967) argument that attitudes formed using simple information processing are more categorical (and more likely to be extreme), while attitudes formed using more complex information processing, drawing on a range of information, are less categorical and less extreme. ICT enables exploration of associations between complexity of thinking and attitude direction and extremity, in the absence of persuasive messaging. This helps identify potential public responses to fuel management strategies, and can inform design of communication able to be processed effectively.

The relationships between attitude direction, attitude extremity and complexity of thinking are not simple. For example, Carroll and Bright (2009) found more extreme attitudes about prescribed burning were associated with lower IC, and that support for prescribed burning was associated with higher IC. Many factors can contribute to whether IC predicts acceptability, including how complexity of thinking interacts with knowledge about an issue (Bright and Barro 2000), and how a person’s thinking is affected by their stress levels (Raphael 1982). Some studies have found those with higher IC rely less on values and beliefs in forming attitudes about prescribed burning, and more on their integratively complex thinking (with some exceptions), resulting in a higher acceptance of management approaches different to those they usually approve of (Carroll and Bright 2009 & 2010; Czaja et al. 2016). This is consistent with HSM and ELM, which argue those with more systematic processing rely on critically analyzing available information, and less on other factors to form attitudes. Burtz and Bright (2014), however, suggest that those with higher IC rely more on values when forming attitudes.

For those with lower IC (heuristic processing), other aspects of communication may influence attitude formation, particularly how credible they find the information source (Petty 1986; Eagly and Chaiken 1993; Toman et al. 2006; Czaja et al. 2016): social trust in an organization commonly predicts a higher acceptance of actions they recommend (Siegrist and Cvetkovich 2000; Winter et al.

2004). A person with low IC may rely on their level of trust in those communicating the information when forming attitudes, rather than critically evaluating the information content (Trumbo and McComas 2008).

Past studies suggest IC is likely to differ between more and less familiar practices. As a person becomes familiar with a practice – through directly observing it, or being exposed to differing information about it – they build more knowledge and think more complexly about it (e.g. Bright and Barro 2000). This means attitude formation about less familiar practices may rely more on factors other than processing information received. However, this posited difference in information processing versus other factors is likely to differ depending on the extent to which a person is motivated to seek out new information on a subject and their ability to critically evaluate messages (Petty and Cacioppo 1984). A person who feels they already have a good understanding of fuel management may have a reduced willingness to understand different points of view, or process new information – the Dunning-Kruger effect (Kruger and Dunning 1999; Motta et al. 2018) – presenting potential challenges for communication strategies (Kunda 1990). This means it is important to identify whether a person actively seeks out information on an issue, and feels they have a high level of knowledge about it, as part of understanding whether and why they rely on information processing versus other factors in forming attitudes.

This past work suggests that in our study IC is likely to be higher for the more familiar strategy of prescribed burning than the less familiar strategies of mechanical thinning and livestock grazing. It also suggests high IC will more likely be associated with moderate attitudes than extreme positive or negative attitudes, and that the extent to which individuals rely on IC versus other factors such as self-rated knowledge, information seeking behavior and social trust will vary when forming attitudes. A person who feels they have adequate knowledge about fuel management is less likely to process new information, irrespective of their objective knowledge level (Motta et al. 2018); the extent to which a person is motivated to seek out new information about fuel management will also influence reliance on information processing (Petty and Cacioppo 1984). Those with lower IC have been found in previous studies to rely more on trust or perceptions about information credibility than on evaluating information content (Petty 1986; Eagly and Chaiken 1993; Trumbo and McComas 2008; Czaja et al. 2016). Finally, these factors will interact with other factors known to influence acceptability of fuel management, including (i) residence location (rural or urban), (ii) being personally impacted by a wildfire in the past, and (iii) household income level (Mylek and Schirmer 2016).

To better understand implications of ICT for communicating about fuel management, it is therefore useful to explore how IC, self-rated knowledge, information seeking, social trust, and past experiences are associated with the strength and direction of acceptability of different fuel management strategies. This paper contributes to addressing this need through exploring associations between these factors and how they vary for more and less familiar fuel management practices.

6.5 Methods

We examined IC and attitudes towards prescribed burning, mechanical thinning and livestock grazing using a quantitative postal survey.

6.5.1 Study region

Data were collected using a quantitative postal survey of adults living in the Australian Capital Territory (ACT) and surrounding parts of New South Wales (NSW), Australia. This region includes the capital city of Canberra and nearby regional towns of Queanbeyan and Yass, and includes urban, peri-urban and rural areas. A wildfire in January 2003 caused four deaths, loss of over 500 homes, and damaged over half the region's pasture, forests and conservation areas; 160,000 hectares (395,000 acres) burnt in the ACT, and 100,000 hectares (247,000 acres) in adjoining areas of NSW (McLeod 2003).

6.5.2 Survey distribution and response

The survey sample was randomly drawn from the public telephone directory, the only publicly available source of addresses. The sample was stratified into residents of (i) urban or peri-urban areas and (ii) rural areas, to ensure both were adequately represented. With no agreed definitions of 'peri-urban' in existing literature (Allen 2003), we consulted local experts to identify a meaningful local definition. Properties were defined as urban or peri-urban if situated within Canberra, Queanbeyan or Yass or within 1000 meters of an urban area (in peri-urban areas, residents often have more urban than rural lifestyles), and rural if situated outside these areas. In October 2011, 1254 paper surveys were distributed via mail, with 552 surveys reaching urban/peri-urban residences, 562 reaching rural residences, and 140 removed as invalid (e.g. the addressee had died or moved).

An adapted version of Dillman et al.'s (2014) tailored design method was used to recruit survey respondents. First, an introductory letter was sent with the survey, together with an information sheet and pre-paid return envelope. This was followed by two reminder cards to non-respondents (in weeks 1 and 2). A second copy of the survey was sent in week three and a final reminder in week four

The response rate was 44% (40% in urban/peri-urban areas and 47% in rural areas). No completed surveys were unusable, with a total valid sample of 446, described in Mylek and Schirmer (2016).

In order to increase response rate, and to reduce non-response bias, we used several reminders in our recruitment strategy. A non-response bias study was not done, as after multiple reminders it could increase survey burden (Schirmer 2009). Instead we compared respondents to the Australian Census of Population and Housing (Australian Bureau of Statistics 2011). Respondents were biased towards male, older, more educated and wealthier people (Mylek and Schirmer 2016). Survey weighting was not used, because we did not seek to make claims about the population.

6.5.3 Survey items

Respondents were provided definitions of fuel and fuel management. They were then provided information about prescribed burning, livestock grazing and mechanical thinning, and asked about these practices (Table 6-1). Answers were used to calculate IC scores and acceptability scales for each strategy, and to assess self-rated knowledge, information seeking and trust in information sources.

Table 6-1 Survey items analysed in this paper

	Survey questions	**Measure/scale**
IC about fuel management[1]	Please list any arguments FOR ("Pros") and any arguments AGAINST ("Cons") (i) controlled burning (CB) (ii) mechanical thinning (MT) and (iii) livestock grazing (LG). *Please list as many as you can in each FOR and AGAINST section. It is ok if you cannot fill all the available spaces.*	Open ended
	Please indicate on a scale of 1 to 7, how STRONGLY you feel about each argument you listed.	1 (not at all strong) to 7 (extremely strong)[2]
Acceptability of fuel management	How unacceptable/acceptable do you personally feel it is to carry out (i) CB (ii) MT (iii) LG, specifically for the purpose of reducing bushfire[3] risk to life and property … in general? in native forests? in farming areas? in plantations? close to home?	1 (highly unacceptable) to 7 (highly acceptable)
	How ineffective/effective do you personally feel CB/MT/LG is, for the purpose of reducing bushfire risk to life and property?	1 (highly ineffective) to 7 (highly effective)
	How risky/sensible do you personally feel CB/MT/LG is, for the purpose of reducing bushfire risk to life and property?[4]	1 (highly risky) to 7 (highly sensible)
Knowledge and information	How would you rate your current level of awareness and knowledge about fuel management?	1 (very poor) to 5 (very good)
	Have you actively sought information about fuel management in the past?	Yes; No
Previous experience with wildfires	(i) Were you living (or visiting) the Canberra region during the bushfires in January 2003? (ii) Have you seen or experienced any other bushfires close to where you live/lived, whether in Canberra or elsewhere?	Yes; No
	If respondent experienced a bushfire: How were you impacted?	Multiple choice: Loss of family/friends; loss of personal assets; damage to personal assets; personal injury or health impacts; personal anxiety; friends/family experienced damage/loss of assets; friends/family experienced injury or health impacts; colleagues/neighbours/other associates were negatively impacts in some way; not

	Survey questions	Measure/scale
		impacted at all; other impacts
Trust in information sources	What is your level of trust in the information about fuel management delivered by the following sources? (i) government agencies; (ii) private forestry companies and (iii) bushfire brigades (paid and volunteer)	1 (very low) to 5 (very high)
Socio-demographic characteristics	Please describe the area in which you live	Urban/suburban; City outskirt or peri-urban; Rural town/rural residential; Rural property.
	Please indicate the approximate total household income including all wages and salaries, pensions, investments, dividends, property returns, before tax in the last 12 months	Up to $20,000; $20,001 to $50,000; followed by $30,000 increments up to $200,000 and 'Over $200,000'

[1] IC measured using Carroll and Bright's (2009 & 2010) method; asked separately for prescribed burning, livestock grazing and mechanical thinning.

[2] Scale labels differ from Carroll and Bright's (2009); they used the scale 'extremely weak' to 'extremely strong'.

[3] The term 'bushfire' was used in the survey as it is used in Australia rather than 'wildfire' or 'wildland fire'.

[4]Different terms, risky and sensible, were used as scale ends. The term 'risky' is used colloquially by Australians to mean 'non-sensible', rather than as a measure of risk perception, and may not be generalisable across differing backgrounds (Mylek and Schirmer 2016).

6.5.4 Measuring IC

IC is traditionally measured by analyzing historical archival sources (e.g. speeches or media reports), or asking small samples of people to write an essay or complete sentence stems about a topic (de Vries and Walker 1987). Text is analyzed by two or more qualified scorers who review text and agree on an IC score from 1 (absences of both differentiation and integration) to 7 (maximum differentiation and integration) (Baker-Brown et al. 1992).

This method is time consuming, has small samples (Bright and Barro 2000) and non-generalizable results (Carroll and Bright 2010; Burtz and Bright 2014). Recognizing this, Carroll and Bright (2009 & 2010) developed a less burdensome and more repeatable quantitative survey IC measure, which we used, enabling quantitative exploration of IC across a larger sample.

Survey respondents were asked to list as many arguments as possible for and against each fuel management strategy (measuring differentiation), and to rate how strongly they felt (from 1 to 7) about each argument they listed (measuring integration). IC scores were based on both differentiation and integration, and were calculated by (i) counting the arguments made for and against each strategy, and dividing the smaller number by the larger to obtain a differentiation score from 0 (no differentiation) to 1 (highest differentiation), (ii) measuring integration by calculating the mean strength of for and against arguments (mean of the 1–7 rating) and dividing the smaller mean by the larger mean to obtain a score from 0 (no integration) to 1 (highest integration), and (iii) calculating an

IC score from 0 (lowest IC) to 1 (highest IC) by multiplying the differentiation score and integration score.

6.5.5 Measuring acceptability

Exploratory factor analysis, published in Mylek and Schirmer (2016), was used to develop scales measuring acceptability of i) prescribed burning (PB), ii) mechanical thinning (MT) and iii) livestock grazing (LG). The scales were calculated as the average score of seven survey items: How acceptable is [PB/MB/LG] (i) in general, (ii) in farming areas, (iii) undertaken in native forests, (iv) undertaken in plantations, (v) undertaken close to my home; (vi) how effective is [PB/LG/MT]; and (vii) how risky/ sensible is [PB/LG/MT].

All three scales met recommended criteria: Kaiser–Meyer–Oklin values exceeded 0.60 (Kaiser 1970) and *p*-values for Bartlett's test of sphericity (Bartlett 1954) were <0.00. Cronbach's alpha indicated high internal consistency for each acceptability scale (prescribed burning = 0.88, livestock grazing = 0.87 and mechanical thinning = 0.88) (Cronbach 1951).

6.5.6 Measuring self-rated knowledge, information seeking and trust in information sources

Three communication-related factors (self-rated knowledge, motivation to seek information, and trust in information sources) were measured:

- Self-rated knowledge: Respondents self-rated their knowledge about fuel management from 1 (very poor) to 5 (very good).
- Information-seeking: Respondents indicated whether they had previously sought information about fuel management.
- Trust in information sources: Respondents rated their trust in seven sources of information about fuel management from 1 (very low) to 5 (very high); these were then analysed in three groups: private forestry companies, bushfire brigades (paid or volunteer), and government agencies involved in wildfire management (Australian, ACT and NSW).

6.5.7 Other factors

Three factors that were associated with acceptability of fuel management in Mylek and Schirmer (2016) were included in our analysis: (i) residence location (rural or urban), (ii) past personal impacts by a wildfire (e.g. injury, loss of pet/assets), and (iii) household income (Table 6-1).

6.5.8 Data analysis

Univariate and bivariate analyses were used to explore the data, followed by regression analysis to identify the extent to which IC, communication-related factors, and other factors were associated with (i) direction and (ii) extremity of acceptability

First, IC was calculated in Microsoft Excel. Arguments for and against each strategy were counted manually to ensure all were identified (some respondents listed multiple arguments in a single line). Bivariate and regression analyses used Statistical Package for Social Sciences Version 23. Spearman's rho (r_s) was used for correlations between continuous or ordinal variables where one or more variables were not normally distributed, and the Kruskal–Wallis H test (*H*) was used to identify differences in responses to an ordinal variable between two or more independent groups (Field 2013).

Six regression models were developed after identifying data were suitable for modelling: VIF values ranged from 1.04 to 2.09 and tolerances from 0.48 to 0.96. These values are considered outside the thresholds for likely multicollinearity (O'brien 2007).

6.6 Results

6.6.1 IC scores

Survey participants, on average, identified more arguments for and against prescribed burning (PB) than mechanical thinning (MT) or livestock grazing (LG) (Table 6-2). More arguments were made for than against PB and MT, and more against than for LG. Differentiation scores were lower for LG (0.4) than PB (0.6) or MT (0.6). Integration scores were lower for MT (0.5) than PB (0.6) or LG (0.6).

IC was higher for PB than MT or LG (Table 2): 12.0% of respondents had the lowest IC score (0.0) for PB, fewer than for MT (23.2%), and LG (53.7%).

Table 6-2 Integrative complexity for prescribed burning, mechanical thinning and livestock grazing

	n	Range	Mean	Median	St. Dev	% with lowest score (0.0)
Number of arguments for…						
…PB[1]	446	0-8	3.1	3.0	1.7	0.7%
…MT[2]	423	0-7	1.9	2.0	1.2	3.3%
…LG[3]	409	0-7	1.4	1.0	1.5	39.6%
Number of arguments against…						
…PB	446	0-9	2.8	2.0	1.9	9.6%
…MT	423	0-6	1.7	1.0	1.3	14.7%
…LG	409	0-8	2.3	2.0	1.6	6.6%
Differentiation score *(measured 0-1.0)*						
PB	446	0-1.0	0.6	0.6	0.3	10.3%
MT	423	0-1.0	0.6	0.5	0.4	18.0%
LG	409	0-1.0	0.4	0.3	0.4	46.2%
Integration score *(measured 0-1.0)*						
PB	435	0-1.0	0.6	0.7	0.3	12.6%
MT	406	0-1.0	0.5	0.7	0.4	27.8%
LG	427	0-1.0	0.6	0.7	0.4	23.2%
Integrative complexity *(measured 0-1.0)*						
PB	435	0-1.0	0.4	0.4	0.3	12.0%
MT	406	0-1.0	0.4	0.3	0.3	23.2%
LG	397	0-1.0	0.2	0.0	0.3	53.7%

[1]Prescribed burning
[2]Mechanical thinning
[3]Livestock grazing

6.6.2 Bivariate analysis

We explored associations between acceptability of each fuel management strategy and IC, communication-related factors and other factors; and IC and communication/other factors. Some associations were reported in Mylek and Schirmer (2016); in these cases the paper is referred to.

6.6.3 IC and acceptability

IC was significantly associated with a slightly lower acceptability of PB (r_s=0.30, p=0.00, n=384), MT (r_s=0.18, p=0.00, n=361), and LG (r_s=0.16, p=0.00, n=356). More moderate attitudes towards fuel management were associated with higher IC, and more extreme attitudes (positive or negative) with lower IC (Figure 6-1); particularly for PB and LG.

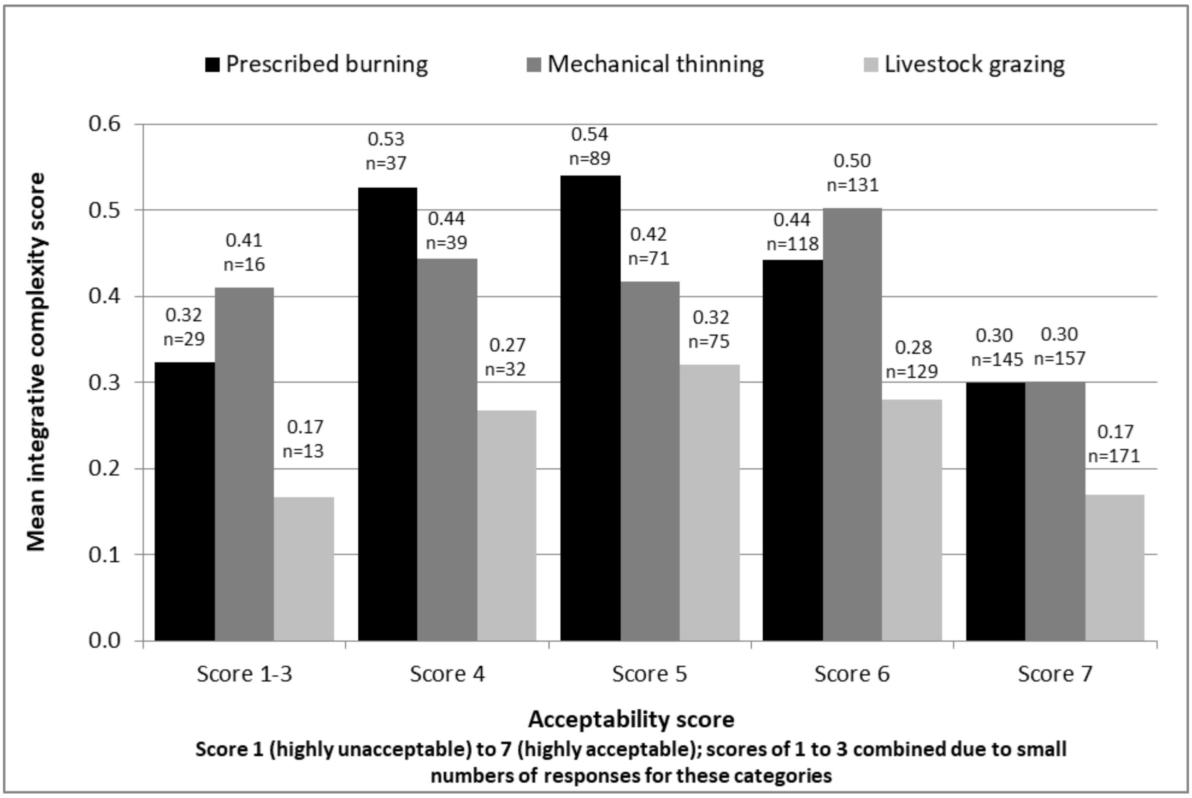

Figure 6-1 Relationship between IC scores and acceptability of prescribed burning, livestock grazing and mechanical thinning

6.6.4 Self-rated knowledge, information seeking and trust in information sources

Self-rated knowledge about fuel management was associated with acceptability of all three strategies (Mylek and Schirmer 2016). There was a negative relationship between self-rated knowledge and IC for PB (r_s=0.11, p=0.02, n=432), but not MT (r_s=0.06, p=0.22, n=403) or LG (r_s=0.07, p=0.15, n=395). Those with lower self-rated knowledge (score of 1, 2 or 3) had higher IC scores (mean=0.46), consistent with the Dunning–Kruger effect, while those with a self-rated knowledge score of 4 had lower IC scores (mean=0.42), and those with a score of 5 had even lower IC (mean=0.38).

Seeking information about fuel management was associated with acceptability for PB (H=9.71, p=0.00, n=412), MT (H=5.14, p=0.02, n=409) and LG (H=17.57, p=0.00, n=415); those who had previously sought information were more likely to find all three acceptable. There was no significant relationship between information seeking and IC for PB (H=0.01, p=0.92, n=429), MT (H=1.70, p=0.19, n=400) or LG (H=0.11, p=0.74, n=392).

Trust in information delivered by organizations involved in fuel management was associated with acceptability of all three strategies (Mylek and Schirmer 2016). Trust and IC were less often significantly associated; trust in government agencies was positively associated with IC for PB

(r_s=0.15, p=0.01, n=366) and MT (r_s=0.11, p=0.05, n=336), and trust in wildfire brigades was negatively associated with IC for LG (r_s=0.12, p=0.02, n=345).

6.6.5 Other factors

Mylek and Schirmer (2016) identified that being personally impacted by a wildfire in the past, location of residence and household income were associated with acceptability. Household income was significantly associated with IC for PB (r_s=0.11, p=0.04, n=392) and MT (r_s=0.16, p=0.00, n=369), but not LG (r_s=0.02, p=0.67, n=360). There was no association between IC (for any fuel management strategy) and past wildfire impact, or living in an urban versus rural area (see Table Sup6 for supplementary material at the end of this chapter).

6.6.6 Multiple regression

Six regressions models were produced. Three examined whether IC, communication related factors and other factors (income, residence and past wildfire experience) were associated with *directionality* of acceptability of the three strategies. As IC was expected to be associated with extremity but not necessarily direction of attitude, three further models examined whether IC, communication and other factors were associated with attitude *extremity* (positive or negative).

All three models examining attitude direction (Table 6-3) explained a significant but low amount of variance in acceptability of the strategies (p<0.01), with R^2 values ranging from 0.08 to 0.16. IC was significantly associated with acceptability of PB, with higher IC being associated with a lower acceptability, but not with acceptability of MT and LG. Higher trust in information sources was associated with higher acceptability for all three strategies, although less so for MT. Previous wildfire impacts and household income were associated with acceptability of PB at the 0.05 level.

In models examining attitude extremity (Table 6-3), higher IC was associated with more moderate attitudes to PB and LG, however not with MT. Trust was not generally associated with attitude extremity, although a higher trust in private forestry companies was associated with a higher acceptance of PB and LG. Seeking information about fuel management was associated with more extreme attitudes towards PB and MT, and living in a rural area with more moderate attitudes towards LG.

Table 6-3 Factors associated with acceptability of fuel management

		Acceptability scale (1 highly unacceptable-7 highly acceptable) Linear regression						Acceptability extremity (1, 2, 6, 7 = extreme, 3-5 = moderate) Logistic regression					
	F	R^2	**Sig.**	***B***	**Std Err *B***	***β***	***T***	R^2	**Sig.**	***B***	**Std Err *B***	***Wald***	**Exp(B)**
Prescribed burning	**F(9,329) =7.18**	**0.16**	**0.00**					**0.23**	**0.00**				
Constant			*0.00*	*4.50*	*0.51*		*8.82*		*0.00*	*-2.33*	*0.78*	*8.84*	*0.10*
IC			0.00	-0.74	0.23	-0.16	-3.16		0.00	1.93	0.53	13.40	6.86
Information-seeking			0.07	0.28	0.16	0.10	1.82		0.04	0.71	0.35	4.13	2.04
Self-rated knowledge			0.21	0.11	0.08	0.07	1.25		0.60	-0.18	0.35	0.27	.83
Trust: private forestry			0.00	0.26	0.07	0.21	3.73		0.00	-0.63	0.17	13.95	.54
Trust: bushfire brigades			0.01	0.25	0.10	0.15	2.54		0.17	0.49	0.36	1.90	1.64
Trust: government agencies			0.01	-0.22	0.09	-0.17	-2.58		0.24	0.24	0.20	1.39	1.27
Past wildfire impact			0.03	0.39	0.17	0.12	2.25		0.08	0.71	0.41	3.07	2.03
Household income			0.01	-0.08	0.03	-0.13	-2.46		0.08	0.13	0.07	3.18	1.14
Rural resident (dummy)			0.25	-0.18	0.15	-0.07	-1.15		0.45	0.23	0.31	0.57	1.26
Mechanical thinning	**F(9,316) =4.02**	**0.10**	**0.00**					**0.18**	**0.00**				
Constant			*0.00*	*4.83*	*0.47*		*10.19*		*0.00*	*-3.04*	*0.89*	*11.58*	*0.05*
IC			0.20	-0.25	0.19	-0.07	-1.29		0.42	0.38	0.47	0.65	1.46
Information-seeking			0.38	0.13	0.15	0.05	0.88		0.15	0.57	0.40	2.09	1.77
Self-rated knowledge			0.46	0.06	0.08	0.04	0.74		0.00	1.07	0.35	9.29	2.91
Trust: private forestry			0.20	0.08	0.07	0.08	1.28		0.38	-0.15	0.17	0.78	0.86
Trust: bushfire brigades			0.00	0.33	0.09	0.22	3.56		0.16	0.54	0.39	1.94	1.71
Trust: government agencies			0.00	-0.24	0.08	-0.21	-3.01		0.70	0.08	0.21	0.15	1.09
Past wildfire impact			0.13	0.25	0.16	0.09	1.52		0.07	0.85	0.47	3.23	2.34
Household income			0.06	-0.06	0.03	-0.11	-1.89		0.21	0.10	0.08	1.59	1.10
Rural resident (dummy)			0.49	-0.10	0.14	-0.04	-0.69		0.82	0.08	0.34	0.05	1.46

	F	R^2	Sig.	*B*	Std Err *B*	*β*	*T*	R^2	Sig.	*B*	Std Err *B*	*Wald*	Exp(B)
	Acceptability scale (1 highly unacceptable-7 highly acceptable) Linear regression							**Acceptability extremity (1, 2, 6, 7 = extreme, 3-5 = moderate) Logistic regression**					
Livestock grazing	**F(9,320) =7.48**	**0.17**	**0.00**					**0.22**	**0.00**				
Constant			*0.00*	*4.25*	*0.44*		*9.59*		*0.00*	-3.57	0.90	15.70	*0.03*
IC			0.19	-0.24	0.19	-0.07	-1.31		0.03	1.06	0.49	4.67	2.88
Information-seeking			0.10	0.22	0.13	0.09	1.66		0.11	0.63	0.40	2.55	1.88
Self-rated knowledge			0.10	0.12	0.07	0.10	1.67		0.32	0.36	0.36	1.01	1.44
Trust: private forestry c			0.01	0.15	0.06	0.15	2.54		0.03	-0.38	0.17	5.00	0.69
Trust: bushfire brigades			0.00	0.27	0.08	0.19	3.21		0.16	0.51	0.37	1.96	1.67
Trust: government agencies			0.00	-0.21	0.07	-0.19	-2.89		0.23	0.24	0.20	1.42	1.27
Past wildfire impact			0.05	0.29	0.15	0.11	1.94		0.05	0.95	0.48	3.97	2.59
Household income			0.14	-0.04	0.03	-0.08	-1.49		0.08	0.13	0.08	3.04	1.14
Rural resident (dummy)			0.06	0.25	0.13	0.11	1.89		0.01	0.81	0.33	6.00	2.25

6.7 Discussion

Our results suggest people think more complexly about more familiar fuel management strategies: Average IC was highest for the strategy most commonly used in the study region (prescribed burning), and lower for the less commonly used strategies (mechanical thinning and livestock grazing). This is likely related to the lower amount of information participants had engaged with about the latter two practices, resulting in limited processing of arguments for or against their use. The findings suggest residents could more effectively process complex information about prescribed burning than mechanical thinning or livestock grazing (Eagly and Chaiken 1993; Czaja et al. 2016). The higher IC for prescribed burning also suggests presenting overly simplified information about this practice could be interpreted as condescending or unnecessary (Schroder et al. 1967; Czaja et al. 2016), with detailed information about issues such as the costs and benefits of prescribed burning likely to be better received and processed. Conversely, simpler information about mechanical thinning and livestock grazing, for example focusing on explaining what each is and how it operates, is more likely to be effectively processed.

The level of trust a person had in information provided by organizations involved in wildfire management was associated with direction of acceptability for all three strategies, while IC was only associated with direction of acceptability for prescribed burning, the strategy with highest IC. This is consistent with the argument that those with low IC rely more on heuristic processing to form opinions (Petty and Cacioppo 1984, Czaja et al. 2016), and with prior work where trust in wildfire organizations and attitudes towards prescribed burning were more strongly associated for those with lower than higher IC (Czaja et al. 2016). It is also consistent with multiple studies in which social trust has been associated with a higher acceptability of fuel management strategies (e.g. Siegrist and Cvetkovich 2000; McCaffrey 2004b; McCaffrey et al. 2013). People with limited knowledge of or experience with fuel management are less able to directly assess different practices, and more likely to use social trust in forming acceptability judgements (Siegrist and Cvetkovich 2000).

In our sample, most people found all three strategies acceptable, meaning that for some, high acceptance is associated with low IC. If people process information most effectively at a level of complexity at which they function (Eagly and Chaiken 1993; Schroder et al. 1967), high acceptability could arguably be sustained by providing relatively simple information (e.g. making simple statements about benefits of prescribed burning without also identifying more nuanced realities around costs and benefits of implementing this practice). However, this approach has risks: people using more heuristic processing are more likely than those using peripheral processing to change their attitudes based on emotions, views about the credibility of the source or even attractiveness of the messaging (Petty and Cacioppo 1984; Eagly and Chaiken 1993). Over-simplified messaging intended to maintain high acceptability therefore has potential to increase polarization if not developed appropriately, the information source is not trusted, the wrong tone is used, or people are exposed to contradictory messaging (National Research Council 1989, Sandman et al. 1993).

Consistent with past studies (e.g. de Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000), high IC was associated with moderate attitudes regardless of whether a person found a strategy acceptable or unacceptable. While increasing acceptability is often described as the aim of communication about fuel management, and the focus of several existing studies (e.g. Brunson and Shindler 2004; McCaffrey 2004a; Toman et al. 2006), ICT suggests potential to rethink this objective. Aiming for a very high acceptance may result in strong views that are more subject to rapid change than more moderately held views. Longer term support for fuel management may require designing communication that builds more complex understanding of fuel management, resulting in more moderate attitudes that are less likely to change rapidly (Tetlock 1983). This can reduce likelihood of strongly polarized views about fuel management and associated social conflict, while not necessarily resulting in extreme levels of support. Achieving this alternative objective is challenging, however, given effective information processing ideally requires communication matched to the complexity at which a person currently functions (Eagly and Chaiken 1993), and that communication is typically targeted to an entire community rather than tailored to individuals within that community.

We did not examine the use of different communication strategies to change IC, or the effects of changing IC levels on acceptability of fuel management, limiting conclusions that can be drawn. Hunsberger et al. (1992) achieved growth in IC through encouraging people to understand an issue from multiple viewpoints. Greater IC growth occurred through encouraging dialog about different arguments for and against a particular viewpoint, and less through delivering one-way information. This suggests that simply delivering detailed information about fuel management with the intention of increasing understanding about fuel management may not be effective for building more moderate, resilient attitudes (McCaffrey 2004b; Toman et al. 2006; McCaffrey et al. 2008; Mylek and Schirmer 2016). Instead, creating opportunities for constructive dialog about fuel management that enables individuals to understand different arguments for and against different practices may be more effective. The community engagement literature provides insight into effective processes that can support constructive dialog about different dimensions to an issue (differentiation) and address tensions between potential impacts (integration) (Tetlock 1986). Many studies argue that interactive dialog can encourage sharing of different viewpoints, generate constructive debate, and reduce social conflict through exposure to a range of arguments for and against a topic (e.g. McEntee and Mortimer 2013; Morrison et al. 2015; Lei and Kelly 2015; Schirmer et al. 2016). ICT suggests this reduces conflict through enabling participants to build complexity of thinking, however no studies have evaluated whether this is in fact the case. Further research is needed to explore whether and what types of dialog and engagement successfully build IC, and whether higher IC is in fact associated with more stable, resilient attitudes.

Our findings also suggest a potential challenge to building IC via information delivery or dialog. Many people with low IC had high self-rated knowledge about fuel management, consistent with the Dunning-Kruger effect (Kruger and Dunning 1999; Motta et al. 2018). A person with low IC who feels their knowledge is already high (irrespective of objectively measured knowledge) may be less likely to engage with and process new information about fuel management, whether delivered in the form of traditional communication materials or via opportunities for engagement and dialog (Kunda 1990; Bright and Barro 2000).

It is well recognized that communication about wildfire management should use different messages, as well as media, to be effective in reaching as many people as possible (McCaffrey 2004a; Toman et al. 2006), and that information should be targeted to people’s familiarity with and interest in fuel management (McCaffrey et al. 2008). Our findings add to this existing body of knowledge. Both one-way information delivery and more interactive dialog can be designed to provide a diversity of information that matches the range of existing complexity at which a population is thinking, and to build complexity of thinking through exposing people to more complex arguments in a gradual manner. However, this may require change in thinking about communication objectives, in particular shifting from an objective of increasing acceptability to one of increasing depth of understanding about fuel management. Further research is needed to better understand what works best to build IC across a population and whether this change is, as predicted by ICT, associated with reduced social controversy about fuel management.

6.7.1 Limitations

Multiple factors influence attitudes towards fuel management: personal experiences, knowledge, social trust, beliefs and values are just a few (Winter et al. 2004; Brunson and Evans 2005; Toman et al. 2006; Mylek and Schirmer 2016). While IC was significantly associated with acceptability, the total amount of variation explained in the models was relatively low, suggesting a need to examine broader factors influencing attitudes and information processing in combination with IC, including factors such as values and stress levels identified as influencing IC in past work (Tetlock 1986; De Vries and Walker 1987). The extent to which findings from this study are generalizable to other populations is unknown, although many of our findings are consistent with studies conducted in different countries (e.g. de Vries and Walker 1987; Tetlock 1989; Bright and Barro 2000), suggesting some generalisability.

Our study examined views of the general public, but not stakeholder groups with a strong interest in fuel management, who often influence public discussions about its use. These groups may not have the same associations between IC, acceptability and knowledge; they may for example have high knowledge about fuel management but only draw on a small number of these arguments when forming opinions, discarding information inconsistent with their existing views (Schroder et al. 1967; Petty and Cacioppo 1984; Bright and Barro 2000).

This study was cross-sectional and could not confirm directionality of the associations identified (e.g. between IC and social trust), although findings are consistent with the causal directionality hypothesized in ICT. There may be bidirectional causal relationships with IC influencing acceptability, and acceptability influencing IC (De Vries and Walker 1987; Hunsberger et al. 1992). Most survey participants found all three fuel management practices acceptable, and this limited variance reduced our ability to explore the views of those who found them unacceptable. More nuanced measures of acceptability may be necessary to better explore variance in attitudes.

Analyzing IC quantitatively is relatively new, and a further development of measures is warranted. For example, the method of scoring used in this study means a person listing one argument against and one for an issue receives the highest possible differentiation score, identical to someone listing several arguments for and against that issue. Additionally, the same weight is given to those with high differentiation but low integration, and low differentiation but high integration, suggesting a need for further development of measures.

6.8 Conclusion

Understanding how complexly a person thinks about fuel management can provide wildfire managers with additional information to inform design of communication about fuel management. In our study, IC scores for the more familiar practice of prescribed burning were significantly higher than for the less familiar practices of mechanical thinning and livestock grazing. Higher IC was associated with more moderate attitudes to all three practices but not typically directionality, while trust in organizations conducting fuel management was associated with directionality. This is consistent with theories that argue more heuristic processing relies less on critically evaluating information, and more on other factors such as trust. Our results suggest potential to achieve more moderate, resilient attitudes about fuel management by better understanding how to match communication to the complexity of thinking of different groups, and encouraging growth in complexity of thinking about fuel management. Further research is needed to develop methods for achieving this, as well as to confirm that increasing IC does result in more stable, resilient attitudes over time as posited in ICT.

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6.12 Supplementary data

Table Sup6: Supplementary data, bivariate results

	Acceptability			**IC**		
	Prescribed burning	**Mechanical thinning**	**Livestock grazing**	**Prescribed burning**	**Mechanical thinning**	**Livestock grazing**
IC: Prescribed burning (r_s, p, n)	**-0.30,0.00, 384**	-	-	-	-	-
IC: Mechanical thinning (r_s, p, n)	-	**-0.18, 0.00, 361**	-	-	-	-
IC: Livestock grazing (r_s, p, n)	-	-	**-0.16, 0.00, 356**	-	-	-
Self-rated knowledge (r_s, p, n)	**0.20, 0.00, 415**[1]	**0.16, 0.00, 411**[1]	**0.27, 0.00, 418**[1]	**-0.11, 0.02, 432**	-0.06, 0.22, 403	-0.07, 0.15, 395
Information seeking[2] (H, p, n)	**9.71, 0.00, 412**	**5.14, 0.02, 409**	**17.57, 0.00, 415**	0.01, 0.92, 429	1.70, 0.19, 400	0.11, 0.74, 392
Trust: Wildfire brigades[3] (r_s, p, n)	**0.16, 0.00, 362**	**0.17, 0.00, 358**	**0.17, 0.00, 358**	0.03, 0.55, 377	-0.03, 0.57, 348	**-0.12, 0.02, 345**
Trust: government agencies[4] (r_s, p, n)	**-0.14, 0.01, 346**	**-0.16, 0.00, 344**	**-0.17, 0.00, 352**	**0.15, 0.01, 366**	**0.11, 0.05, 336**	0.05, 0.34, 335
Trust: Private forestry companies (r_s, p, n)	**0.15, 0.01, 339**[1]	0.07, 0.24, 335	**0.11, 0.04, 345**[1]	-0.00, 0.97, 355	-0.04, 0.50, 326	0.01, 0.93, 330
Past wildfire impact[5] (H, p, n)	**12.12, 0.00, 418**[1]	**7.37, 0.01, 414**[1]	**15.02, 0.00, 420**[1]	2.35, 0.13, 435	0.23, 0.64, 406	0.01, 0.94, 397
Household income (r_s, p, n)	**-0.13, 0.01, 375**[1]	**-0.12, 0.02, 379**[1]	**-0.08, 0.13, 380**[1]	**0.11, 0.04, 392**	**0.16, 0.00, 369**	-0.02, 0.67, 360
Rural resident (dummy variable) (H, p, n)[6]	1.52, 0.22,408	1.97, 0.16, 405	**23.34, 0.00, 411**	1.2, 0.27, 428	3.7, 0.05, 400	0.23, 0.63, 391

[1] Previously reported in Mylek and Schirmer (2016)

[2] Those who had sought information in the past were more likely to find all three strategies acceptable

[3] Combined scale: trust in paid wildfire brigades and volunteer wildfire brigades

[4] Combined scale: trust in the federal government, in the ACT government agency - Park Conservation and Lands and in the NSW State government agency - National Parks

[5] Being personally impacted by a wildfire in the past (for example through injury, illness or through loss of a pet or assets)

[6] Those living in rural areas were more likely to find livestock grazing for fuel management acceptable

7 Understanding acceptability of fuel management to reduce wildfire risk: informing communication through understanding complexity of thinking

7.1 Foreword

The traditional qualitative way of measuring integrative complexity (using archival sources such as written documents, diplomatic communications, public speeches or essays about a topic) is time consuming, has small samples and non-generalizable results. Recognising this, Carroll and Bright (2009 & 2010) developed a less burdensome and more repeatable survey measure, which was used in the paper presented in Chapter 6. However, they identified improvements might be needed and that there is a need to continue developing the measure. After conducting the analysis presented in Chapter 6 I identified that Carroll and Bright's (2009 & 2010) measure resulted in many people being classified as having high complexity of thinking, contradictory to typical results of qualitative studies, where IC levels are generally quite low for the general public.

The paper presented in this chapter and published in the journal *Forest Policy and Economics* proposes and tests a modified quantitative method of scoring integrative complexity which more closely aligns with the distribution of integrative complexity seen in qualitative studies, and compares it to the original scoring method. This modified integrative complexity score is then used to explore the communication mediums considered most useful by people who have differing levels of integrative complexity, and implications for designing communication that can be readily processed by recipients. The modified measure is better suited to this type of exploration than the original scoring method as it better identifies those people who have low to moderate complexity of thinking about fuel management.

This chapter contributes to addressing two of my research questions:

(i) Question 3, *how is acceptability influenced by the way people structure their thinking about fuel management?* is further explored by using a modified measure of IC with a more realistic distribution to explore the association between IC and acceptability of fuel management.

(ii) Question 4, w*hat are the implications of better understanding acceptability for communication?* is further addressed through using the modified IC scoring method to identify communication mediums considered most useful by people with lower versus higher IC, and implications for designing effective communication.

While this paper uses the term ‘preferred information mediums’, it is important to note that this was not the terminology used in the survey question. Survey respondents were asked how useful they felt different information mediums were. ‘Preferred’ and ‘useful’ can be interpreted differently, and this limitation is considered further in chapter 8.6.

This paper was primarily written by me, with input and review by my co-author Associate Professor Jacki Schirmer. With the exception of minor formatting edits, the text presented in this chapter is identical to that published in 2020 in *Forest Policy and Economics*:

Mylek, M.R., and J. Schirmer. 2020. Understanding acceptability of fuel management to reduce wildfire risk: informing communication through understanding complexity of thinking. *Forest Policy and Economics* 113, 1-10

7.2 Abstract

Understanding the social acceptability of managing forest fuels to reduce wildfire risk is essential to achieving long-term investment in fuel management that is supported publicly and politically. Integrative Complexity Theory (ICT) examines how people think about complex issues, and provides a way to better understand acceptability of potentially controversial issues, and inform design of communication that can achieve more stable social and political support; higher integrative complexity (IC) is argued to result in more moderate, but resilient attitudes. However, existing IC measures have limitations in identifying the distribution of IC across a population, restricting their usefulness for informing communication strategies targeted to differing levels of complex thinking. We propose a modified IC measure that aligns more closely with IC theory to better understand IC across a population, and test it using a sample of 435 Australians. The modified IC measure enables better identification of the groups who have lower complexity of thinking, and their preferred ways of receiving information: those with lower IC preferred information about fuel management delivered via traditional one-way mediums that typically use simpler styles of messaging. To achieve long-term resilient attitudes to fuel management, communication may need to use these mediums to both build complexity of thinking, and to encourage a shift to accessing information via mediums that are better suited to communicating the complexities of fuel management

Key words: Integrative Complexity Theory, fuel management, acceptability, political support, communication

7.3 Introduction

Wildfires can present a serious threat to a range of social, economic and environmental assets, including commercial and non-commercial forests (Stephenson et al. 2012; Gill et al. 2013). It is argued that reducing or altering the fuel available to burn in forest landscapes through activities such as prescribed burning, mechanical thinning and livestock grazing is an important component of managing wildfire risk (Pollet and Omi 2002; Gill 2008). To be effective in reducing wildfire risk, fuel management needs long-term investment that is maintained over multiple political cycles as well as across numerous regions that may be governed by different entities, e.g. by different local government bodies. However, fuel management is a complex and sometimes controversial forest management issue, often attracting public debate (Carroll and Bright 2010; Altangerel and Kull 2013; Eckerberg and Buizer 2017). Public controversy is often accompanied by wavering political support, and inconsistent political and public support for fuel management is recorded in multiple studies (e.g. Shindler et al. 2002; Carroll et al. 2007; Hammer et al. 2009; Bowman et al. 2011; Buxton et al. 2011; Burrows and McCaw 2013). Achieving the long-term bipartisan political support needed for successful implementation of fuel management is more likely if there is relatively stable public acceptance of its use in reducing wildfire risk. Multiple studies have examined attitudes towards fuel management (e.g. Walker et al. 2007; McCaffrey et al. 2008; Toman et al. 2011; McCaffrey et al. 2013; Czaja et al. 2016; Mylek and Schirmer 2016). These have highlighted the importance of ensuring communication and engagement of the public is informed by understanding public concerns and expectations about fuel management (Shindler and Toman 2003; McCaffrey et al. 2008; Carroll and Bright 2010; McCaffrey et al. 2013; Eckerberg and Buizer 2017).

Integrative Complexity Theory (ICT) provides an important lens through which long-term public support for fuel management can be better understood. Integrative Complexity Theory has been used to explore acceptability of multiple controversial issues, including fuel management (Carroll and Bright 2009 & 2010; Czaja et al. 2016; Mylek and Schirmer 2019). Integrative Complexity Theory argues that the complexity with which a person thinks about an issue is associated with their acceptability of that issue: this means it is important to not only understand what people think about an issue, but also how they think about that issue (Bright and Barro 2000; Burtz and Bright 2014; Czaja et al. 2016; Mylek and Schirmer 2019). Core to ICT is that people who think more complexly about an issue have less extreme attitudes that are more stable over time (De Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992).

Integrative Complexity Theory and other information processing theories suggest that information should be targeted at a level of complexity at which a person thinks about an issue, and that there is opportunity to build complexity of thinking through effective communication (detailed subsequently) (Hunsberger et al. 1992; Bright and Barro 2000; Carroll and Bright 2009; Czaja et al. 2016; Mylek and Schirmer 2019). To do this requires accurately understanding the likely range of integrative complexity (IC) across a population, to enable design of communication that can be better processed by the intended recipients and used to build IC over time.

Integrative complexity has traditionally been measured using qualitative methods that are time consuming, with small samples that do not enable examination of differences across a population (Bright and Barro 2000; Carroll and Bright 2010; Burtz and Bright 2014). One quantitative measure of IC developed by Carroll and Bright (2009 & 2010) has since been used in other studies exploring acceptability of fuel management (Czaja et al. 2016; Mylek and Schirmer 2019). However, this method of measuring IC tends to suggest a relatively large proportion of the population has moderate to high IC (Carroll and Bright 2010; Mylek and Schirmer 2019), different to most qualitative studies which consistently identify that most people have low IC about controversial issues (e.g. Raphael 1982; Tetlock 1989; Baker-Brown et al. 1992; Bright and Barro 2000; Burtz and Bright 2014). To be able to better use ICT to inform communication, IC measures should reflect as best as possible the distribution of IC in a given population: ideally, quantitative IC measures should better represent the distribution of IC expected when using qualitative measures.

In this paper we propose and test a modified quantitative IC scoring method using data from a sample of 435 Australians. We have two main objectives: (1) to identify whether our proposed modified IC scoring method better reflects the distribution of IC that might be expected in a population, and (2) to explore whether more accurately understanding the range in IC has communication implications for more effectively targeting complexity of information that is better received and processed in a population.

First, we review existing literature on ICT, the associations between IC and acceptability, and how understanding IC can inform communication strategies. We then compare existing qualitative and quantitative methods of scoring IC and propose a modified scoring method. We describe how we tested this measure, present findings and examine whether the modified measure enables improved understanding of communication preferences. Our discussion focusses on considering how the modified IC scoring method can be used to inform development of communication strategies.

7.4 Integrative Complexity Theory

7.4.1 Integrative Complexity Theory, acceptability and communication

Integrative Complexity Theory offers a way to better understand how someone thinks about complex issues. It focuses on the way people structure their thoughts, rather than on the content of those thoughts (Tetlock 1989), by examining both the number of arguments considered about an issue (differentiation), and whether complex connections between those arguments are recognised (integration). People with high IC will better understand that an issue is complicated, and that there are trade-offs between different arguments (Tetlock 1989; Suedfeld et al. 1996; Bright and Barro 2000; Carroll and Bright 2010).

Integrative Complexity Theory was originally used to explore political preferences and actions put in place by decision makers during international crises. For example, Tetlock (1989) explored whether conservatives or liberals thought more complexly about political issues, Suedfeld et al. (1977) examined communications by government leaders during international crises, comparing those settled peacefully versus those resulting in war, and Raphael (1982) analysed how ICT can be used to forecast international crises. More recent studies have shifted to examining IC amongst the general public, and how IC is associated with attitudes about complex and controversial issues. This includes studies exploring attitudes towards capital punishment (De Vries and Walker 1987), debates about slavery (Tetlock et al. 1994), the use of nuclear weapons (Kristiansen and Matheson 1990), the practice of abortion (Dillon 1993), views about plant and wildlife protection (Bright and Barro 2000), and wildfire management (Burtz and Bright 2007; Carroll and Bright 2009 & 2010; Czaja et al. 2016; Mylek and Schirmer 2019).

Most studies have found attitude direction (support or opposition for a practice) is not strongly related to IC, but attitude extremity is, with higher IC typically associated with less extreme, more moderate attitudes (e.g. De Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000, Carroll and Bright 2009; Mylek and Schirmer 2019). The link between low IC and extreme attitudes may result from those with low IC often relying on factors that require low mental effort to form attitudes, such as personal mood, trust in the source of information and attractiveness of the messaging. This can result in attitudes that change rapidly based on changes in trust, mood, and attractiveness of messaging that seeks to sway attitudes. Those with higher IC, meanwhile are argued to have more stable attitudes, as they critically evaluate evidence on an issue to arrive at a reasoned attitude based on understanding the complexity of the issue (Chaiken 1980; Petty 1986; Eagly and Chaiken 1993; Mylek and Schirmer 2019). Based on this, Mylek and Schirmer (2019) argued that rather than trying to achieve high levels of social acceptance of fuel management – which may result in many people having low IC and views that can change rapidly - it may be preferable to seek to increase IC about fuel management, to achieve attitudes that are more resilient to change (albeit more likely to be moderately, rather than extremely supportive).

There may be opportunity to build IC through designing effective communication (Hunsberger et al. 1992) that assists in achieving more stable attitudes. A person is more likely to effectively process information if it is targeted to the level of complexity at which they are already thinking (Czaja et al. 2016; Mylek and Schirmer 2019). Someone who receives information that is more complex than their current level of thinking about an issue can experience information saturation, resulting in poor information processing due to ‘shutting down’ when faced with complex information. This can then lead to attitudes that are a result of factors other than an understanding of the specific actions being invested in. Conversely overly simplified information could be interpreted as condescending or unnecessary, again resulting in poor information processing (Schroder et al. 1967; Czaja et al. 2016). This suggests a need to carefully design communication strategies to gradually build higher complexity of thinking – which in turn requires understanding existing distribution of IC across a population.

7.4.2 Measuring IC

Integrative complexity is traditionally measured using qualitative methods, assessing both past and present materials. For past events, archival sources such as written documents, historical records, diplomatic communications, documented interviews and public speeches are analysed to examine the complexity of rhetoric and connect it to actions (Raphael 1982; Tetlock 1989; Suedfeld et al. 1996). When measuring IC of the general public using qualitative methods, participants are typically asked to write an essay about a topic, or complete sentence stems about a topic in a Paragraph Completion Test (PCT), and to describe their attitudes and beliefs towards an issue (De Vries and Walker 1987). Two or more qualified scorers analyse text for differentiation (the ability to see more than one dimension to an issue) and integration (recognition of complex connections between those issues).

Qualitative methods score IC from 1 to 7, by measuring IC of five randomly selected paragraphs, and then taking the average of these five scores. The lowest score represents the absence of both differentiation and integration, where the individual sees only one side to an issue. A score of 3 represents moderate or high differentiation but no or minimal integration. This is where the individual acknowledges more than one side to an issue and that there are both positive and negative aspects of each, but does not recognise that these arguments are connected. A score of 5 represents moderate to high differentiation as well as moderate integration. This is where an individual acknowledges not only multiple sides to an issue, but also recognises the interactions and tradeoffs between those arguments. The highest score of 7 represents the maximal level of differentiation and integration (De Vries and Walker 1987; Baker-Brown et al. 1992; Suedfeld et al. 1996; Carroll and Bright 2010). Integration cannot occur without some differentiation first.

While measuring IC qualitatively has advantages, in particular enabling the in-depth exploration of rhetoric about a topic, the methods are time consuming, typically use small samples and have non-generalisable results (Bright and Barro 2000; Carroll and Bright 2010; Burtz and Bright 2014). For this reason, Carroll and Bright (2009 & 2010) developed a method for measuring IC in a quantitative survey.

Carroll and Bright's (2009 & 2010) quantitative measure aimed to capture both differentiation and integration. Survey participants list as many arguments they can think of ‘for’ and ‘against’ an issue, measuring differentiation (conceptualised as the extent to which they recognise multiple sides of an issue). They then rate how strongly they feel (from 1 to 7) about each arguments listed, measuring integration – the recognition of interrelationships between the different sides, which is linked to the relative strength of feeling about the arguments listed on both sides. An IC score is then calculated using a three step process: (i) the number of arguments ‘for’ and ‘against’ are counted, and the smaller number divided by the larger number to obtain a differentiation score between 0 (no differentiation) and 1 (highest differentiation); (ii) the mean strength of both the ‘for’ and ‘against’ arguments are calculated, and the smaller mean divided by the larger mean to obtain an integration score between 0 (no integration) and 1 (highest integration); and (iii) the IC score is calculated by multiplying the differentiation and integration scores, resulting in an IC score between 0 (lowest IC) and 1 (highest IC).

7.4.3 Typical distributions of integrative complexity in populations

Multiple studies using the traditional qualitative method of measuring IC have found that most people have relatively low IC scores for the issues examined in these studies. Baker-Brown et al. (1992) suggest that while complexity scores vary depending on the situation, IC scores are typically skewed towards lower scores rather than higher scores, with mean IC scores of around 2 out of 7 for people with general knowledge about an issue, and perhaps as high as 4 out of 7 amongst people with more specialised knowledge. It is rare for anyone to receive the highest IC score of 7. Similarly, Tetlock (1986) argued that people generally prefer simple styles of reasoning, and that it is not unreasonable to expect more than half of IC scores to be at the lowest value of 1 out of 7. When examining complexity of thinking about rare species protection, Bright and Barro (2000) reported a mean IC of 1.7 out of 7, with 70% of respondents with IC of 2 or less, while Raphael (1982) found that IC scores for decision makers involved in international crises ranged from 1.2 to 1.4 out of 7.

Understanding IC across a population ideally requires quantitative studies examining large samples of people, and for this reason Carroll and Bright (2009 & 2010) developed a quantitative measure of IC. However, this measure typically identifies a relatively large proportion of the population as having, on average, higher IC compared to what might be expected using the original qualitative methods described above. Mean IC scores were 0.48 and 0.59 (on a scale from 0 to 1) for two groups examined in Carroll and Bright's (2010) study, suggesting relatively high average IC. A subsequent study using the same quantitative measure (Mylek and Schirmer 2019) suggested that a high proportion of respondents were thinking very complexly about fuel management, particularly prescribed burning, with a mean of 0.4 (on a scale from 0 to 1), and only 12% of respondents obtaining the lowest IC score of 0.

While Carroll and Bright (2010) suggest that the quantitative method is a good reflection of the traditional IC methods of measurement, resulting in a strong correlation between the two (r=0.81, p<001, Carroll and Bright, 2010), they acknowledge a need for further use and refinement of the measure. The next section proposes a modified scoring approach.

7.4.4 Identifying a potential modified scoring approach

Using Carroll and Bright's (2009 & 2010) quantitative method, IC scores are typically skewed higher than is typical for qualitative methods. We believe this may be due to the measure not considering the total number of arguments made about a topic when scoring differentiation. Someone listing one argument for and one argument against an issue receives the highest possible differentiation score, identical to someone listing ten arguments for and ten arguments against an issue. Someone who can identify several dimensions to an issue demonstrates higher differentiation compared to someone who can only identify two dimensions to an issue (Bright and Barro 2000; Carroll and Bright 2010), however this is not effectively captured in Carroll and Bright's method. The qualitative method involves assessing at least five separate paragraphs in a document for differentiation and integration, and then creating a mean IC score from the IC scores assigned to each paragraph. A person recognising multiple aspects for and against an issue across multiple paragraphs is more likely to be assigned a high IC score than one who recognises less. This can be likened to listing more or less arguments about an issue using quantitative methods.

We therefore propose a modified quantitative measure that incorporates the total number of arguments made when scoring differentiation. Doing this would mean those previously assigned the highest possible differentiation score when listing only one argument for and one argument against an issue, would have a lower differentiation score compared to those listing several arguments for and against. This is likely to result in lower overall IC scores for a population, which is what is expected when using qualitative measures (e.g. Raphael 1982; Tetlock 1989; Suedfeld et al. 1996; Bright and Barro 2000). This will better enable identification of population segments with lower versus higher complexity of thinking. The next section describes the method used to calculate the modified measure.

7.5 Methods

A survey of residents living in the Australian Capital Territory (ACT) and surrounding parts of New South Wales (NSW) was used to measure IC and acceptability of three fuel management strategies - prescribed burning, mechanical thinning and livestock grazing. The results of this survey have been used to examine factors associated with acceptability of fuel management used in the region (Mylek and Schirmer 2016), as well as the relationship between acceptability and IC using the original quantitative IC scoring method (Mylek and Schirmer 2019). These studies are referenced throughout the methods and results section of this paper where appropriate.

All three strategies are used to reduce wildfire risk in the study region, with prescribed burning more commonly used and discussed within the study region and throughout Australia more broadly. Mechanical thinning (the removal or alteration of fuels using machinery) and livestock grazing (the use of livestock to reduce fuel levels), are less commonly used or discussed in the media within the study region. All three strategies were included in this study to examine the change in distribution of IC using the modified measure for more and less familiar strategies.

As previously reported in Mylek and Shirmer (2016), the study region was significantly impacted by wildfire in January 2003, and includes urban areas (the capital city of Canberra and nearby regional centres), rural residential properties (used principally for residential purposes rather than agricultural purposes), rural townships, rural properties used for agriculture, nature conservation areas and commercial plantations.

7.5.1 Survey sample

A postal survey was distributed to a random selection of addresses drawn from the publicly available telephone directory in 2011. To ensure both urban and rural areas were represented, the sample was stratified, with 552 surveys sent to urban/rural residential addresses, and 562 surveys sent to rural addresses. Addresses were considered urban or rural residential if located within Canberra, Queanbeyan or Yass or within 1000 m of these urban areas, and rural if located outside of these areas. A total of 140 surveys were returned with invalid addressees (the addressee had died or moved).

A shortened version of the tailored design method (Dillman et al. 2014) was used to increase response rates and reduce non-response bias. This strategy involved posting an introductory letter, information sheet and return envelope together with the survey in the first week, followed by two different coloured reminder cards sent to non-respondents in the following two weeks. Another copy of the survey was sent in the third week, followed by a final reminder card in the fourth week. A non-response bias study was not conducted due to the potential for increased survey burden after having already used the multiple reminder strategy (Schirmer 2009).

A response rate of 44% was achieved, with a total valid sample of 435 respondents (those who provided enough detail to score IC). Respondents were compared to the Australian Census of Population and Housing (ABS 2011), and were biased towards male, wealthier, older more educated people (Mylek and Schirmer 2016). The survey data was not weighted, as the intention was not to extrapolate to a population level.

7.5.2 Survey questions measuring IC

Survey questions examined IC using Carroll and Bright's (2009 & 2010) methods. Respondents were first asked to list as many arguments for and against each fuel management strategy (measuring differentiation). They were then asked to rate how strongly they felt about each argument, from 1 ‘not at all strong’ to 7 ‘extremely strong’. These scale ends differ slightly from Carroll and Bright's (2009), which ranged from ‘extremely weak’ to ‘extremely strong’.

7.5.3 Scoring of integrative complexity

IC was scored using both the original method developed by Carroll and Bright (2009) and our modified scoring method.

Using the original IC scoring method, differentiation was calculated by counting the number of arguments for and against a strategy, and dividing the smaller number by the larger number to create a score between 0 and 1. Integration was calculated by calculating the mean strength of the arguments for and against, and dividing the smaller number by the larger to create a score between 0 and 1. IC was then calculated by multiplying the differentiation score and the integration score, with a lowest IC score of 0 and a highest IC score of 1.

In the modified IC score, differentiation was calculated by counting the number of arguments for and against a strategy, and dividing the smaller number by the larger number to create a score between 0 and 1, identical to the original IC scoring method. To consider the total number of arguments, this score was then multiplied by the total number of arguments listed in the survey (the number of arguments ‘for’ plus the number of arguments ‘against’). This resulted in a differentiation score higher than 1, making it difficult to compare results between the original and modified scores (where the original differentiation scale sits between 0 and 1). In order to make the scores comparable, the figure was rescaled so that both the original differentiation scale and modified differentiation scale had the same lower and upper limit (between 0 and 1). To achieve this we used the following formula: $Y = (\frac{X-Xmin}{Xrange})n$. where Y is the adjusted score, X is the original score, Xmin is the minimum value on the original scale and Xrange is the difference between the maximum potential score and the minimum potential score on the original scale, and n is the upper limit of the rescaled scale (Giannoulis 2017). The integration score was calculated using the same method as the original IC method. The modified IC score was calculated by multiplying the modified differentiation score and the integration score, resulting in an overall IC score from 0 to 1.

The relationship between the original and modified IC scores was examined by comparing distribution of scores, as well as their relationship to acceptability of fuel management.

7.5.4 Survey questions measuring acceptability

Survey respondents were asked how acceptable they felt each fuel management strategy was in five contexts, from 1 highly unacceptable to 7 highly acceptable: ‘how acceptable is [prescribed burning/ mechanical thinning /livestock grazing]…(i) in general?, (ii) in farming areas?, (iii) undertaken in native forests?, (iv) undertaken in plantations?, and (v) undertaken close to my home?’. Respondents were also asked ‘how effective is [prescribed burning/livestock grazing/mechanical thinning]?’ from 1 highly ineffective to 7 highly effective, and ‘how sensible is [prescribed burning/livestock grazing/mechanical thinning]?’ from 1 highly risky to 7 highly sensible. The term ‘risky’ is used colloquially by Australians to mean ‘non-sensible’ and was therefore chosen as one of the scale ends. It should not be confused with formal measures of risk perception (Mylek and Schirmer 2016). The term is culturally specific and results might not be generalisable across respondents of differing backgrounds (Warnecke et al. 1997).

We hypothesised that the various items measuring acceptability about each fuel management strategy in different contexts would measure an underlying construct, and that they would be suitable for combining into one acceptability measure for each strategy. Exploratory factor analysis was used to explore this hypothesis, with full results published in Mylek and Shirmer (2016). The results for each strategy supported our hypothesis, with all three Kaiser-Meyer-Oklin values above 0.6 (Kaiser 1970) and *P*-values for Bartlett's test of sphericity below 0.00 (Bartlett 1954). The acceptability scales for each fuel management strategy were thus calculated as the average score of these seven survey items.

7.5.5 Survey questions measuring preferred information mediums

Preferred methods of receiving information about fuel management in general were examined by asking respondents how useful they found information about fuel management (from 1 not useful at all to 5 highly useful) delivered in: television news reports; documentaries or television programs; radio programs; radio news reports; newspapers; internet websites; pamphlets/brochures/booklets/ factsheets; information material sent in the mail; field days open to the public; one-on-one discussions with an expert; wildfire training courses; community events or information sessions; scientific papers and reports; and via family and friends. Analysis then explored whether the modified IC scoring method better supported identification of preferred communication mediums.

7.5.6 Data analysis

Using Microsoft Excel® and the Statistical Package for Social Sciences® (SPSS) Version 25, the dataset was explored using univariate and bivariate analysis. Spearman's rho (r_s) was used to explore correlations between responses where one or more variables were ordinal but not normally distributed. Kruskal–Wallis tests (H) were used to explore differences between two or more independent groups in responses to an ordinal variable. Where significant relationships were identified, they were further explored to determine the nature of the relationship.

7.6 Results

The original IC scores and modified IC scores were explored to identify similarities and differences.

7.6.1 Distribution of integrative complexity

Table 7-1 compares original and modified IC scores. The modified method resulted in much lower mean IC scores for each strategy, with a reduction in mean IC of 0.23 for prescribed burning (from 0.42 to 0.19), 0.24 for mechanical thinning (from 0.39 to 0.15) and 0.15 for livestock grazing (from 0.24 to 0.09). The overall distribution of scores also changed significantly from a bimodal distribution with little variability between the two ends, to a positively skewed distribution (Figure 7-1). Using the original IC scores, a relatively large proportion of the study population had very high IC scores, many having the highest possible score of 1.0, whereas the modified method resulted in few scores above 0.6. The smaller standard deviation and more parametric (while skewed) distribution improves the statistical properties of the modified scale (Field 2013). Mean IC scores for prescribed burning remained higher (0.19) compared to mechanical thinning (0.15) and livestock grazing (0.09) using the modified measure.

Table 7-1 Mean original and modified IC scores

IC Scale	n	Method	Mean	St. dev
Prescribed burning	435	Original[1]	0.42	0.29
		Modified	0.19	0.17
Mechanical thinning	406	Original[1]	0.39	0.34
		Modified	0.15	0.16
Livestock grazing	397	Original[1]	0.24	0.32
		Modified	0.09	0.14

[1] Previously reported in Mylek and Schirmer (2019)

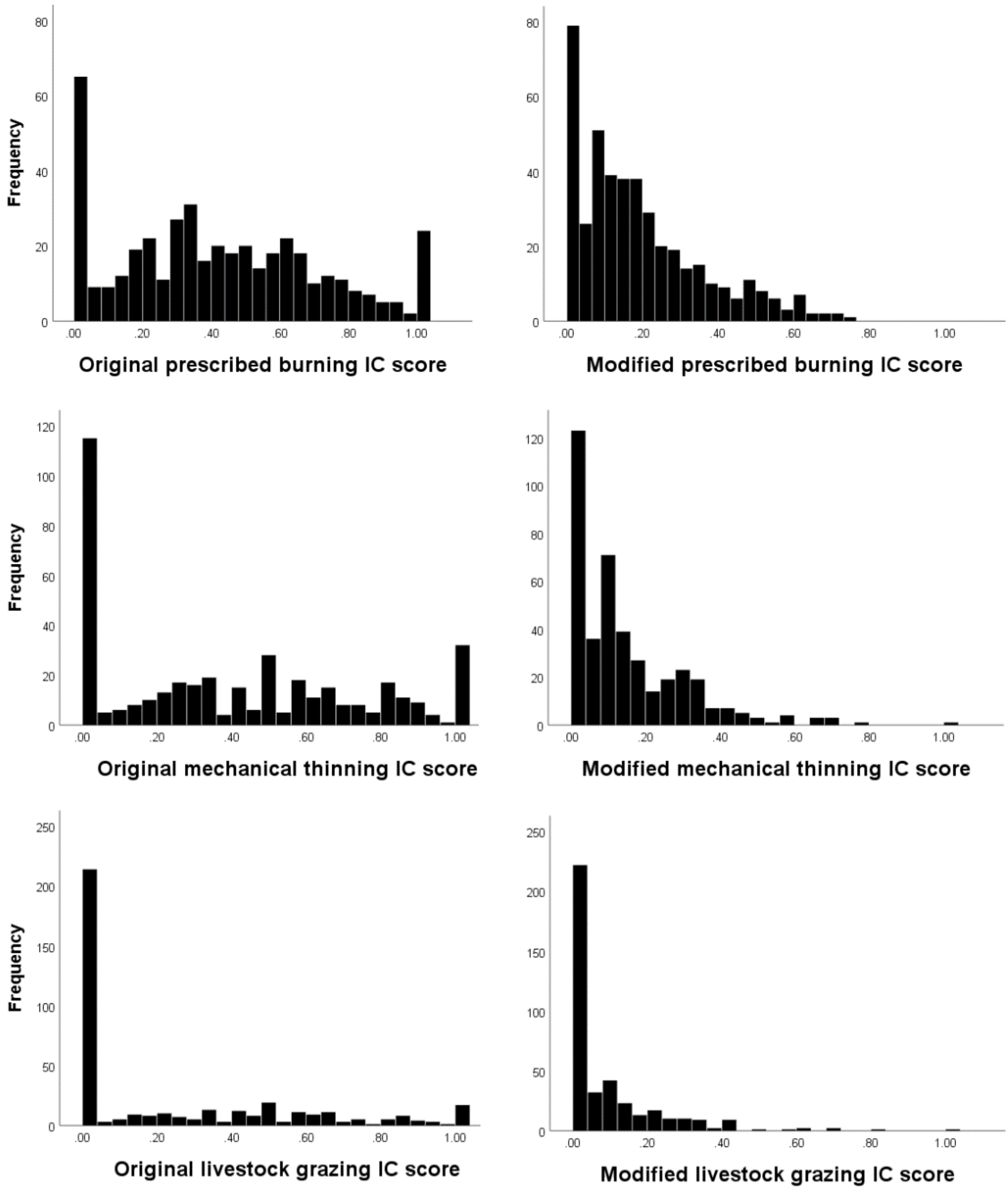

Figure 7-1 Distribution of original and modified IC scores

7.6.2 Associations between IC scores

Despite the change in distribution, the original IC score and modified IC score were highly correlated (prescribed burning r_s=0.83, p=0.00, n=435; mechanical thinning r_s=0.91, p=0.00, n=406; livestock grazing r_s=0.97, p=0.00, n=397). Those with higher original IC were more likely to have higher modified IC, and those with lower original IC were more likely to have lower modified IC.

7.6.3 Integrative complexity scores and attitude extremity

Most respondents indicated that all three strategies were acceptable (66.7 % for prescribed burning, 76.7% for mechanical thinning and 72.5% for livestock grazing). Both the original and modified IC scores were associated with direction of acceptability when examining acceptability as a scale (from 1 highly unacceptable to 7 highly acceptable), with slightly lower acceptability associated with higher IC for all three strategies. Both the original and modified IC scores were also strongly associated with extremity of attitudes about each fuel management strategy, with lower IC predicting more extreme attitudes (scores of 1, 2, 6 and 7 on the acceptability scale – irrespective of whether that attitude was positive or negative), and higher IC predicting more moderate attitudes (scores of 3, 4 and 5 on the acceptability scale) (Table 7-2).

Table 7-2 Associations of original and modified IC scores with direction and extremity of acceptability of fuel management

	Original IC scores for associated strategy		**Modified IC scores for associated strategy**	
Acceptability of…	**Attitude direction[1,2]** ***r_s, p, n[4]***	**Attitude extremity[3]** ***H, p, n***	**Attitude direction[1,2]** ***r_s, p, n***	**Attitude extremity[3]** ***H, p, n[4]***
Prescribed burning	-0.30**, 0.00, 384	24.9**, 0.00, 384	-0.27**, 0.00, 384	19.33**, 0.00, 384
Mechanical thinning	-0.18**, 0.00, 361	9.24**, 0.00, 361	-0.15**, 0.00, 361	7.19**, 0.01, 361
Livestock grazing	-0.16**, 0.00, 356	15.93**, 0.00, 356	-0.17**, 0.00, 356	15.64**, 0.00, 356

**Significant at 0.01 level.

[1] Attitude direction measured as a scale from (1) highly unacceptable to (7) highly acceptable. Associations suggest slightly lower acceptability is associated with higher IC for all three strategies.

[2] Associations with original IC score previously reported in Mylek and Schirmer (2019).

[3] Attitude extremity measured as two groups derived from the acceptability scale: Extreme acceptability = scores of 1, 2, 6 and 7; moderate acceptability = scores of 3, 4, and 5.

[4] These analyses include only those respondents who answered both the IC questions and the acceptability questions in the survey, therefore the total n is lower than for the findings of individual questions presented previously.

7.6.4 Preferred information sources

Preferred methods of receiving information about fuel management were explored using the original and modified IC scores to better understand (i) whether the modified IC distribution identifies differing associations compared to the original (Table 7-3), and (ii) whether this can assist in identifying how to develop and communicate information that can better match current levels of IC and, ideally, build IC. In order to explore the identified associations between IC and preferred methods of receiving information (Table 7-4), the modified IC score was categorised into three groups of (i) low IC being scores of 0.0, (ii) moderate IC being scores between 0.01 and 0.25, and (iii) high IC being scores of 0.26 and above.

Information mediums rated most useful by survey participants were wildfire training courses (64.1% rating these useful), printed information (pamphlets/brochures/factsheets) (62.4%), one-on-one discussions with an expert (62.3%) and information materials sent in the mail (60.7%). Obtaining information about fuel management via scientific papers/reports (33.1%) and friends/family (40.3%) were rated as least useful (Table 7-3).

In most cases, the modified IC score showed stronger and/or more significant differences between preferences for information mediums by those with lower versus higher IC (Table 7-3), suggesting the modified IC distribution provides a better platform to identify communication preferences of those with differing IC levels (Table 7-4):

- Prescribed burning: using the original IC method, IC was not associated with differing preferences for any information mediums. The modified IC score showed that those with lower IC more commonly preferred information about fuel management sent in the mail and published in newspapers, while those with higher IC preferred information provided on websites.
- Mechanical thinning: using the modified IC score, those with lower IC were found to prefer information about fuel management provided in television news reports, and those with higher IC information provided on websites. Some weaker associations were also observed between mechanical thinning IC and preferred information mediums, particularly for information provided in wildfire training courses and in scientific papers or reports.
- Livestock grazing: using the original IC scores, those with lower IC preferred information about fuel management delivered at field days open to the public. The modified IC score remained significantly associated with information delivered at field days, as well as showing that those with lower IC more commonly preferred information about fuel management delivered via radio news reports and newspapers. There was also a significant association between IC scores and usefulness of radio programs, where a higher proportion of those with lower IC rated this as ‘not useful’.

While not all associations between information mediums and IC were statistically significant, some overall patterns of difference were evident (Table 7-4). For all three strategies, those with lower IC typically preferred information about fuel management delivered via one-way information delivery methods, such as television programs/news reports, radio programs/news reports, newspapers and information sent in the mail. These information mediums tend to lend themselves to shorter, simpler styles of messaging. Information delivery methods more conducive to including detailed information about fuel management were more strongly preferred by those with higher IC for prescribed burning and mechanical thinning, including information delivered via websites, wildfire training courses, one-on-one discussions with experts, and scientific papers. This was not seen for livestock grazing, possibly reflecting the overall lower IC for livestock grazing compared to prescribed burning and mechanical thinning.

Table 7-3 Associations between preferred information mediums and the original and modified IC scores

		Prescribed burning			Mechanical thinning			Livestock grazing		
Information medium	**% useful[1] (%, n)**	**n**	**Original IC *H, p*[2]**	**Modified IC *H, p*[2]**	**n**	**Original IC *H, p*[2]**	**Modified IC *H, p*[2]**	**n**	**Original IC *H, p*[2]**	**Modified IC *H, p*[2]**
Wildfire training courses	64.1, 396	365	0.13, 0.94	4.34, 0.11	339	8.23*, 0.02	4.38, 03.11	334	3.50, 0.17	2.33, 0.31
Pamphlets/ brochures/etc	62.4, 426	390	0.03, 0.99	2.81, 0.25	360	0.63, 0.73	1.03, 0.60	355	1.35, 0.51	1.10, 0.58
One-on-one discussion with experts	62.3, 382	351	0.22, 0.90	1.67, 0.44	324	1.15, 0.56	1.36, 0.51	321	0.12, 0.94	0.10, 0.95
Information sent in mail	60.7, 399	364	5.09, 0.08	12.76**,0.00	338	2.77, 0.25	1.69, 0.43	328	2.98, 0.23	3.52, 0.17
Documentary /TV programs	55.0, 422	381	2.19, 0.34	0.58, 0.75	353	2.33, 0.31	2.60, 0.27	346	0.47, 0.79	1.06, 0.59
Community events/ info sessions	52.0, 392	361	1.41, 0.50	3.15, 0.21	334	1.38, 0.50	0.83, 0.66	331	0.45, 0.80	0.12, 0.94
TV news reports	49.1, 438	394	0.37, 0.83	1.87, 0.39	364	5.01, 0.08	9.59*, 0.01	356	0.95, 0.62	2.03, 0.36
Websites	47.9, 397	366	1.53, 0.46	6.98*, 0.03	339	5.95*, 0.05	8.57**, 0.01	335	5.42, 0.07	5.69, 0.06
Radio news reports	44.9, 423	381	0.23, 0.89	2.21, 0.33	355	1.72, 0.42	6.64*, 0.04	346	4.50, 0.11	6.50*, 0.04
Field days	43.3, 388	359	0.31, 0.86	0.53, 0.77	333	0.13, 0.94	0.00, 0.99	328	7.86*, 0.02	7.51*, 0.02
Radio programs	41.1, 406	369	0.35, 0.84	4.07, 0.13	343	0.55, 0.76	2.54, 0.28	337	5.81, 0.06	6.46*, 0.04
Newspapers	40.6, 416	380	4.16, 0.13	9.60**, 0.01	351	0.58, 0.75	4.44, 0.11	346	3.38, 0.19	5.96*, 0.05
Friends/ family	40.3, 404	369	2.99, 0.22	5.60, 0.06	342	0.54, 0.76	0.87, 0.65	335	3.72, 0.16	4.49, 0.11
Scientific papers/ reports	33.1, 378	348	1.62, 0.44	3.95, 0.14	324	6.37*, 0.04	5.51, 0.06	320	0.87, 0.65	0.36, 0.84

**Significant at 0.01 level. *Significant at 0.05 level.

[1] Responses of 4 and 5 to: ‘How useful would you find information delivered in the following ways about fuel management?’ - 1 not useful at all to 5 highly useful. Asked of fuel management in general.

[2] Information usefulness grouped and used in Kruskal Wallis test: not useful (score of 1 and 2), neither useful/not useful (score 3), useful (score of 4 and 5)

Table 7-4 Preferred methods of receiving information about fuel management for people with higher and lower modified IC scores

	% rated this information medium as useful[1]											
	Prescribed burning				**Mechanical thinning**				**Livestock grazing**			
Information medium	**n**	**Low[2] IC**	**Mod IC**	**High IC**	**n**	**Low IC**	**Mod IC**	**High IC**	**n**	**Low IC**	**Mod IC**	**High IC**
Wildfire training courses	365	66.7	57.7	76.2	339	65.1	61.3	69.3	334	68.5	61.0	61.3
Pamphlets/ brochures/etc	390	59.1	62.2	64.2	360	64.2	59.5	68.0	355	63.4	56.7	67.9
One-on-one discussion with experts	351	63.4	62.2	68.4	324	62.8	59.5	71.4	321	62.8	64.4	60.7
Information sent in mail	364	65.1	63.6	54.1	338	66.7	60.7	55.7	328	57.5	62.2	60.6
Documentary /TV programs	381	59.6	53.8	56.3	353	56.3	52.3	52.6	346	55.6	52.1	48.6
Community events/ info sessions	361	55.3	49.5	55.9	334	50.0	48.5	57.9	331	52.8	47.0	57.1
TV news reports	394	57.7	46.1	48.6	364	58.3	47.8	33.8	356	48.2	50.4	28.6
Websites	366	38.5	45.6	56.3	339	40.7	47.2	52.8	335	49.5	42.1	51.5
Radio news reports	381	62.5	40.6	43.7	355	51.0	47.8	29.3	346	46.0	43.8	31.4
Field days	359	52.3	41.4	43.4	333	48.9	40.5	48.6	328	49.2	38.6	30.3
Radio programs	369	56.5	40.5	34.7	343	45.7	42.5	32.9	337	41.2	41.5	41.2
Newspapers	380	51.0	42.8	31.1	351	43.0	43.0	31.1	346	44.7	41.3	14.3
Friends/ family	369	47.4	38.3	36.6	342	42.0	37.6	42.1	335	37.6	42.7	35.3
Scientific papers/ reports	348	27.8	32.5	34.7	324	29.3	32.5	43.7	320	34.3	30.1	33.3

[1] Responses of 4 and 5 to: 'How useful would you find information delivered in the following ways about fuel management?' - 1 not useful at all to 5 highly useful. Asked of fuel management in general.
[2] Low IC = Modified IC scores of 0.0; Moderate IC = Modified IC scores of 0.01 – 0.25; High IC = Modified IC scores of 0.26 and above

7.7 Discussion

Managing fuels to reduce wildfire risk requires long-term planning and political support, which in turn requires social support that does not change rapidly. Given that higher IC has been linked to more stable attitudes, achieving the long-term political and social support required for investment in fuel management may require targeting communication that works towards increasing complexity of thinking, rather than aiming for strong acceptability. However, little is known about how to achieve this. This paper provides a basis for better targeting communication about fuel management by accurately understanding the range of IC in a community, and better understanding how to deliver information about fuel management to groups with differing IC levels that enables them to build a more complex understanding of fuel management.

The modified IC score remained consistent with IC theory, in that higher IC predicted more moderate attitudes and lower IC more extreme attitudes (Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000; Czaja et al. 2016). The modified IC distribution is more consistent with what might be anticipated when using the qualitative scoring methods than the original quantitative measure, with IC scores skewed to the lower end (Raphael 1982; Tetlock 1986; Baker-Brown et al. 1992; Bright and Barro 2000). This difference in distribution has important communication implications. The original scoring method suggests a large proportion of the population think as complexly as possible about fuel management; however, this would not be expected using qualitative methods. Understanding the true range of IC in a given community is critical when designing effective communication strategies that more accurately reflect the complexity of information that can be processed by different people within a population (Schroder et al. 1967; Czaja et al. 2016), and that can build IC (Hunsberger et al. 1992; Mylek and Schirmer 2019).

Integrative complexity is argued to be higher for more familiar topics (Bright and Barro 2000; Mylek and Schirmer 2019), and in our study IC for the more commonly used and discussed practice of prescribed burning was higher than for mechanical thinning and livestock grazing using both the original and modified measures. The consistency in relative mean IC scores for each strategy using both the original and modified measures suggests the modified measure continues to reflect the higher exposure to and available information about prescribed burning in the study region compared to the less familiar strategies of mechanical thinning and livestock grazing (Mylek and Schirmer 2019). While more complex information can potentially be presented for prescribed burning than for mechanical thinning or livestock grazing, the population might not be thinking as complexly about prescribed burning as the original measure suggests, with mean IC for prescribed burning falling from 0.42 using the original measure, to 0.19 using the modified measure. The low IC resulting from the modified measure suggests that despite existing high levels of acceptability for fuel management in this Australian context, there is greater potential for rapid change in acceptability (Chaiken 1980; Petty 1986; Eagly and Chaiken 1993), which can lead to loss of political support or reduction of investment for at least some periods of time. In order for wildfire managers to find ways of increasing IC through effective communication about fuel management, it is useful to understand preferred ways of being informed about fuel management by those with low IC in particular.

In our study, those with higher IC preferred information about fuel management delivered in ways that are more conducive to including complex information about fuel management, such as websites and scientific papers and reports. These information mediums can be useful in providing complex messages for those who want to access it. However, while these mediums are better suited to deliver complex messaging about fuel management, they are more likely to reach the audiences with already high IC, limiting their usefulness in building IC.

Those with lower IC were more likely to prefer information about fuel management delivered via more traditional and one-way information mediums that lend themselves to less complex forms of communication, such as television news reports, newspapers, radio news reports, radio programs and information sent in the mail. These information mediums typically focus on short and direct content with relatively simple and sometimes polarised messaging. While these information mediums play an important role, particularly through reaching a wide audience, they are not always appropriate for complex communication (McEntee and Mortimer 2013). Using these mediums to deliver simple information may be appropriate to enable better information processing for those with lower IC, but they have limited ability to include complex messages about fuel management, and they may not be conducive to building IC (Mylek and Schirmer 2019).

Some information mediums can be effective in communicating a range of complexity of messaging, from simple messaging through to complex messaging. For example, hard copy materials such as pamphlets or brochures, information sent in the mail, wildfire training courses, one-on-one discussions with an expert and websites – all of which were preferred by most respondents irrespective of IC levels. Field days open to the public can also be particularly useful, because several communication mediums can be used that enable delivery of and engagement with information that is pitched at differing levels of complexity. Using these mediums and designing content to suit several levels of complexity may be more successful in achieving effective information processing for a range of IC in a population. They may also be more effective in building IC, as some argue IC growth is more likely to be achieved when people are encouraged to engage in constructive dialogue that incorporates the complex connections that exist between different dimensions to an issue (differentiation and integration) (Tetlock 1986; Hunsberger et al. 1992; Schirmer et al. 2016; Mylek and Schirmer 2019).

However, these methods were not preferred by many with lower IC, presenting a challenge and highlighting an important question – should wildfire managers find creative ways to gradually build the complexity of messages delivered via traditionally simple styles of communication preferred by those with low IC? Or find ways of encouraging those with lower IC to engage with different information mediums? It is likely that both are required to some degree in order to successfully build IC in a community, however, this was not explicitly tested in our study. Two-way interactive communication mediums are arguably important tools for building IC, but focussing on these methods alone risks failing to reach those that could most benefit from building IC. This suggests that there is a need to gradually build complexity of messaging using traditional one-way mediums, and through these avenues also encourage engagement with mediums that better lend themselves to building IC.

Drawing on ICT to better understand acceptability is not limited to fuel management. It can be applied to multiple aspects of forest management that require long-term planning and investment horizons, including (but not limited to) native forest harvesting, plantation establishment on agricultural land, chemical use, management of recreational activities and management of native wildlife (Ford et al. 2007; Schirmer 2007; Ford et al. 2009; Jones et al. 2012; Schirmer 2013; Ford and Williams 2016; Schirmer et al. 2016; Eckerberg and Buizer 2017; Floress et al. 2019).

7.7.1 Limitations

Integrative Complexity Theory offers one way to understand acceptability, but many other factors can influence views about fuel management, including social trust, knowledge about fuel management, and perceptions about benefits and costs of fuel management (McCaffrey et al. 2013). These were not examined in this paper, and the extent to which the results in this paper can be applied to other communities is unknown. However, given the findings are consistent with core IC theory (Tetlock 1989; Bright and Barro 2000; Carroll and Bright 2009), they suggest at least some generalisability.

We did not examine the effect different communication (content or mediums) has on effective information processing or on changes to the level of integrative complexity or acceptability about a topic in a given population. There are also many factors that may influence IC – such as a person's values, personality traits, level of educational attainment and many others. Further research is needed to better understand the relationship that communication may have in relation to IC, information processing and acceptability, with consideration given to other factors that have been found to have complex interactions with IC and acceptability, such as personal values, pre-existing beliefs about an issue, and others (Czaja et al. 2016).

Our modification was limited to the total number of aspects a respondent considered, resulting in a modified differentiation score. Other aspects of qualitative IC scoring could also be considered. For example, identifying what is referred to as ‘setting up and knocking down a straw man’ (Baker-Brown et al. 1992): someone may acknowledge several arguments, but then proceeds to ‘knock down’ one side of the arguments, receiving the lowest possible IC score. While the original quantitative measure may result in a low IC score if completely polarised strength in arguments is selected (resulting in low integration), the IC score would still not result in 0.

Finally, further use of this modified measure and testing against qualitative methods is needed to confirm whether it more successfully captures the traditional components of ICT.

7.8 Conclusion

Forest policies and actions requiring long-term planning and implementation need stable political and social support over time. Understanding IC about controversial forest management issues, such as managing fuels to reduce wildfire risk, can be a useful tool in predicting stability of attitudes, because ICT suggests higher complexity of thinking results in more moderate attitudes that are resilient to change. This may be more informative and relevant than understanding the direction of attitudes, particularly in regions like Australia where acceptance dominates but might not always be stable. It is important to accurately understand the likely range in IC of a community to be able to suitably match communication to the level of complexity at which a community is thinking, or to understand the starting point to build IC. Our results suggest that our modified IC scoring method is more consistent with underpinning IC theory, where the distribution of IC about a topic in the general community is generally skewed to the lower end. This has important communication implications. Design of communication intended to match that complexity of thinking or to gradually build IC may not be possible if the IC distribution in a community is not accurately understood.

Understanding preferred information mediums of those with differing levels of IC can be useful in designing appropriately complex communication and delivering it in ways that are likely to be successfully received. Traditional one-way mediums were generally preferred by those with lower IC and can be useful in providing less complex information that can be distributed to a wide audience, but their use is likely to be challenging to build IC. Other avenues such as hard copy materials and information sent in the mail, as well as wildfire training courses, one-on-one discussions with an expert and websites can be more conducive to including more complex messaging but are not preferred by many with low IC. Finding creative ways to (i) build the complexity of messages using traditional one-way mediums, and (ii) encourage people with low IC to engage with other information mediums that lend themselves to building IC, is likely needed to effectively build IC in a community that results in less extreme, more stable support over time.

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8 Synthesis and conclusions

8.1 Introduction

The objective of this study was to understand the acceptability of fuel management strategies used to reduce wildfire risk in an Australian context, focussing on factors theorised to influence acceptability of fuel management. This was done with a specific focus on examining aspects of acceptability that can be then drawn on to inform design of communication about fuel management. Ideally future studies should also examine how the design of fuel management strategies themselves can better respond to community concerns and expectations, however that was largely outside the scope of this thesis, beyond identifying key perceptions about positive and negative impacts of the practices used to reduce fuel loads.

This chapter synthesises research findings presented in Chapters 3 to 7 related to the four research questions of this thesis:

1. How acceptable is the use of different fuel management strategies in Australia?
2. To what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?
3. How is acceptability influenced by the way people structure their thinking about fuel management?
4. What are the implications of better understanding acceptability for communication?

8.2 Acceptability of different fuel management strategies

Literature examining social acceptability of fuel management in Australia is limited, therefore my first research question was relatively simple: *how acceptable is the use of different fuel management strategies in Australia?* Through interviews and the first quantitative survey acceptability of three fuel management strategies used in Australia was compared - prescribed burning, mechanical thinning and livestock grazing - and whether acceptability differed depending on the location in which these strategies commonly take place.

The results presented in Chapters 3 and 4 suggest all three fuel management strategies have relatively high social acceptability. The majority of survey respondents residing in and around the ACT felt that the use of all three fuel management strategies was highly acceptable, with no significant differences in acceptability between them. The results also suggest low acceptability of not undertaking any fuel management activities to reduce wildfire risk. When exploring acceptability of prescribed burning across Australia in Chapter 5, the majority of respondents found prescribed burning to reduce wildfire risk highly acceptable, suggesting results from the case study region of the ACT and surrounds are likely to be applicable to Australia more broadly.

This is inconsistent with the perception that there is often low support for fuel management strategies. Some informed experts interviewed in this study felt there was a belief that the public do not support fuel management strategies (whether or not they themselves also felt this way). However, almost all informed experts felt that attitudes ranged from strong support for fuel management to strong opposition, but felt that opposition was generally confined to a relatively small proportion of the community. Many also felt that the majority of the public have a lack of interest in fuel management.

This suggests that the high overall acceptability identified in the surveys differs to the typical feedback wildfire managers often receive. Managers are likely to be made more aware of opposition and hence may form a view that this opposition is more common than it is in reality. This feedback impacts support for fuel management: it is likely that decision makers who determine levels of investment in fuel management also believe opposition to fuel management is higher than it actually is in the population. This is consistent with Brunson's (1996) statement that social acceptability is not always obvious, except when reflected in behaviours that indicate the absence of acceptability, such as negative comments or actions. This may mean it is relatively easy to lose political support for long-term investment in fuel management, due to a lack of understanding of actual levels of support for fuel management in the broader community and a perception of higher levels of opposition than actually occur.

This is likely reinforced by the effect of negative reports about fuel management strategies in the media. This is often highlighted when those who have opposed fuel management strategies or raised concerns about them are often criticised in the immediate aftermath of a fire, often being accused of reducing support for fuel management. There is a perception that negative comments about fuel management contribute to lower community support, leading to a reduction in the use of fuel management to reduce wildfire risk (Anderson et al. 2018). This ultimately leads to social tensions about the use of fuel management strategies temporarily dissolving immediately following a wildfire, which then reduces meaningful discussions about the complexities of wildfire management (Collins and Bolin 2009; Anderson et al. 2018). This reduction in complex and often polarised discussions about fuel management immediately after a wildfire event potentially contributes to the notion that acceptability is higher for fuel management after experiencing a wildfire, reducing as length of time increases (discussed in Chapter 5).

However, the results of this study suggest that raising concerns about fuel management does not necessarily translate into lower overall social acceptability, and that those concerns might not always stem from low acceptability either. Instead, these concerns may be reflecting more complex thinking about fuel management, highlighting a desire for communication to focus on the complex decisions made when designing and implementing fuel management strategies, and a need for those concerns to be incorporated into those designs. Encouraging debate about the benefits and costs of fuel management may be what is needed for less extreme and stable attitudes over the long-term, because constructively engaging with all sides of the debate can help people arrive at a more reasoned and stable attitude where they accept fuel management, even if they have some concerns about specific aspects of its application.

Acceptance of a policy or practice in general can be different to acceptance of that same policy or practice in a particular setting, and can be contextual, or depend on personal impacts and benefits (Devine-Wright 2005 and 2009; Moula et al. 2013; Brudermann et al. 2019). While all three fuel management strategies were considered acceptable in general by the majority of survey respondents in survey 1, all were considered slightly less acceptable in landscapes perceived to be more natural (conservation areas and native forests), compared to areas dominated by human activity, such as farming areas, plantations and residential areas. This is consistent with other studies that have found acceptability of land management actions is often lower when the action is perceived to be modifying 'natural' landscapes, or 'nature' in general, compared to areas that are seen as less natural or where human alteration is believed to have already occurred (Gunderson and Watson 2007; Park et al. 2008; Corner et al. 2013).

All three fuel management strategies were considered acceptable when undertaken close to home, inconsistent with the popular idea that acceptability is closely related to the proximity of controversial actions to a person's place of residence, also known as 'not in my back yard' theory (NIMBY) (Dear 1992). This finding is also inconsistent with some North American studies which found acceptability of some fuel management activities was lower when conducted close to the urban interface compared to when they were conducted further away (Winter et al. 2002; Brunson and Shindler 2004; Weisshaupt et al. 2005; Paveglio et al. 2010). The results are, however, consistent with studies that have argued NIMBY theory masks more complex factors that drive acceptability, such as people's interests, values, beliefs and behavioural motives (Upreti 2004; Kempton et al. 2005; Wolsink 2006; Devine-Wright 2005 & 2009). This again highlights that when designing communication it is important to critically examine the assumptions sometimes made about the factors associated with acceptability, and to focus communication on underlying drivers such as perceptions of benefits and costs of fuel management activities, rather than surface issues such as proximity to people's home.

While the results suggest high social acceptability for fuel management, they do not identify how stable that acceptability is over the long-term, or what level of social acceptability is needed to implement long-term strategies into the future. However, the analysis of information processing theories suggested that those who have low complexity of thinking are more likely to have extreme attitudes that can change rapidly in response to new inputs (such as a negative report in the media), whereas those who have high complexity of thinking are likely to have more stable, albeit more moderate attitudes. The modified IC measures developed and applied suggests that low IC is common, even for the most familiar and well understood strategy of prescribed burning. This in turn suggests there is a real risk of rapid change in attitudes, despite overall high support for fuel management in Australia.

Interviews conducted with wildfire managers suggest the key need for managers is long-term stable support, preferably without overly polarised or extreme views, to reduce the risk of decreased willingness to invest in fuel management. This suggests that rather than focussing communication strategies on attempting to gain extreme acceptance, it may be preferable to focus on designing communication to achieve long-term moderate and stable support for fuel management.

8.3 Factors influencing acceptability of fuel management in an Australian context

I explored various factors found to influence acceptability of fuel management in North America, and examined whether they applied in the Australian context examined in this study. This addresses my second research question: *to what extent do commonly theorised factors influence acceptability of different fuel management strategies in Australia?*. This section summarises where my findings parallel those from North America, and where they don’t, and explores what this might mean in this Australian context.

Factors examined included the perceived outcomes of fuel management strategies (e.g. the costs and benefits), trust in agencies delivering information about fuel management, previous experiences with wildfires and fuel management, knowledge about fuel management, perceived vulnerability to wildfires, perceived risk of wildfires occurring, the location in which the fuel management operation is taking place in relation to areas of personal value (discussed above in 8.2), the perceived need for fuel management, the importance placed on a person’s own actions in reducing wildfire risk at home, and some socio-demographic characteristics.

Many of the findings were consistent with North American findings. In particular, two factors commonly found to influence acceptability of fuel management in North America were strong predictors of acceptability in this study: Social trust and knowledge about fuel management (McCaffrey et al. 2013). Higher trust in information delivered by agencies or groups directly responsible for wildfire management predicted higher acceptability of all three fuel management strategies (Chapters 4 and 6). This is not surprising, as adults are not likely to believe information from a source they do not view as credible (Lachapelle et al. 2003; Toman et al. 2006). It is important to note, however, that direct trust in agencies was not explicitly examined in this study, instead trust in the information provided by different organisations was explored. While these are technically different, my findings are still consistent with North American studies that have identified the level of trust a person has in those making decisions about fuel management is typically associated with acceptability of fuel management, and that lack of trust in those delivering information is a common barrier to social acceptance of natural resource policies and actions (e.g. Siegrist and Cvetkovich 2000; Shindler et al. 2002; Winter et al. 2002; Winter et al. 2004; Vogt et al. 2005; McCaffrey 2006; Toman et al. 2006; Vaske et al. 2007; Lijeblad et al. 2009; Toman et al. 2011; McCaffrey et al. 2013; Czaja et al. 2016). This suggests a need to understand how and why high trust promotes acceptance, and to identify whether high trust is effective for promoting attitudes that remain stable over time – or whether trust is subject to change, and thus does not provide an optimal pathway to achieving stable attitudes that support long-term investment in fuel management. This question is examined further when discussing findings related to my fourth research question.

Acceptability of each fuel management strategy was also higher for those who self-rated their knowledge about fuel management as high (Chapter 4). While self-rated knowledge was examined, not objectively measured knowledge, my findings are consistent with multiple other North American studies that have found an association between knowledge and acceptability of fuel management (McCaffrey 2004; McCaffrey 2013). This consistency in findings is found whether the study uses objectively measured knowledge, such as the use of a true/false quiz (e.g. Shindler and Toman 2003; Ascher et al. 2013) or self-rated knowledge like in this study (e.g. McCaffrey 2002; Blanchard 2003; Shindler et al. 2003; McCaffrey 2004; Blanchard and Ryan 2007; Absher and Vaske 2007). While higher self-rated knowledge about fuel management is associated with higher acceptability, the acceptability it is associated with is often extreme – the type that may indicate low complexity of thinking and risk of rapidly changing attitudes. This is consistent with studies that have identified that those with high self-rated knowledge often have low objective levels of knowledge, and lack receptivity to new information (Kunda 1990; Kruger and Dunning 1999; Motta et al. 2018). This means that rather than assuming it is positive to observe high correlation between high levels of self-rated knowledge and acceptance of fuel management, a more critical examination is needed that questions whether this is in fact a good indicator of long-term stable support for fuel management. This again points to a need to understand whether the attitudes of those with high self-rated knowledge are stable long-term, and whether those with high self-rated knowledge successfully process new information. Better understanding the relationship between self-rated knowledge, acceptability and complexity of thinking can shed some light on the opportunities and challenges this presents, and is discussed further in the next section (Section 8.4).

The extent to which a person felt vulnerable to the threat of wildfires at their current residence was associated with acceptability of livestock grazing and mechanical thinning in bivariate analysis (Chapter 4), However, results of regression analysis suggest that this association is not strong once other factors are taken into account. This may mean that feeling vulnerable is a proxy to other, underlying factors driving acceptability, rather than a driver in and of itself (McCaffrey 2004b). Furthermore, while a high proportion of survey respondents felt that wildfire risk was high in their local region, and felt worried about possible impacts of wildfires, these perceptions did not predict acceptability of prescribed burning (Chapter 5). This is inconsistent with studies that have found perception of wildfire risk is positively correlated with acceptability of fuel management (e.g. Carroll et al. 2004; Weible et al. 2005; McCaffrey et al. 2013). However, it is consistent with broader natural hazard literature that suggests while people may know about the risks associated with the hazard, that knowledge is not always used when assessing the full range of costs and benefits associated with a practice or action (Rubin 1996, Kates 1994). Risk perception and its association with action, or in this case support for action, is not straightforward, with several studies argue there is not necessarily a direct link between risk awareness and behavioural response (e.g. Haynes et al. 2008, Miceli et al. 2008, Wachinger et al. 2013).

The results may also reflect a cultural adaptation to wildfire hazard in Australia, which has a long history of wildfires, resulting in overall acceptance of the costs associated with risk mitigation activities (Laska 1990; Bell and Oliveras 2006; Mockrin et al. 2018). It is possible that in the Australian context, the high awareness of risk is a necessary, but not sufficient driver for acceptability of fuel management. People may rely more on trust in information provided by those responsible for fuel management to effectively reduce that risk without unnecessary negative impacts. Siegrist and Cvetkovich (2000) hypothesise that trust influences both perceived risk and perceived benefit. The risk of impact from wildfires, and the role of fuel management in reducing that risk, is not always obvious to those without the technical knowledge. Those without the technical knowledge will therefore rely on risk-benefit information provided by sources they trust (Paton 2008; Wachinger et al. 2013). Communication strategies may be more effective if targeted at addressing factors with stronger associations with acceptability of fuel management, such as trust building initiatives or building a more complex understanding of the decision making process with regard to wildfire risk mitigation actions.

I found only a weak bivariate relationship between acceptability of fuel management and whether a respondent had previously experienced a wildfire, unless the person was directly and personally affected in a negative way by that fire (e.g. through negative impacts on their own physical or mental health or loss of assets). This weak association was not present in regression modelling, suggesting that after accounting for other factors, wildfire experience was not a predictor of acceptability. This is consistent with some studies that have not found past experience of wildfires to be a significant predictor of acceptability of fuel management (e.g. Vogt et al. 2005; Winter et al. 2005), but inconsistent with others that found past personal experiences of wildfire increased acceptability of prescribed burning (e,g. Blanchard and Ryan 2004). The findings of regression modelling suggest that the weak bivariate association initially found between experiencing a wildfire and acceptability of fuel management might actually reflect other factors that are better predictors of acceptability of fuel management, although this was not specifically tested in this study. For example, those who felt it is important to personally reduce wildfire risk at home were more likely to have higher acceptance of fuel management. Experiencing a wildfire might increase the awareness of personal action in reducing wildfire risk at home, and thus increasing acceptability of fuel management. This is important, as while communication strategies cannot change whether a person has directly experienced wildfire, they can potentially influence other attitudinal aspects that might be gained partly through that direct experience, such as understanding how to act to reduce wildfire risk at home (Chapter 4). Further research examining the relationship between perceptions of risk and acceptability of fuel management is needed to better understand how risk perception is formed and whether it plays a role in acceptability of fuel management, or whether risk perception is not a useful predictor of acceptability of fuel management in an Australian context.

Consistent with the finding that direct experience of wildfire was not necessary to achieve acceptance of fuel reduction, the length of time since experiencing a wildfire did not predict acceptability of prescribed burning in Chapter 5. This was despite issue-attention being a commonly theorised factor in explaining acceptability of various wildfire management strategies, and half of the informed experts interviewed in this study believing that increased time since experiencing a wildfire reduced acceptability of prescribed burning. Other factors found in Chapter 5 were stronger predictors of acceptability of prescribed burning irrespective of personal experiences with wildfire or length of time since that experience. These included perceptions about fuel load, the ability to undertake prescribed burns, the effects of prescribed burning on vegetation and on animals, risk of prescribed burns escaping and health concerns related to smoke from prescribed burns. These findings are consistent with existing literature about factors influencing acceptability of natural resource management policies and practices (e.g. Vaske et al. 2007; Eriksson et al. 2008; Vining and Merrick 2008; McCaffrey et al. 2013; Everett et al. 2016). Perceptions about the benefits and costs of the three fuel management strategies were explored in detail in Chapter 3. The most commonly perceived benefit of all three fuel management strategies was the ability to reduce wildfire risk and hence risk of experiencing wildfire impacts. Perceived costs identified by survey participants were most commonly related to the risk of prescribed fires getting out of control and causing unwanted damage to assets, smoke impacts, impacts on plants, animals and the environment generally, and the cost and labour required to carry out the strategies, particularly mechanical thinning.

There is scope to further examine the issue-attention cycle, particularly through identifying whether high media coverage of wildfires reduces the relevance of direct experiences in influencing acceptability of fuel management, whether there are more complex links with other factors that are stronger predictors of acceptability, or whether issue-attention simply isn’t a useful predictor despite a long held theory among many land managers that it is an important consideration. While it is possible that a significant wildfire in Australia or around the world being reported in the media on a regular basis may be sufficient to maintain attention and support for fuel management over time, rather than requiring personal experience or recent exposure to that wildfire, further research is needed to identify whether this is the case, as it was not examined in this thesis.

These results suggest building support for fuel management strategies requires increasing trust in agencies responsible for fuel management, building understanding of fuel management, and addressing concerns about the benefits and costs of undertaking fuel management. This is more likely to be effective than focusing communication on raising awareness of risks or sustaining issue-attention to these risks over time. A review of the broader natural hazard literature suggests providing simple fear-based messaging about wildfire risk may be relatively ineffective as there is little evidence to show that providing hazard information leads to action, or in this case increased acceptability of action to reduce the risk (Tierney 1993, McCaffrey 2004b; Wachinger et al. 2013). Instead there is an increased need to focus more on communicating about the complex dynamics involved in fuel management activities in a context such as Australia, where awareness of wildfire risk is high and there is already some acceptance of wildfire as part of life and the landscape (McCaffrey 2004b; Bell and Oliveras 2006).

8.4 Acceptability of fuel management and complexity of thinking

Effectively managing fuels to reduce wildfire risk requires long-term investment, planning and implementation. This in turn is more likely to be achieved if there is stable social support for fuel management actions, without highly polarised views, something highlighted by wildfire managers interviewed. This suggests a need to focus on how people think about fuel management and likely volatility of attitudes, as well as what they think about fuel management.

The findings related to *what* people think about fuel management also pointed to a need to also understand *how* they think about it, as they suggested that there is high acceptance of fuel management, but did not identify how likely it is that this acceptance could change. This suggests a need to better understand how the complexity of thinking about fuel management is associated with acceptability judgments. More generally, it raises the question of what the objective of wildfire managers should be – if there is already high acceptability for fuel management, does that mean little investment is needed? The finding that despite high acceptance many people held concerns about the potential for negative impacts from fuel management suggests that there is a need to better understand whether acceptance levels could change rapidly, and to rethink what long-term objectives of communication about fuel management should be.

I drew on Integrative Complexity Theory (ICT), together with other information processing theories more focused on communication, to better understand acceptability of fuel management and inform communication strategies, addressing my fourth research question: *what are the implications of better understanding acceptability for communication?* Consistent with numerous previous studies, the results presented in Chapters 6 and 7 suggest higher integrative complexity (IC) predicts less extreme and more moderate, but stable attitudes that are likely to be more resilient to change, while lower IC predicts how extreme acceptability is regardless of the direction (acceptable or unacceptable) (Suedfeld et al. 1977; Raphael 1982; de Vries and Walker 1987; Tetlock 1989; Bright and Manfredo 1992; Bright and Barro 2000, Carroll and Bright 2009; Czaja et al. 2016).

IC was higher for the more familiar practice of prescribed burning compared to livestock grazing and mechanical thinning, which are not as widely used or discussed in the media. Given higher IC can be likened to more systematic types of information processing, in which people are able to think more critically and arrive at a reasoned, evidence-based attitude which is more resilient to change, this suggests communication about prescribed burning in Australia may be more effective if complex information about its use is presented. It also suggests that expressions of concern about fuel management are not necessarily a sign of low acceptance, as was assumed by some land managers interviewed, but rather a sign of higher IC, and therefore more moderate attitudes that may have longer term stability. However, this is likely to be the case only if the desire for more complex information indicated by the higher IC for prescribed burning is responded to. Presenting overly simplified information about this practice could be interpreted as condescending or unnecessary (Schroder et al. 1967; Czaja et al. 2016), and may have the unintended effect of reducing acceptance and increasing concern about the potential impacts of prescribed burning. The results suggest simple messaging focussed on factors such as preparing for wildfire risk, which was not a predictor of acceptability, can have the potential to fail if not designed properly. There is a need for communication that supports more complex ways of thinking, such as communication that examines the benefits and costs associated with prescribed burning, and the trade-offs that may need to be considered. These hypotheses need further exploration in future studies, to better understand the effect of different types of communication that match well or poorly to current complexity of thinking, and whether there is a risk of lowering acceptance if communication is not designed in a way that responds to current complexity of thinking.

In this study, a large proportion of respondents with low IC had very high acceptance of fuel management (Chapter 6). Given that trust in information provided by agencies responsible for fuel management was a consistent predictor of higher acceptability, the results suggest that many who had low IC relied on trusted information as a key part of forming their attitudes. Those with lower IC are more likely to use more heuristic styles of information processing, whereby they rely on factors other than the content of the messaging to form their opinions, such as identifying whether the messages come from a trusted source. Given those with low IC tend to have less resilient attitudes, it is essential to better understand who these groups trust to provide information about fuel management, and in particular whether they trust sources of information that are likely to give conflicting messages about the acceptability of fuel management over time. For example, if they trust specific media sources, this may indicate a high level of risk of changing attitudes, as many media outlets in Australia have run negative stories critical of some aspects of fuel management at times. If this leads to credibility being given by those with low IC to messages opposing the use of fuel management, the strong acceptance found amongst many in the Australian community in this study may change to greater levels of opposition.

A higher level of self-rated knowledge was associated with higher acceptability, as well as with lower IC (which in turn is associated with more extreme attitudes). This can be particularly challenging, as people who already feel they have a good level of knowledge about fuel management (regardless of objectively measured levels of knowledge), in addition to having less complex understanding of fuel management, have been found to be less receptive to new information in studies of information dissemination about other topic (Kunda 1990; Kruger and Dunning 1999; Bright and Barro 2000; Motta et al. 2018). Communicating to those who have low IC and high self-rated knowledge about fuel management may first require convincing them they still have new things to learn. On the other hand, it is possible that those reporting lower self-rated knowledge and higher IC do so because they more likely recognise there are elements about fuel management that they are not familiar with, making this group particularly receptive to new information.

High acceptability is often considered to be preferable to being weakly or moderately supportive of fuel management. Reflecting this, increasing acceptability is often the implicit goal of communication about fuel management, although this goal is typically not specifically articulated. This implicit goal needs to be critically examined: is very strongly held acceptance actually needed, or even best, when considering what is needed to achieve successful long-term fuel management planning and implementation? I argue that current information processing theories suggest it may be better to seek to achieve moderate support that is more stable over the long-term. While this could not be directly tested in this thesis, the results strongly point to a need for reconsidering the overall goals of communication, and also for ensuring that land managers do not inappropriately consider the raising of concerns about aspects of fuel management as indicating a lack of support for using fuel management. The results of this study suggest that most of those who raise concerns about negative impacts of fuel management still support its use, but often with more moderate acceptability and more complex thinking about fuel management compared to those who more strongly support fuel management. This clearly demonstrates that there is not a simple correlation between concern about negative impacts and loss of acceptability, and combined with insights into information processing presented in Chapter 6, suggests that those who are thinking more complexly may be more likely to moderately support fuel management consistently over time. This type of 'quiet support' underpinned by a complex understanding is less subject to rapid change, and likely to better support ability to achieve long-term investment in fuel management.

Ideally, communication to support building long-term moderate support should consider not only *what* people think about fuel management, but also *how* they think about it using ICT or other information processing theories to inform design. The next section considers the potential to focus communication objectives on matching communication to existing complexity of thinking, and on building more complex understanding of fuel management, resulting in more moderate attitudes that are less likely to change rapidly (Tetlock 1983).

8.5 Implications for communicating about fuel management

Better understanding acceptability of fuel management can assist wildfire managers to acknowledge and incorporate public concerns, values and expectations in their planning, and to improve the effectiveness of their communication about fuel management. Importantly, this does not mean simply identifying the *topics* that should be included in communication, but also how communication can be designed to enable the best possible likelihood of effective processing of that information by its intended recipients.

The results of this thesis have several implications for the effective design of communication strategies about fuel management. In particular, they demonstrate a need to i) carefully target what topics to communicate about - for example the findings suggest it is important in the Australian context to communicate about the benefits and costs of fuel management, and may be counter-productive to invest further in risk-based messaging, and ii) identify the objectives of the communication (to achieve high acceptance that is subject to rapid change, or more moderate but stable acceptance). This section explores the implications of the findings for communicating about fuel management, addressing my fourth research question: *what are the implications of better understanding acceptability for communication?*

Core to this thesis was understanding *how* people structure their thoughts about complex issues such as fuel management, through exploring ICT, and how understanding this together with *what* people think, can help inform communication strategies. The findings of this thesis confirm the existing well documented association between more complex thinking and more moderate attitudes. While ICT is often argued to have insights that can inform the design of more effective communication, it is not always readily evident how findings of ICT studies can be drawn on to do this.

Higher trust in information provided by agencies responsible for fuel management was one of the most consistent predictors of higher acceptability of fuel management in this study (Chapters 4 and 6). The majority of respondents in this study found fuel management very acceptable, and very high acceptability was associated with less complex thinking about fuel management (low IC). Based on this, it could be argued that acceptability can be maintained by using simple messaging. However, there are risks associated with this, identified in the previous section.

This lead to the question of what investment land managers are best making: should they invest in building trust in agencies responsible for fuel management, or is building complexity of thinking more important? The results suggest that both are equally important. It is unrealistic to expect an entire population to build high IC about fuel management, particularly when past studies suggest that in most cases the ‘default position’ of thinking about any given issue amongst the broader public will be one of having relatively low complexity of thinking. The level of investment required to achieve uniformly high IC across an entire population is likely to be unrealistic. Therefore trust building initiatives are essential to ensure that those who are not interested in or willing to invest in building understanding of fuel management are likely to trust information provided by wildfire managers. This requires the information they provide to be trusted and viewed as credible by those with more heuristic styles of information processing, to minimise the risk of a person with low IC changing their views from high acceptability to low acceptability based on receiving information strongly opposing fuel management from another source.

While the ultimate goal should not be seeking to achieve very high IC across entire population, there is evidence of potential to support growth in IC through encouraging people to understand an issue from multiple viewpoints (Hunsberger et al. 1992). While not explicitly tested in this study, efforts to build complexity of thinking suggest there is potential to create more moderate attitudes that are less likely to change rapidly based on trust or other emotions. Even achieving small increases in IC may assist in achieving more stable and less polarised attitudes that remain more consistent over time. This is mostly likely to be achieved by carefully matching communication to current levels of complexity of thinking, and gradually building complexity of thinking through messages that build understanding without resulting in cognitive overload and reduction of receptivity to messaging. However, drawing in ICT to effectively communicate about fuel management requires accurately understanding the range in IC of a community. This was explored in Chapter 7, proposing a modified method of scoring IC which more closely aligns with the distribution of integrative complexity seen in qualitative studies.

The results presented in this thesis suggest several avenues for communicating in ways that i) match current levels of complexity of fuel management, and through doing so improve processing of information, and that ii) slowly build complexity of thinking about fuel management. The following four examples are based on findings reported in different papers, and suggest potential avenues for matching existing IC, and increasing complexity of messaging.

First, the differences identified in acceptability of fuel management when undertaken in natural and less natural landscapes suggest an entry point for increasing complexity of thinking and reducing risk of rapid shift in attitudes. These simpler styles of reasoning about fuel management in areas perceived to be more natural are more likely to provoke 'extreme' attitudes (whether involving a view that fuel management can protect pristine places, or will destroy it), and share the attribute of being based on low complexity of understanding of arguments for and against use of fuel management in natural areas. These differences in acceptability suggest that when undertaking fuel management in landscapes considered to be more natural, communication in the Australian context may need to start with simple messages about how fire is a part of natural landscapes and fuel management strategies such as prescribed burning can be designed to mimic natural processes. This can then be followed up by gradually introducing more complex messaging about how different fuel management strategies can be used to mimic natural processes, and to reduce damage to natural landscapes in the event of a wildfire. This is an example of fostering complex thinking, as it focuses on shifting from a simpler conceptualisation of how fuel management can impact a place considered 'natural' or 'non-natural', to a more complex understanding of how fuel management can be used in natural areas to enhance or protect the values associated with it.

Second, past experiences with wildfire and the length of time since personally experiencing a wildfire were not strong predictors of acceptability of fuel management (Chapter 4 and 5), suggesting a focus on increasing issue-attention is not likely to be necessary or effective. Better predictors of acceptability included perceptions about fuel loads and whether enough fuel management is taking place, perceptions about the effects of prescribed burning on vegetation and animals, concerns about prescribed burns escaping containment lines and health concerns related to smoke from prescribed burns. This suggests that rather than continually seeking to reinforce the nature of the problem (risk of wildfire), long-term stable support for action may require more focus on communicating in ways that address concerns about the benefits and costs of undertaking fuel management, supporting more complex levels of thinking. The results suggest that the messages about wildfire risk have already been effective, even for people that haven't personally experienced wildfires, creating sufficient issue-attention in the context of Australia. This means wildfire managers can focus on communicating more complex messages about the decision making processes related to the implementation of fuel management strategies, and that overly simple messages about wildfire risk can be counterproductive, as these types of messages do not address the issues that people appear to be interested in.

Third, it is well recognised that communication about wildfire management should use different messages, as well as mediums, to be effective in reaching as many people as possible (McCaffrey 2004a; Toman et al. 2006), and that information should be targeted to people's familiarity with and interest in fuel management (McCaffrey et al. 2008). Hunsberger et al. (1992) suggest that greater growth in IC can be achieved through encouraging two-way dialogue about the benefits and costs of an issue rather than through one-way information delivery. This creates opportunities for constructive dialogue about fuel management that can support discussion about the different dimensions to an issue (differentiation) and address tensions between potential impacts (integration). The results presented in Chapter 7 appear consistent with these observations, suggesting those with already higher IC are more likely to find information accessed using more active (often but not always two-way) discussion or information seeking behaviours, such as wildfire training courses, discussions with experts and information presented on websites, useful. This suggests that encouraging people to discuss fuel management more actively can help match existing high levels of IC, and also has potential to build IC. However people with low IC typically did not indicate these methods of information delivery about fuel management to be useful, and therefore are less likely to engage in these types of communication methods. More passive (one-way) information mediums were considered useful by those with lower IC, and can be used to provide less complex information that matches the level of complexity at which they are thinking. However they are not the methods typically recommended when discussing building IC, with more intensive two-way forms of communication typically recommended in the literature. This suggests a disconnect in which there is lack of recognition that many with low IC are unlikely to be willing to access these types of discussions. This presents a challenge: is it better to try to build IC through encouraging those with low IC to engage in more two-way discussions? Or alternatively should there be more investigation of the potential to build the complexity of messaging using traditional one-way mediums? While this thesis could not answer this question, a combination of both is likely to be important to building IC, as it provides options for building complexity of thinking that can be accessed by a much wider range of people than is the case if only quite complex forms of information are provided.

Both one-way information delivery and more interactive dialogue can be designed to provide a diversity of information that matches the range of existing complexity at which a population is thinking, and to build complexity of thinking through exposing people to more complex arguments in a gradual manner. Avenues such as hard copy materials and information sent in the mail, as well as wildfire training courses and one-on-one discussions with an expert, were considered useful methods of receiving information overall, and can be designed to include a range of levels of complexity of information. This can enable individuals to build their complexity of thinking about fuel management. However, this requires a change in thinking about communication objectives, in particular shifting from an objective of increasing acceptability to one of increasing depth of understanding about fuel management. Further work is required to test different approaches to doing this, for example through sending materials of increasing complexity to households, versus nesting information of differing levels of complexity on a website or within a brochure so a person can continue reading until they reach the level they are comfortable processing.

8.6 Limitations and opportunities for further research

As with any research, there will always be limitations to the results and opportunities for further research. Many limitations and further research needs were identified in the individual papers presented in Chapters 3 to 7. Some of these limitations are summarised again here, together with more general limitations related to the study and needs for further research.

There are limitations associated with the data collection methods used. Both surveys used to collect data were cross-sectional, meaning this study examined a single snap-shot in time, and cannot confirm hypothesised causal relationships. However, many of the findings are consistent with other studies examining acceptability of fuel management, and this has been the basis for making some inference throughout. Ideally longitudinal studies should be conducted that identify how attitudes change over time in response to differing information and experience.

The first survey distributed in and around the ACT was conducted eight years ago. There has been a population increase in the ACT since the time the survey was conducted, from approximately 367,800 in 2011, to 424,000 in 2019, as well as changing events around fire management. It is therefore possible that attitudes have changed since that time, particularly given at least some of the population increase is from people migrating to the region. Further studies in the region would be useful to gain an insight into whether or not attitudes have changed.

In this study, trust in information about fuel management provided by different sources and how it relates to acceptability of fuel management was explored, rather than explicitly examining direct trust in agencies. However my findings suggest there is some overlap, as trust in information sources predicted higher acceptability of fuel management, consistent with North American studies that find higher levels of trust in agencies consistently predicts acceptability (McCaffrey et al. 2013). Social trust is not a straightforward concept, and further investigation about how these two similar, albeit different concepts about social trust are related would be useful.

There were some instances of negative findings in this study, for example some factors were significantly correlated with acceptability of fuel management in bivariate analysis however they were not predictors in regression analysis (e.g. perceptions of vulnerability and risk), and some factors such as personal experiences with wildfire were not predictors of acceptability despite theory suggesting it might be. While it is possible these factors are simply not useful predictors of acceptability of fuel management compared to other factors, it is unknown given the exploratory nature of this work in Australia, and the generally inconsistent findings with North American studies. I have recommended further exploration of these negative findings in the individual chapters where they are reported to determine whether they are in fact not important predictors of acceptability of fuel management in an Australian context compared to other factors, or whether these negative findings are a result of limitations in the data, sample, questions asked or the analysis.

When exploring whether length of time since experiencing a wildfire is associated with acceptability of fuel management in Chapter 5, the survey question analysed only asked Australian residents whether they had experienced a wildfire in the past ten years. It is possible the timeframe was not long enough to see a decline in issue-attention, and therefore acceptability. Additionally, there was a focus in Chapter 5 on the impact of direct personal experiences of wildfire on acceptability of fuel management, and the possible influence of media on issue attention. However the role of wildfire in the media and issue attention was not explicitly examined in this thesis, and there is also a need to acknowledge that personal experience and media are not the only avenues that may draw attention to wildfire management. For example wildfire management activities occurring at the very local scale may capture attention about fuel management in that local context. It is also possible that indirect experience, such as having a friend or relative threatened by wildfire, can influence acceptability (McCaffrey 2004b). Questions about activities occurring at a small local scale, the extent to which individuals accessed media reporting about wildfires or prescribed burning, whether wildfires were experienced in the local region without being personally impacted, or whether they had contact with others impacted by wildfires were not asked. This limits the understanding generated about the relationship between acceptability of fuel management and personally experiencing a wildfire, versus the potential reinforcing effect of the media or other people's experiences in the issue-attention cycle, and should be examined in future studies.

Most survey participants found all three fuel management practices acceptable, and this limited range of variance reduced the ability to explore the views of those who found them unacceptable. More nuanced measures of acceptability may be necessary to better explore variance in attitudes in future. Furthermore, the majority of survey participants felt it was unacceptable not to carry out any fuel management practices. While I briefly examined this in my bivariate analysis in Chapter 4, further exploration of these results in future might assist in understanding the variance in views about fuel management.

Analysing IC quantitatively is relatively new, and further development of measures is warranted. The modification to the scoring of IC proposed in Chapter 7 was limited to the scoring method and not the survey measure itself. The way IC measures are designed for quantitative surveys has potential to provide a range of different valuable insights for wildfire managers when developing communication strategies, and therefore deserves further exploration in future studies. Furthermore, while ICT suggests potential for reduced conflict through building complexity of thinking, further research is needed to explore whether and what types of dialogue and engagement successfully build IC, and whether the resulting higher IC is in fact associated with more stable, resilient attitudes.

This study examined attitudes and complexity of thinking of the general public, but not amongst stakeholder groups with a strong interest in fuel management. This is an important limitation, as members of these stakeholders can have polarised views and influence public discussions about the use of fuel management. They are thus likely a key influence on attitudes about fuel management, particularly if they are highly trusted by those with low IC. These groups may not have the same associations between IC, acceptability and knowledge identified in this study. Exploring these interactions would be useful in future research; for example whether these interactions are somewhat captured by the ‘setting up and knocking down a straw man’ analogy in the coding manual for qualitatively measuring IC (Baker-Brown et al. 1992). This is where someone may acknowledge the existence of several different arguments (indicating high knowledge about fuel management and displaying high differentiation), but then proceed to ‘knock down’ one side of the arguments, receiving the lowest possible IC score using qualitative methods. Further exploration of this situation, for example when measuring IC in a survey, is needed.

In the paper published and presented in Chapter 7, the term ‘preferred’ information mediums is used. However this is not the term that was used in the survey questions. Rather, survey respondents were asked how useful they felt each information medium was in providing information about fuel management. This is an important distinction, as these terms can be interpreted differently. A preferred information medium might not be the same as what is considered to be a useful medium in obtaining information about fuel management. Further investigation is needed to determine whether responses to the phrasing of ‘useful’ compared to ‘preferred’ is the same.

Finally, this study was limited to investigating acceptability fuel management used to reduce wildfire risk to life and property, due to the need to limit the scope of the research. It is unknown whether or not acceptability of prescribed burning (and to some extent mechanical thinning) would be different when used for different purposes, such as achieving specific ecological outcomes, or whether other approaches such as the use of traditional Aboriginal methods of burning are considered more or less acceptable. Further research to explore differences in attitudes between different management objectives and approaches could enhance understanding of social acceptability of fuel management in an Australian context.

8.7 Conclusions

Managing fuels to reduce wildfire risk requires long-term investment, planning and implementation, and this is more likely to be achieved if there is stable social support for use of fuel management strategies. In the Australian Capital Territory, a region with high awareness and occurrence of wildfires, three different fuel management strategies (prescribed burning, mechanical thinning and livestock grazing) all have high levels of acceptance amongst the population, and prescribed burning has high acceptance Australia-wide. However, despite this high acceptance, wildfire managers reported concern about polarisation of attitudes, and potential for rapidly changing attitudes. This suggests a need to explore tools for communicating in ways that can build more stable, resilient attitudes that are less polarised. These findings pointed to a need to understand *how* people think about fuel management, as there is little understanding about how stable this high acceptance is, or whether it is likely to change.

With little understanding about how literature on acceptability of fuel management developed in North America can be applied in other regions around the world, this thesis provides an overview of some of the similarities and differences in an Australian context. Consistent with North American studies, acceptability was predicted by trust in information about fuel management provided by agencies responsible for fuel management, self-rated knowledge about fuel management, the perceived costs and benefits of undertaking fuel management and the level of complex thinking about fuel management, while perceptions of wildfire risk and past experiences with wildfire, and length of time since personally experiencing fire, did not predict acceptability of fuel management.

Integrative Complexity Theory was used to explore how people process and structure complex arguments about fuel management to form their views. People thought more complexly about prescribed burning compared to mechanical thinning and livestock grazing. Prescribed burning is a more familiar fuel management practice in Australia, as it is more commonly used compared to mechanical thinning and livestock grazing, and more commonly discussed in the media. Higher levels of complex thinking predicted more moderate attitudes towards fuel management, and two other information processing theories – Elaboration Likelihood Model and Heuristic-Systematic Model – suggest that these more moderate attitudes are more likely to be resilient to rapid change. The findings suggest that building trust in agencies responsible for providing information about fuel management and building complexity of understanding about fuel management are equally important in gaining less extreme and more stable acceptability over time. While building IC may be able to achieve this goal, it is unrealistic to expect an entire population to build high IC about fuel management, and therefore trust building initiatives are essential to ensure that those who are not interested in or willing to invest in building understanding of fuel management are likely to trust information provided by wildfire managers. These findings provide an insight into the level of acceptability that is needed for long term implementation of fuel management practices, and challenges the often suggested assumption that higher acceptability is better.

While previous studies have suggested information campaigns can be designed to cater to the level of complexity at which a person is thinking, few have explored this in any detail. In this Australian context, the results suggest that people are receptive to more complex messaging being delivered about fuel management. Wildfire managers could focus less on simple messaging about how fuel management reduces wildfire risk, which appears to have already been effective (and perceptions of wildfire risk not predicting acceptability), and instead focus on more complex and nuanced communication about the decisions made when implementing fuel management strategies, particularly for prescribed burning. Overly simple messages could be counterproductive if considered condescending or unnecessary, and not effectively address the concerns about fuel management identified in the survey. An approach that includes communicating more complex arguments around fuel management may be needed to satisfy those with higher complexity of thinking and to address the concerns about the benefits and costs of fuel management, and has potential to build complexity of thinking resulting in more resilient attitudes over the longer term.

There is a need for further research specifically examining different approaches that seek to build complexity of thinking, to test whether doing so results in more moderate, but resilient attitudes over time. Future research should aim to identify whether shifting from targeting information to groups based on whether they have higher versus lower acceptability, to targeting based on both this *and* their complexity of thinking, can achieve more stable long-term moderate support that better enables managers to achieve long-term implementation of fuel management strategies necessary for effective reduction of wildfire risk.

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Appendix 1: Example of informed expert interview invitation

Email subject: PhD thesis research - perceptions about fuel modification

Dear ….

My name is Melinda Mylek and I am a PhD student at the Fenner School of Resources, Environment and Society of the Australian National University (ANU).

I am currently conducting thesis research into perceptions about fuel modification strategies used to reduce bushfire risk to life and property. I hope to identify if different individuals or groups within the community are more or less likely to accept different fuel modification strategies and why. Examining these issues will help develop policies and management strategies that better incorporate the needs and concerns of the public.

To help guide the study and ensure it has practical application, I would like to invite you to participate in my research as an interviewee. Your experience would be highly valuable in guiding my research, and in order to understand how this study could have a practical application on completion. Your contribution would also be used to help design a survey to be sent to members of the public to better understand their perceptions.

I hope that you will consider this invitation to participate. The attached introductory letter and information sheet explains my research in greater detail, including the research purpose and methods, the interview style, and privacy and ethical considerations.

Should you be willing to participate in this research, please contact me by reply email or on 0409 xxx xxx, and we can organise an interview time and place that suits you.

At the start of the interview, I will ask you to sign the attached Consent form, which indicates your voluntary participation in my research and your understanding of the research as per the Introduction Sheet. I will be happy to answer any questions you have about the research either before or at the interview.

If you would like to participate in this research as an interviewee, or you have any further question about the research, Information Sheet or Consent Form please contact me on:

Mobile: 0409 xxx xxx

Email: melinda.mylek@anu.edu.au

Regards

Melinda Mylek

Appendix 2: Example of community member interview invitation

Email subject: Mel Mylek needs your help with her PhD Studies

Hi,

As you probably know, I'm studying at the ANU, doing my PhD.

I need your help…..

My study is looking at how people feel about different fuel management methods that are commonly used to reduce bushfire risk to life and property. This includes activities like prescribed burning (burning off), grazing of livestock, and mowing grass.

The main method I will use to collect information from the public will be a postal survey. But, in order to design a comprehensive survey that asks all the right questions, I first need to interview some people from the general public.

This is where you come in….

To make sure I do not create any bias in the types of people that I interview, **I will not be interviewing direct friends or family**, so although you might like to help directly as an interviewee, I can't let you to participate in that way – **the best thing you can do to help me is to forward this on** to your friends, colleagues and family.

Please forward this email on to your friends, colleagues and family that live in or around **Canberra** to ask if they would be interested/willing to participate in my study as a volunteer interviewee (make sure the attachments are also forwarded – they contain more detailed information). The interview would take no more than 1-2 hours, at a location most convenient for the volunteer interviewee, and all information and contact details will be kept strictly confidential.

I will be selecting a range of different types of people – for example, both men and women, of different ages, different interests, and different residence, so that I do not interview the same types of people. There is a possibility that if I have interested people that are very similar, I may not be able to include all of them in the study.

I need to complete all interviews before 15 September 2010.

Please ask anyone who is interested in participating to email me at:

melinda.mylek@ghd.com, or Melinda.mylek@anu.edu.au,

or call me on: 0409 xxx xxx

Feel free to include the following in your forwarded emails:

Invitation for members of the community to participate in research on fuel management methods that are commonly used to reduce bushfire risk to life and property.

My name is Melinda Mylek and I am a PhD student at the Fenner School of Resources, Environment and Society of the Australian National University (ANU). Your contact details were obtained through the recommendation of friends or family.

I am currently conducting thesis research into perceptions about fuel modification strategies used to reduce bushfire risk to life and property. I hope to identify if different individuals or groups within the community are more or less likely to accept different fuel modification strategies and why. Examining these issues will help develop policies and management strategies that better incorporate the needs and concerns of the public.

To help design a comprehensive postal survey, I would like to invite you as a member of the community to participate in my research as an interviewee. Your participation would be highly valuable in gathering information about how members of the community view certain aspects of fuel management.

Please find more details about the interview process in the attached documents.

Regards

Melinda Mylek

INTRODUCTORY LETTER

My name is Melinda Mylek and I am a PhD student at the Fenner School of Resources, Environment and Society of the Australian National University (ANU). Your contact details were obtained through the recommendation of friends or family.

I am currently conducting thesis research into perceptions about fuel modification strategies used to reduce bushfire risk to life and property. I hope to identify if different individuals or groups within the community are more or less likely to accept different fuel modification strategies and why. Examining these issues will help develop policies and management strategies that better incorporate the needs and concerns of the public. This research is funded by the Cooperative Research Centre for Forestry.

To help design a comprehensive postal survey, I would like to invite you as a member of the community to participate in my research as an interviewee. Your participation would be highly valuable in gathering information about how members of the community view certain aspects of fuel management. Your contribution can assist in examining the types of fuel management issues that arise in the general community, and will help in developing a comprehensive and realistic postal survey, which is the main data collection method for this study.

The interview will take approximately 1-2 hours, and will take on the form of a guided discussion. You will be invited to talk about your perceptions of fuel modification strategies used to reduce bushfire risk to life and property, your reasons for and/or against these fuel modification strategies, and to discuss any past experiences with bushfire and fuel modification. The interview will be recorded.

I hope that you will consider this invitation to participate. The attached Information Sheet explains my research in greater detail, including the research purpose and methods, the interview style, and privacy and ethical considerations.

Should you be willing to participate in this research, I would be grateful if you could contact me (my contact details are below). I will then ask you for some information about your gender, age, occupation, area of residence and spare time interests. This is to help me ensure I identify people from a diversity of backgrounds to interview; there is a possibility that if I have interested people similar to you I may not be able to include you in the study. If suitable, I will then organise an interview time and place that suits you. At the start of the interview, I will ask you to sign the attached Consent form, which indicates your voluntary participation in my research and your understanding of the research as per the Introduction Sheet. I will be happy to answer any questions you have about the research either before or at the interview.

If you would like to participate in this research as an interviewee, or you have any further question about the research, Information Sheet or Consent Form please contact me on:

Mobile: 0409 xxx xxx
Email: melinda.mylek@anu.edu.au

Yours Sincerely,

Melinda Mylek

Appendix 3: Interview guide – informed experts

Thank you for taking the time to meet with me and participate in my research.

Your participation is completely voluntary, you can stop at any time, or withdraw any of the information that you have given me.

Comments will not be identifiable in any way, unless you are happy to be quoted.

Did you have a chance to read over the information sheet and consent form?

I just want to remind you that the interview will be recorded so that I make sure I don't miss anything important in my notes.

Sign the consent form.

This study is examining whether different individuals or groups within the community are more or less likely to accept different fuel modification strategies, and why.

There has been a lot of good research looking at perceptions and acceptance of different fuel modification strategies in the USA that indicates there are quite strong differences in perceptions, however we have very little knowledge about perceptions about fuel modification here in Australia.

Understanding public perceptions of fuel management can help with developing appropriate strategies and policies that address the needs and priorities of the community. It can also help in recognising when existing policies might be supported by the public, or when proposed or existing policies are likely to meet opposition, and can assist in the development of information campaigns designed to increase public understanding about potential and existing controversial strategies.

This study will focus on prescribed burning, which appears to be the more controversial of the strategies commonly used to reduce fuel. The study will also examine whether other fuel reduction strategies such as grazing, slashing or thinning are more socially acceptable, and under what circumstances.

The main data collection method for this study will be a postal survey, where I'll be able to analyse the results using statistics. The reason that I have am interviewing informed experts is to help guide my study in the right direction, and try to make sure I ask the right questions so that the research can have some practical use or meaning in the end.

I will also be interviewing members of the public to help me design a survey that addresses the issues raised and makes sure I'm using the right terminology in the survey.

As part of the study I want to examine if there is a difference in perceptions depending on the time since a major fire event. Currently I will be working in two case study areas, ACT and Victoria. Depending on my available resources and the information gained in these areas, I might venture into another region, but that is still be to decided.

This is a guided interview, where I have a small list of set topics that I would like to cover, but within those topics we can discuss the issue broadly and in detail.

- **In your opinion, what are the most appropriate fuel modification strategies needed to reduce the risk of bushfires to life and property? And why?**
    - *Check them off as they go, and ask about any that they don't initially discuss. Prompt list – have you heard about? If no define. – Prescribed burning, grazing, slashing.*
- **Have you heard about biomass thinning as it is used in the USA?** *If no, define. Thinning is less common in the Australia for the purpose of fuel modification, however a common fuel reduction method used in the USA is biomass thinning, where forest trees and understorey shrubs are 'thinned out' in order to reduce the amount of combustible fuels in a forest. Larger trees are able to be sold and therefore the cost of removing this fuel is paid for, however smaller fuel need to be chipped or removed off site at the cost of the land manager. This causes some controversy in the US, as to what should be removed from the forest and in what proportion.*
    - ***Do you think there is a place for thinning as a means of fuel modification in Australia?***
- **What community reactions have you observed with the different fuel modification strategies, e.g. prescribed burning, grazing, slashing?**
- **Would knowing more about perceptions and attitudes about fuel modification improve policy development and land management?**
    - *Explore this question in depth.*
    - *If yes, what do we need to know about perceptions and attitudes to assist in policy development and land management?*
    - ***Why do you need to know………***
    - *If no, why would you not benefit from knowing more about perceptions and attitudes?*

Appendix 4: Interview guide – community members

Thank you for taking the time to meet with me and participate in my research. I'm just going to give you a quick overview of my project and why I have asked members of the public to participate as interviewees.

Before I do I just want to remind you that this interview is completely voluntary and that you can stop at any time. You can also withdraw any of the information that you have given me, and you and your comments will not be identifiable in any way.

Did you have a chance to read over the information sheet and consent form? So I'd like to remind you that the interview will be recorded so that I make sure I don't miss anything important in my notes, and I'd just like to set up the recorder now before I start explaining the research in any detail.

My project is looking at how individuals and groups of people in the community perceive fuel modification methods used the reduce bushfire risk to life and property. By fuel modification I mean where fuels, like grass, shrubs, leaves, trees or any kind of flammable material is changed, like removed, reduced or re-arranged in some way, to reduce the likelihood, or the intensity of a bushfire.

I'm looking at how the community views different types of fuel modification activities so that land managers and policy makers can better understand community concerns and be able to manage the land in a way that incorporates the community's needs.

My main data collection method for this study will be a postal survey, where I'll be able to analyse the results using statistics. The reason for asking members of the public to participate in interviews is to help me design a survey that addresses the issues raised and makes sure I'm using the right terminology in the survey.

So we might go through signing the consent form now before we begin.

Introductory questions

Just to get an idea of your bushfire experience or knowledge, I'd like to spend just 5-10 minutes on some quick introductory questions.

- **Have you seen/experienced a major bushfire? How did it affect you?**
- **Is this a topic that you have thought about in the past? Discussed with friends/family/colleagues? Or are interested in?**
- **Where have you/do you see information about bushfires? i.e. what sources of information?**

I'm now going to ask a range of questions involving 4 different fuel management options. The questions are virtually the same about each management option so it might seem a bit repetitive but it is important to get a good understanding about how you view each of them.

Prescribed Burning

- **Have you ever heard of prescribed burning and how would you describe it if you have?**

  - **Have you ever heard it called by a different name?**
- **Have you ever seen/experienced prescribed burning? Describe the circumstances.**
  - **Do you think we need to do more or less of this? and why?**
  - **What are the advantages and disadvantages (plusses and minuses) of prescribed burning?**
- **What would make it more or less acceptable?**

<u>Grazing</u>

- **Have you ever heard of the use of livestock grazing, like sheep and cattle, to reduce fuel loads? and how would you describe it if you have?**
  - **Have you ever heard it called by a different name?**

If not explain: Sometimes livestock, such as sheep or cattle, can be used to reduce fuel loads. It can be particularly common on farms and in forests or plantations to reduce grassy fuels in certain areas. Historically it was used in the mountains here, but also you may have seen cows in some reserves here in the ACT? They are actually used as a fuel reduction strategy.

- **Have you ever seen/experienced grazing for fuel reduction? Describe the circumstances.**
  - **Do you think we need to do more or less of this? and why?**
  - **What are the advantages and disadvantages (plusses and minuses) of grazing?**
- **What would make it more or less acceptable?**

<u>Slashing/mowing</u>

Do you know what I mean by slashing or mowing?

If not explain: you may have seen people mowing the sides of the roads sometimes? This is what is meant by slashing or mowing, but in a broader sense. It can be on the side of the road, in reserves, on the urban fringe, in parks, on the edge of the forest as a firebreak, in the fields, etc.

- **Have you ever heard of slashing or mowing being used as a means to reduce fuel loads? and how would you describe it if you have?**
  - **Have you ever heard it called by a different name?**
- **Have you ever seen/experienced slashing? Describe the circumstances.**
  - **Do you think we need to do more or less of this? and why?**
  - **What are the advantages and disadvantages (plusses and minuses) of slashing?**
- **What would make it more or less acceptable?**

<u>Thinning</u>

- **Have you ever heard of biomass thinning, or physical removal of fuel from a forest or a landscape, as a means of fuel management?**

Thinning is less common in the Australia generally for the purpose of fuel modification, although used quite often in the ACT, however a common fuel reduction method used in the USA is biomass thinning, where forest trees and understorey shrubs are 'thinned out' in order to reduce the amount of combustible fuels in a forest. Larger trees are able to be sold and therefore the cost of removing this fuel is paid for, however smaller fuel need to be chipped or removed off site at the cost of the land manager. This causes some controversy in the US, as to what should be removed from the forest and in what proportion.

- **How acceptable do you think this practice would be if it were introduced into Australia for both commercial profit and fuel modification?**

Final Questions

- **(If they've experienced a bushfire – from the first question): Has it changed your feelings about fuel modification?**

If they are comfortable to answer personal questions about themselves:

- **What is your age?**
- **Profession?**
- **Where do you live (if the interview is not at their home)? Have you always lived there/here? And for how long?**
- **Do you have any other issues/concerns/questions regarding the different fuel modification strategies that that you would like to discuss?**

Appendix 5: Survey 1 – ACT and surrounding region of NSW

A BUSHFIRE MANAGEMENT SURVEY

Attitudes towards fuel management strategies used to reduce bushfire risk to life and property

2011

A PhD research project conducted by Melinda Mylek,

at The Australian National University,

in affiliation with the Cooperative Research Centre for Forestry (Forestry CRC)

.

This survey asks your views about **fuel management** used to reduce bushfire risk to life and property (an information sheet has been included with this survey, and relevant definitions are also included in later sections of the survey).

The survey forms part of a PhD study I am undertaking at The Fenner School of Environment and Society at the Australian National University, and is being undertaken in Canberra and the surrounding region of ACT and NSW.

Surveys have been sent to a random selection of residents whose addresses were obtained from the White Pages. I ask that one member of your household complete the survey; if the person(s) to whom the survey is addressed is unavailable, I would appreciate any other person aged over 18 in the household completing the survey instead.

You are assured of complete confidentiality. Your name will never be placed on the survey or used in any reports unless permission has been granted by you. Only myself and my supervisors will have access to these surveys. See the information sheet sent to you together with this survey for details.

An identification number has been placed on this survey in order to manage survey responses across different locations.

By posting this survey back you have consented to the use of your response as part of this study. The survey should take about 30 minutes to complete.

Thank you for your assistance. Please do not hesitate to contact me (see contact details on information sheet) if you have any questions or concerns.

Melinda Mylek, Fenner School of Environment and Society, ANU

SECTION 1: INTRODUCTORY QUESTIONS

First, I'd like to get an idea of where you currently live.

1. Please write down your *suburb, town or nearest town* (if you live on a rural property). ____

2. Please describe the area in which you live, *by ticking one option provided below.*

   ( ) Urban/suburbia ( ) Rural town/Rural residential

   ( ) City outskirts or peri-urban ( ) Rural property

3. How long have you lived at your current address? _____________ years

Now, I'd like to ask a few questions about your experience/exposure to bushfires.

4. Were you living (or visiting) the Canberra region during the bushfires in January 2003, which resulted in the loss of life and property in and around Canberra? *(please circle your answer)*

   YES NO

   If YES, please continue to Question 4a.

   If NO, please move to Question 5.

4a. How were you impacted by the 2003 Canberra bushfires? *(Please tick all that apply)*

( ) Loss of family/friends
( ) Personal injury or health impacts
( ) Loss of personal assets
( ) Personal anxiety
( ) Damage to personal assets
( ) Friends/family experienced injury or health impacts
( ) Friends/family experienced damage/loss of assets
( ) Colleagues/neighbours/other associates were negatively impacted in some way
( ) Not impacted at all
( ) Other ____________________

5. Have you seen or experienced any other bushfires close to where you live/lived, whether in Canberra or elsewhere? *(please circle your answer)*
YES NO

If YES, how were you impacted? *(Please tick all that apply)*

( ) Loss of family/friends
( ) Personal injury or health impacts
( ) Loss of personal assets
( ) Personal anxiety
( ) Damage to personal assets
( ) Friends/family experienced injury or health impacts
( ) Friends/family experienced damage/loss of assets
( ) Colleagues/neighbours/other associates were negatively impacted in some way
( ) Not impacted at all
( ) Other ____________________

6. How vulnerable do you personally feel to the possible threat of future bushfires at your current residence (for example, direct loss of life or assets, or significant health impacts)?
(Please tick the box that applies)

Not at all vulnerable	**Only a little vulnerable**	**Moderately vulnerable**	**Vulnerable**	**Very vulnerable**	**Unsure**
( )	( )	( )	( )	( )	( )

7. How important do you personally feel your own actions around your property/place of residence are in reducing bushfire risk to you? (for example clearing your gutters, removing debris and dead vegetation, keeping your grass and trees/bushes trimmed etc.)
(Please tick the box that applies)

Not at all important	**Only a little important**	**Moderately important**	**Important**	**Very important**	**Unsure**
( )	( )	( )	( )	( )	( )

I'd now like to ask a few questions about your level of awareness and knowledge about <u>fuel management</u> undertaken by public and private authorities.

Fuel *can be defined as any material that can burn, for example grass, leaves, sticks, logs etc.* ***Fuel management*** *is the practice of reducing or changing fuel, in order to reduce the amount that is available to burn, in turn reducing the risk to life and property during a bushfire.*

8. How would you rate your current level of awareness and knowledge about **fuel management**?
(Please tick the box that applies)

Very poor	Poor	Neither poor nor good	Good	Very good	Unsure
( )	( )	( )	( )	( )	( )

9. Have you actively sought information about fuel management in the past?
(please circle your answer)
YES NO

If YES, were you successful in finding the information you were looking for?

YES NO

And if so, where did you find the information? *(Please list all)*

____

How useful would you find information delivered in the following ways about **fuel management**?

Please tick the box that best represents your answer	**Not useful at all**	**A little useful**	**Moderately useful**	**Useful**	**Highly useful**	**Unsure**
Television news reports	( )	( )	( )	( )	( )	( )
Documentaries or television programs	( )	( )	( )	( )	( )	( )
Radio programs	( )	( )	( )	( )	( )	( )
Radio news reports	( )	( )	( )	( )	( )	( )
Newspapers	( )	( )	( )	( )	( )	( )
Internet websites	( )	( )	( )	( )	( )	( )
Pamphlets/brochures/booklets/factsheets	( )	( )	( )	( )	( )	( )
Information materials sent in the mail	( )	( )	( )	( )	( )	( )
Through education facilities such as schools, TAFE/CIT or universities	( )	( )	( )	( )	( )	( )
Field days open to the public	( )	( )	( )	( )	( )	( )
One-on-one discussions with an expert	( )	( )	( )	( )	( )	( )
Bushfire training courses	( )	( )	( )	( )	( )	( )
Community events or information sessions	( )	( )	( )	( )	( )	( )
Scientific papers and reports	( )	( )	( )	( )	( )	( )
Through friends/family	( )	( )	( )	( )	( )	( )
Other *(Please describe)*	( )	( )	( )	( )	( )	( )

SECTION 2: Fuel Management

In this section, you will be asked a series of questions about your thoughts on different fuel management methods commonly used in the ACT & NSW.

Fuel *can be defined as any material that can burn, for example grass, leaves, sticks, logs etc.*

Fuel management *is the practice of reducing or changing fuel, in order to reduce the amount that is available to burn, in turn reducing the risk to life and property during a bushfire.*

1. What is your level of ***trust*** in the information about fuel management delivered by the following sources?

(Please tick the box that applies)

Please tick the box that best represents your answer	**Very low**	**Low**	**Neither low nor high**	**High**	**Very high**	**Unsure**
Media outlets (for example, TV news, newspapers, radio)	( )	( )	( )	( )	( )	( )
Federal government	( )	( )	( )	( )	( )	( )
Territory Government agency – Parks Conservation and Lands	( )	( )	( )	( )	( )	( )
NSW State Government agency - Department of Primary Industry	( )	( )	( )	( )	( )	( )
NSW State Government agency – National Parks	( )	( )	( )	( )	( )	( )
NSW State forestry agency (e.g. plantation managers)	( )	( )	( )	( )	( )	( )
Private forestry companies	( )	( )	( )	( )	( )	( )
Urban firefighters	( )	( )	( )	( )	( )	( )
Bushfire councils	( )	( )	( )	( )	( )	( )
Paid bushfire brigades	( )	( )	( )	( )	( )	( )
Volunteer bushfire brigades	( )	( )	( )	( )	( )	( )
Community fire units	( )	( )	( )	( )	( )	( )
Education facilities (e.g. schools, TAFE/CIT or universities)	( )	( )	( )	( )	( )	( )
Research institutes (e.g. CSIRO, universities)	( )	( )	( )	( )	( )	( )
Friends and family	( )	( )	( )	( )	( )	( )

Thank you for your input so far. This section will require independent thought about fuel management. Your input in this section is very important to my research.

You will now be asked to list arguments both FOR and AGAINST different fuel management methods that are commonly used around the ACT.

Arguments for and against **controlled burning**

Controlled burning*, also known as a fuel reduction burn, prescribed burning or 'burning-off', is the intentional lighting of fire by land management authorities, in specified locations, under specified weather and vegetation conditions, to meet a particular management objective. One common objective is to reduce the amount of fuel. It is argued that reduced fuel levels can help control the intensity of unplanned bushfires.*

In column A, please list any arguments FOR ("Pros") and any arguments AGAINST ("Cons") controlled burning. ***Please list as many as you can in each FOR and AGAINST section. It is ok if you cannot fill all the available spaces.*** **In column B**, please indicate on a scale of 1 to 7, how STRONGLY you feel about *each* argument you listed (where 1 is not at all strong, and 7 is extremely strong). *Please circle the number that represents your response*.

Example: If you were asked to list arguments for and against seeing a movie at the cinema, an argument 'for' may be that you get to see the newest releases on the big screen, and you feel moderately strong about that argument (4). An argument 'against' may be that you feel ticket prices are too expensive, and you feel extremely strong about that argument (7).

COLUMN A	**COLUMN B**						
Arguments FOR controlled burning (Pros). List as many as you can	Not at all strong			Moderately strong			Extremely strong
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7
Argument AGAINST controlled burning (Cons). List as many as you can.							
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7

Arguments for and against **livestock grazing**

<u>Livestock grazing</u> *for fuel reduction is when livestock are allowed to graze a specified area in order to reduce the amount of grassy fuel in that area. This often includes cattle (cows) or sheep, but could also include animals such as horses, goats, alpacas/llamas, deer, or any other animal that primarily eats grasses. Livestock grazing is used in the ACT and surrounding areas as a fuel management method.*

In column A, please list any arguments FOR ("Pros") and any arguments AGAINST ("Cons") livestock grazing. ***Please list as many as you can in each FOR and AGAINST section. It is ok if you cannot fill all the available spaces.*** **In column B**, please indicate on a scale of 1 to 7, how STRONGLY you feel about *each* argument you listed (where 1 is not at all strong, and 7 is extremely strong). *Please circle the number that represents your response*.

<u>COLUMN A</u>	**<u>COLUMN B</u>**						
Arguments FOR livestock grazing (Pros). List as many as you can	Not at all strong			Moderately strong			Extremely strong
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7
Argument AGAINST livestock grazing (Cons). List as many as you can.							
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7

Arguments for and against **vegetation thinning**

<u>Vegetation thinning</u> *is where some forest trees and understorey shrubs are cut and either removed off site, or left on site to be burnt or decompose over time. It can sometimes also include pruning of branches and/or cleaning of bark from the tree trunks. For fuel management purposes, it is removing available fuel, or changing the structure of the fuel in a forest, in order to help control an unplanned bushfire. In the ACT, it can sometimes be seen in pine plantations, for example along the Tuggeranong Parkway, or in some nature reserves, such as Lyneham Ridge.*

In column A, please list any arguments FOR ("Pros") and any arguments AGAINST ("Cons") vegetation thinning. ***Please list as many as you can in each FOR and AGAINST section. It is ok if you cannot fill all the available spaces.*** **In column B**, please indicate on a scale of 1 to 7, how STRONGLY you feel about *each* argument you listed (where 1 is Not at all strong, and 7 is extremely strong). *Please circle the number that represents your response*.

<u>COLUMN A</u>	**<u>COLUMN B</u>**						
Arguments FOR vegetation thinning (Pros). List as many as you can	Not at all strong			Moderately strong			Extremely strong
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7
Argument AGAINST vegetation thinning (Cons). List as many as you can.							
a	1	2	3	4	5	6	7
b	1	2	3	4	5	6	7
c	1	2	3	4	5	6	7
d	1	2	3	4	5	6	7
e	1	2	3	4	5	6	7
f	1	2	3	4	5	6	7

SECTION 3: HOW ACCEPTABLE IS FUEL MANAGEMENT?

I'd now like to ask you to answer some questions about how acceptable you feel different fuel management methods are in different situations. How **unacceptable/acceptable** do you personally feel it is to carry out the different fuel management methods, **specifically for the purpose of reducing bushfire risk to life and property,**? (*On a scale of 1 to 7, where 1 is highly unacceptable and 7 is highly acceptable; please circle the number that represents your response)*

Please tick the box that best represents your answer	**Highly Unacceptable**			**Neutral/no opinion**			**Highly acceptable**	**Unsure**
i. Controlled burning…								
…used for fuel management in general is….	1	2	3	4	5	6	7	( )
…undertaken in conservation areas is….	1	2	3	4	5	6	7	( )
… undertaken in farming areas is….	1	2	3	4	5	6	7	( )
… undertaken in native forests is….	1	2	3	4	5	6	7	( )
… undertaken in plantations is….	1	2	3	4	5	6	7	( )
… undertaken close to my home is….	1	2	3	4	5	6	7	( )
ii. Livestock grazing…								
…used for fuel management in general is …	1	2	3	4	5	6	7	( )
… undertaken in conservation areas is…..	1	2	3	4	5	6	7	( )
… undertaken in farming areas is…..	1	2	3	4	5	6	7	( )
… undertaken in native forests is…..	1	2	3	4	5	6	7	( )
… undertaken in plantations is…..	1	2	3	4	5	6	7	( )
… undertaken close to my home is…..	1	2	3	4	5	6	7	( )
iii. Vegetation thinning …								
…used for fuel management in general is…	1	2	3	4	5	6	7	( )
… undertaken in conservation areas is…..	1	2	3	4	5	6	7	( )
… undertaken in farming areas is…..	1	2	3	4	5	6	7	( )
… undertaken in native forests is…..	1	2	3	4	5	6	7	( )
… undertaken in plantations is…..	1	2	3	4	5	6	7	( )
… undertaken close to my home is…..	1	2	3	4	5	6	7	( )

How **ineffective/effective** do you personally feel the three different fuel management methods are**, for the purpose of reducing bushfire risk to life and property**? (*On a scale of 1 to 7, where 1 is highly ineffective and 7 is highly effective; please circle the number that represents your response)*

Please tick the box that best represents your answer	**Highly ineffective**			**Neutral/No opinion**			**Highly effective**	**Unsure**
Controlled burning programs in general are….	1	2	3	4	5	6	7	( )
Livestock grazing programs in general are…..	1	2	3	4	5	6	7	( )
Vegetation thinning programs in general are…..	1	2	3	4	5	6	7	( )

How **risky/sensible** do you personally feel the three different fuel management methods are**, for the purpose of reducing bushfire risk to life and property**? (*please tick the box that represents your answer)*. Risky means that the risks associated with fuel management outweighed the benefits (e.g. it may present an unacceptable threat to you or your property), and sensible means that the benefits associated with fuel management outweighed the costs (e.g. overall it may reduce threat of bushfire to you or your property) (*On a scale of 1 to 7, where 1 is highly risky and 7 is highly sensible; please circle the number that represents your response)*.

Please tick the box that best represents your answer	**Highly risky**			**Neutral/No opinion**			**Highly sensible**	**Unsure**
Controlled burning in general is….	1	2	3	4	5	6	7	( )
Livestock grazing in general is…..	1	2	3	4	5	6	7	( )
Vegetation thinning in general is…..	1	2	3	4	5	6	7	( )

4. How **unacceptable/acceptable** do you personally feel it is for land managers to do **no** fuel management at all **for the purpose of reducing bushfire risk to life and property**? (*On a scale of 1 to 7, where 1 is highly unacceptable and 7 is highly acceptable; please circle the number that represents your response)*

Please tick the box that best represents your answer	**Highly Unacceptable**			**Neutral/no opinion**			**Highly acceptable**	**Unsure**
Not doing any fuel management at all is….	1	2	3	4	5	6	7	( )

SECTION 4: BACKGROUND INFORMATION

This last section asks some general questions about you. This information is important for this research to help explain differences in the responses. To protect your privacy, your name will never be linked to your survey responses.

1. Are you male or female? (*Please circle your answer*).

MALE FEMALE

2. How old are you? (*Please write your current age*) ______________________

3. Are you currently? *(Please circle your answer)*

EMPLOYED UNEMPLOYED RETIRED OTHER

If EMPLOYED or OTHER, What is your primary occupation i.e. the occupation you spend the majority of time doing (For example, teacher, accountant, farmer)?

____

4. What is the highest level of formal education you have completed? (*Please tick one only).*

( ) Year 9 or below
( ) Post school certificate or diploma
( ) Year 10 or 11
( ) Bachelor/undergraduate university degree
( ) Year 12 or equivalent
( ) Postgraduate university degree

5. Have you always lived in Canberra or the surrounding area?

YES NO

If 'NO', please indicate where else you have lived. *Please tick all that apply.*

( ) in an urban area of an Australian city

( ) on the outskirts of an Australian city

( ) in an Australian rural town

( ) on a rural property in Australia

( ) overseas

PLEASE NOTE: We appreciate that many people are reluctant to provide information about their incomes. However some information about household income is important for this research. Your name will **NEVER** be linked to your answers and information you provide will never be available to any person outside this research team.

7. Please indicate the approximate **total household income** including all wages and salaries, pensions, investments, dividends, property returns, before tax in the last 12 months (Please tick the appropriate income group).

( ) Up to $20, 000	( ) From $110,001 to $140,000
( ) From $20,001 to $50,000	( ) From $140,001 to $170,000
( ) From $50,001 to $80,000	( ) From $170,001 to $200,000
( ) From $80,001 to $110,000	( ) Over $200,001

8. How many people, including you, are supported at least partly by this income? *(Please write your answer)*___________.

9. What types of activities do you enjoy in your spare time? *(Please tick all that apply)*

( ) Sports ( ) Gardening

( ) Art/craft/photography ( ) Hunting/fishing

( ) Socialising ( ) Shopping

( ) Outdoor/nature activities (e.g. bushwalking, camping, bird watching)

( ) Indoor activities (e.g. reading, movies, computer games, music)

( ) Other (Please specify ________________________________)

10. Are you a member of an organised group? *(Please tick all that apply).*

( ) Sports group ( ) Community group ( ) Parents group

( ) Craft/art group ( ) Environmental group ( ) Bushfire brigade

( ) Land management group (e.g. landcare, parkcare)

( ) Other (Please specify__________________________)

Are you willing to be sent a short follow up survey, or receive a follow up phone call, if more information is needed?

YES NO

If YES, and receiving a survey via email is convenient, please write your email address here:

____

THANK YOU FOR YOUR TIME

How long did it take you to fill out this survey?

____

Do you have any other comments you would like to make?

____

____

____

____

____

____

____

____

____

____

We appreciate the time spent answering these questions. Please return the completed survey in the envelope provided in the next 3 weeks.

Appendix 6: Introductory letter, information sheet and reminder text: Survey 1

PhD Research Project Survey

25 October 2011

Dear Sir/Madam,

My name is Melinda Mylek and I am a PhD student at the Fenner School of Resources, Environment and Society of the Australian National University (ANU). Your contact details were obtained through the White Pages directory.

I am currently conducting research into attitudes towards fuel management strategies used to reduce bushfire risk to life and property. Examining these issues will help develop policies and management strategies that better incorporate the needs and concerns of the public. This research is funded by the Cooperative Research Centre for Forestry.

I would like to invite you to contribute to this research by completing the survey included with this letter. Your contribution will help me to develop a better understanding of perceptions about fuel management strategies used to reduce bushfire risk to life and property.

An identification number has been placed on this survey in order to manage survey responses across different locations. Reminder notices will also be sent in the following weeks to those who have not responded. If you would like to withdraw from the study and not receive any reminder notices, please return a blank survey or contact me (see contact information below).

I hope that you will consider this invitation to participate. The information sheet overleaf explains my research in greater detail, including the research purpose, and privacy and ethical considerations.

If you have any further questions about the research, the information sheet or survey, please do not hesitate in phoning me on 1800 xxx xxx, or emailing me at melinda.mylek@anu.edu.au

Yours Sincerely,

Melinda Mylek

INFORMATION SHEET

Study Title: **Attitudes towards fuel management strategies used to reduce bushfire risk to life and property.**

Research Purpose:
This study is examining whether different individuals or groups within the community are more or less likely to accept different fuel management strategies, and why. Understanding public perceptions and attitudes towards fuel management can help decision makers develop appropriate strategies and policies that address the needs and priorities of the community. It can also help land managers recognise when existing policies might be supported by the public, can help alert them when proposed or existing policies are likely to meet opposition, and assist in the development of information campaigns to help increase public understanding about potential and existing controversial strategies.

Voluntary Participation:
Participation in this research is entirely voluntary. Participants may withdraw from the research project at any time, including withdrawal of consent for use of any of the data they have provided, or withdrawal of consent to use some part of the data. If you would like to withdraw from the study, please contact Melinda Mylek, and the data you have provided will be removed from the study.

Privacy Issues:
Information provided will be kept confidential as far as the law allows. Neither participant name nor traceable feature will be identified in any publication, unless you have given prior permission for this to occur. Information given in confidence at any stage to the researcher may not be reproduced in a publication, nor stored with any identifiable data. All raw data from interviews will be securely stored in a locked filing drawer and any electronic data in a password protected computer. Access is restricted to the researcher and her supervisors.

Publication:
The research will contribute to a PhD thesis and articles published by public or private organisations. In addition, you may request a brief report of findings and/or an electronic copy of the final thesis. The research is being conducted on a part time basis. The expected year of thesis submission for this study is 2015, however some articles may be published prior to thesis submission. This research is financially supported by the Cooperative Research Centre for Forestry.

Ethical Concerns:
Any ethical concerns you have may either be discussed with the researcher, her supervisor Dr Jacki Schirmer, or directed to the ANU Human Research Ethics Committee.

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Dr Jacki Schirmer
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The Secretary, Human Research Ethics Committee Research Office
Chancelry Office
The Australian National University
ACT 0200
Tel: (02) 6125-xxxx Fax: (02) 6125-xxxx
Human.Ethics.Officer@anu.edu.au

Reminder card example (week 2)

A BUSHFIRE MANAGEMENT SURVEY

Two weeks ago you were sent a survey seeking information about attitudes towards fuel management strategies used to reduce bushfire risk to life and property. **If you have already returned the survey, please accept my sincere thanks.**

Examining these issues will help develop policies and management strategies that better incorporate the needs and concerns of the public. If you still have the survey, I encourage you to complete and return it by the **30th November 2011.**

If you did not receive the survey, it has been misplaced, you would like to withdraw from the study, or you have any questions, please contact me on 1800 xxx xxx or email me on melinda.mylek@anu.edu.au.

Yours sincerely,

Melinda Mylek

PhD Research Student, Australian National University

Appendix 7: Survey 2 – Regional Wellbeing Survey

Questions included in this appendix are those from the Regional Wellbeing Survey (RWS) that were relevant to this thesis. Not included are the many other questions included in the RWS.

Acceptability of different industries, land and water uses

Sometimes we find some land or water use practices more acceptable than others, and some industries and land and water management practices are more controversial in rural areas than others. What are your views?

How acceptable do you find the following activities in your LOCAL area? *If they don't currently happen locally, indicate how acceptable you would find them if they did occur*	**NOT AT ALL acceptable** ①	②	③	④	⑤	⑥	**VERY acceptable** ⑦	**Don't know**
Controlled burning to reduce bushfire risk	◯	◯	◯	◯	◯	◯	◯	◯

Has your household been directly affected by any of the following in the last 10 years?	**NOT AT ALL affected** ①	②	③	④	⑤	⑥	**VERY SEVERELY affected** ⑦
Bushfire	◯	◯	◯	◯	◯	◯	◯

In which of the following years did this affect your household? *Select all that apply*	2006-2010	2011	2012	2013	2014	2015	2016
	☐	☐	☐	☐	☐	☐	☐

Your views about managing bushfire risk

Managing bushfire risk is an important issue across Australia. Traditionally, controlled burning and firebreaks have been common ways of reducing bushfire risk in forested areas. Recently, some government inquiries have recommended also using 'mechanical fuel load reduction', particularly near residential areas. This is the use of machinery to remove some of the vegetation in a forest, reducing the amount of potential fuel for a bushfire. Mechanical fuel load reduction is used in some other countries, but hasn't been used much in Australia.

What are your views about use of controlled burning and mechanical fuel reduction?	Strongly DISAGREE ①	②	③	④	⑤	⑥	Strongly AGREE ⑦	Don't know
There is a high risk of bushfire near where I live	○	○	○	○	○	○	○	○
I worry about the potential impacts of bushfires on my property or business	○	○	○	○	○	○	○	○
Fuel loads are too high in forests/woodlands in my local region	○	○	○	○	○	○	○	○
I worry about the health effects of smoke from controlled burning	○	○	○	○	○	○	○	○
Controlled burning is good for forest/ vegetation health	○	○	○	○	○	○	○	○
Controlled burning harms animal and bird populations	○	○	○	○	○	○	○	○
There is a high risk of controlled burns getting out of control in my region	○	○	○	○	○	○	○	○
It's difficult to get enough controlled burning done in this region	○	○	○	○	○	○	○	○

Do you identify as… *Select one*	○ Female ○ Male ○ Other e.g. gender fluid, inter-gender or don't identify with a gender ○ Prefer not to answer
How old are you?	Years: ________________
Where do you live? We ask this because we analyse and produce results for every community where enough people participate in the survey. To do this, we need to ask you where you live. We make sure to protect the privacy of our survey participants when we report results. *If you live in more than one place, please put in your primary residence*	**State / territory you live in:** *e.g. VIC, SA* ________________ **Rural locality, town or suburb you live in:** ________________ **Postcode you live in:** ________________
Do you have more than one residence?	○ Yes ○ No
Is the place where you live most or all of the time *Select one*	○ In a town, suburb or village ○ On a rural property

What ways are you involved in farming or work related to agriculture? *Select all that apply*	☐ I own or co-own a farm business ☐ I manage a farm business (this can be in partnership with others) ☐ I assist in the management of a farm business (whether paid or unpaid) ☐ I work on a farm, but don't help manage it ☐ I work in agricultural contracting ☐ I am in other agriculture-related work

Appendix 8: Full list of arguments for and against each fuel management strategy

Arguments FOR prescribed burning	Frequency of argument[3]
Fuel reduction/reduction in vegetation to burn in fire season/reduce available fuel	254
Assists regeneration of plant life/rejuvenates landscape/rejuvenates native plants, grasses/seed germination (smoke/heat)/ecological requirement	89
Reduces intensity of subsequent fires	79
Risk reduction/preparation/hazard reduction/reduces fire risk	78
Saves/protects property and assets/reduces risk to property/asset/orchard protection	61
Provides a training opportunity/practical experience for fire fighters	52
Saves/protects lives/reduces risk to life/safer community	52
Provides safe areas/fire breaks/safety cordons	34
Provides a level of control to fire fighters in a future fire/fire easier to control/safer for fire fighters	33
Weed control	31
Peace of mind for community/community feels like something is being done/reduces anxiety/feel safer	25
Effective method/best tool available/effective fuel management/best precaution	23
Burning is undertaken in safe/optimum conditions	22
Cost efficient—large areas for little cost/cheap/cost effective	22
Provides/improves tracks/access/exit & entry points	22
Natural phenomenon/part of Australian ecosystem/natural/re-create natural process	22
Reduces impact on environment/wildlife/ecosystems when subsequent fires occur/form of management/sustainable	20
Low temperature/intensity burn (allows greater recovery of vegetation/wildlife)/not as destructive/less pollution	18
Increases community awareness about bushfire risk	18
Can be targeted to areas of high risk	17
Easily controlled/supervised by authorised personnel/managed and controlled method/ok when controlled	17
Reduces damage/less damage than big fires/reduces impact/less loss	17
Australian bush has been managed this way by indigenous people (vegetation has adapted)	14
Reduces likelihood of fires establishing/less chance of fire starting	14
Slow/controlled burn—wildlife has time to escape, less impact/trauma	13
Reduces spread/continuity of fires	13
Prevention/stops fires/stops surface fires	12
Effective for forest and scrublands/woodlands/plantations	12
Pest control ("gets rid of snakes") (snakes and spiders) (feral animals)	12
Time-efficient/fast/quick	12
Low impact on flora and fauna/environment	12

[3] As survey respondents could provide multiple arguments for and against each fuel management strategy, the total number of responses adds up to greater than the number of survey respondents.

Arguments FOR prescribed burning	**Frequency of argument**[3]
Effective for grassland areas (when undertaken at the right time of year)/reduces risk of grassfires	9
Mosaic burning (small increments)	9
Reduces severity of subsequent bushfires	9
Increases soil fertility/good for soil (ash)	9
Burns specific areas—pre-specified/strategic/all aspects considered	8
Proactive management, not reactive (prevention better than cure)/better than nothing	8
Protects stock/reduces risk to stock	8
A must/vital/of course/no brainer	8
Canopy is not burnt/reduces risk of crown fires	7
Reduces speed of fires/rate of spread	7
Keeps areas clean/bush tidy/clears understorey	7
Increases awareness of fire behaviour	6
Reduces frequency of fires	6
Helps farm productivity (green pick for cattle) clears areas/ trash removal	6
Should be done regularly	6
Opens up areas for trees/other veg to grow/enhance biodiversity succession	6
Fun for those implementing (gives firefighters something to do)	5
Should be undertaken near townships, residential areas, schools, access roads, assets	5
Reduces risk of inexperienced people causing damage by fire/reduces risk of accidents like cigarettes or arson	5
Improves fertility of grasslands/grasslands benefit	5
Conducted by professionals/experts	5
Reduces fuel over large areas	5
Reduces a variety of fuel types (grasses through to timber)/effective in both grasslands and forests	5
Creates employment/overtime	5
Well resourced—equipment and manpower (efficient use of resources)	4
Land management/forest management/land care	4
Familiarisation of local area and fuel types/therefore able to develop emergency plans	4
Stops growth/controls fast growing vegetation/suppresses growth of eucalypts and pines	4
Assess strategies, equipment, personnel, communications etc./better planning and procedures put in place	4
Next generation/long-term benefit	3
It's going to burn one day, may as well do it in a controlled way/inevitable	3
Burn along rural roads/some railway lines	3
Lessens impact on water quality following wildfire	3
Science-based/evidence-based	3
Field research into fires, fire behaviour, and control methods etc	3
Reduces economic loss	3
Fuel reduction in hard-to-get-to places/difficult terrain	3
No comment/no knowledge of the issue	3
Urban sprawl and bush interface/sustainable urban living in bush setting	2
Does not sterilise the soil/less impact on soil than wildfire	2
Local landholders should be consulted annually	2

Arguments FOR prescribed burning	Frequency of argument[3]
Upsets the greenies ("which I like”)	2
Community involvement	2
Breathing problems and sore eyes reduced/less smoke issues than wildfire / reduce smoke damage to vineyard	2
Useful in certain circumstances	2
Reduces impact on insurance/reduces insurance premiums	2
Less labour-intensive	2
NIL	2
Provides food source for animals and birds	2
Better than wildfire	2
Necessary after good rain and grass growth/manage spring grass	2
Channel direction of wildfire	2
Allows for wildlife refuge area	2
I agree with burning	2
Community profile of bushfire brigade/community involvement in brigade	2
More needed in state and national parks	2
Reduces size of wildfire	2
Duty of care of government/government being proactive	2
Need to work across states and territories	2
Managed year-to-year	2
Involves local bushfire volunteers	1
Reduction in monoculture habitats	1
Balanced approach	1
Infrequent fires mimicking pre-human regimes stimulate forest growth	1
Locals know variable risks according to growth	1
Districts vary and cannot be dictated by bureaucratic policy	1
Increasing number of people living close to bush vegetation	1
Increasing reservation of bushland for construction (supposedly)	1
Practical	1
Improves recovery after fires	1
Psychological problems reduced when wildfire can be controlled	1
Assists pollination	1
Can be assessed afterwards for effectiveness	1
Lowers firefighter costs	1
Avoids endangered species (controlled)	1
Common sense	1
Better than insurance	1
Reduces social loss	1
Based on arson patterns	1
Control burning (statement)	1
Disease control	1
Wildfires show up quicker	1
Better than poisons	1
Away from assets may be ok	1

Arguments FOR prescribed burning	**Frequency of argument**[3]
Minimise risk of floods	1
Trees need CO_2 created by fires	1
Allows time for community to evacuate	1
Safety (in some circumstances)	1
No special ability to implement needed	1
Communication—top down	1
Responsibility needs to be shared	1
No need for mechanical implements	1
Extension of agricultural practices	1
Make community have bushfire plan	1
Identify rural from urban	1
Gaol for arsonists	1
Reduces ember attack in wildfire	1
Redefine burn conditions	1
Immediate protection	1
Allow for stock management in advance	1
Encourages other preparation	1

Arguments AGAINST prescribed burning	**Frequency of argument**
Getting out of control—causing damage etc.	210
Risk to/death/injury/destruction to wildlife—also to animals, pets, stock	136
Destroys/impacts habitat/ (or food sources)	67
Impacts vegetation/flora/forests	59
Smoke pollution (general/not specified)	58
Smoke—atmospheric pollution/CO_2/global warming/climate change	57
Environmental damage/ecosystem damage/biodiversity loss	50
Smoke—health impacts (e.g. breathing, asthma)/toxic smoke	41
Displaces/disrupts/impacts wildlife	28
NIL	26
Amenity/visual impact (black/burnt)/reduces natural appeal	25
Limited opportunities/too restrictive/can't take place in adverse conditions/dependent on weather conditions/change in conditions/area/fuel/moisture/humidity/etc.	23
Unnatural/Destroys natural cycle/alters natural environment/changes the ecology and community structure/changes veg types	23
Erosion—loss of surface matter	21
Cost	18
Creates anxiety/community thinks it's a real fire/smoke creates panic	17
Poorly resourced burning/not properly controlled/insufficient checks/inexperienced personnel—increases risk	16
Promotes vigorous re growth/leaf drop - counterproductive	16
Impact on water (waterways/quality)	13
Labour and time-intensive—volunteers (and their availability)	12
Requires planning/outside expertise/careful management/experience/skilled professionals/monitoring capacity	12
Risk to homes/farmlands/neighbours/property	11
Frequency of burning matters—e.g. too frequent burning reduces biodiversity/impacts forest vegetation	11
Smoke —reduced visibility/traffic hazard	10
Smoke—bad smell/dirty	10
Promotes weed growth	10
Smoke —upset community/irritation/nuisance	9
Damage to assets—fences, power poles etc.	9
Not suitable in all areas/not best method in some cases (e.g. slashing, grazing etc. may be more appropriate)	9
Vegetation can take a long time to regenerate/recover	9
Not effective for major fires (e.g. 2003) —no impact (other factors such as spot overs, inaccessible areas etc.) (can't beat mother nature)	8
Not right time for burning/incorrect season/conditions—bad for environment/migratory animals	7
Burning areas unnecessarily/burning for the sake of burning/useless destruction	7
Not effective (general)/won't stop fires (other factors increase risk such as weather)	7
Risk of injury to firefighters/firefighter safety/OHS	7
Destroys soil profile/humus/soil organisms/soil nutrition	7
Too large a scale/not targeted enough	7
Health impacts/health hazard (general)	6
False sense of security	5
Not based on correct evidence/not scientifically proven/authorities not understanding	5

Arguments AGAINST prescribed burning	Frequency of argument
the science	
Burning heavy fuel loads—fires too hot	5
Green issues—especially uniformed public protests/no burn policy	5
Reduces supply of grazing material	4
Risky (general)	4
Risk to life	4
Not sure/no comment/no knowledge	4
Conservation areas should be protected/National Park damage	4
Not effective if not done at right time/place etc.	4
Can lead to complacency/no personal precautions taken/removes responsibility from landholders	4
Loss of ground cover/understorey	4
Difficult to maintain control	4
Reduced public access to areas following burn-off	3
Can create monocultures of plants and wildlife (when burning too frequently or too hot)	3
Fire intensity not enough for seed banks to germinate/some forests require hot fires	3
Burning in sensitive environments (cause harm)	3
Should only be done in small areas at a time (to allow animals to escape)	3
Remove soil moisture/ability to retain moisture	3
Need warning/notification	3
Promotes fire-adapted landscapes/fire-prone vegetation	3
Uncertain outcomes/impacts	3
Becomes a political decision/organised by bureaucrats	2
Difficult to get government approval/permits	2
Bushfires will happen anyway—we need good escape routes and maybe bunkers to hide in, early notification of fires in district/access planning and awareness	2
Loss of recreation (e.g. spoils nature walks)/recreational values reduced	2
Forests, in particular, are inaccessible in areas/can't be done in inaccessible areas	2
Organic matter breaks down anyway—debate over need for burning	2
Drying effect on remaining vegetation (increase fire risk)	2
Encourages fire bugs/illegal burning	2
Creates incentive for land clearing/forestry to clear	2
Unselective/everything burns/indiscriminate	2
Upsets the community	2
Resources could be better used elsewhere	2
Inconvenient	2
Often seen as the only precaution needed	2
Only reduces ground fuels	2
Cost/benefit—too much damage for little return/waste of money	2
Shouldn't try to control the environment	2
Impact surrounding industry (e.g. wines)	2
Not effective in tall forests	1
Not effective in grassland	1
We can't predict where the next bushfire will be	1
Owners of small subdivisions (mostly absentee) are uneducated and increasing	1

Arguments AGAINST prescribed burning	Frequency of argument
population for fire control risk	
Ideological	1
May cause alarm to animals	1
To be effective would need to burn all of Australia	1
Volunteers train to protect small absentee farms/small acre	1
Don't like it	1
Takes time to mop up	1
Wait for wildfire to come to firefighters	1
Accelerates a fire in forest	1
House drains/storm water	1
Stress on wildlife	1
National parks have no money to spend on burning	1
RFS don't care	1
Governments have no-burn policies	1
Not effective long-term	1
Can't be used in all environments	1
Cavalier attitude of those conducting	1
Protect executive jobs	1
Difficult to implement in high-hazard years (conditions too hazardous to undertake)	1
Can't always know conditions or fire behaviour in advance	1
Loss of soil carbon	1
Australia doesn't have the equipment to control fires of any size	1
Removes sound barriers	1
Destroys native seed banks	1
Forces wildlife into urban areas	1
Resource-intensive	1
Difficult to implement in rural residential areas	1
Produces heat—heats up already hot weather	1
Poorly executed by administering body	1
Risky near dwellings	1
Difficult to target high-risk areas (e.g. roads)	1
Media attention—creating sensational stories	1
Restricted to crown land generally	1
Not effective when adjoining landholders do not do the same	1
Should exclude bushfires—they promote growth and control disease	1
Disruption to community	1
Lazy solution	1

Arguments FOR livestock grazing	Frequency of argument
Duel benefit —feed for livestock, meat/milk production etc. —helpful to farmers/economic benefit/good use of resource/good during drought	147
Reduces fuel (general)/reduces growth of fuel	132
Reduces grassy fuels/reduces fuel in pastures	66
Practical/cost-effective/cheap/saves money	65
No fire risk involved/less risky/better than burning/no need for burning	47
Reduces bushfire & grassfire risk	30
More natural/naturally reduces fuel	23
Animals contribute to land fertility/recycles nutrients	23
Not harmful/safe/little impact/low-risk (on people etc.)	22
Weed control	21
No waste of grasses/good use of pastures/productive use of land	20
No smoke	18
Less pollution (e.g. CO_2)	18
Less damage to native animals	15
Improves access/maintains access	15
Reduces fire speed/rate of spread	15
Supervised by owners/controlled/managed	14
Effective/efficient	13
Selective fuel reduction (animals selectively graze fine fuels, graze under trees)	12
Rotational grazing/managed grazing—improves plant biodiversity/protects flora/protects other areas	11
Effective fire management tool	11
Effective if done right	10
No total destruction of habitat	9
May access areas inaccessible for burning/no vehicle access/areas not appropriate for burning	9
Creates fire breaks in grass/firebreaks around assets/APZ	9
Continuous control/long-term/(therefore doesn't shock the environment)	9
Common sense/sensible/practical	8
Sustainable land management/sustainable farming/pasture management	7
Grazier presence increases safety/better human vigilance/early detection/oversight/help with planning/monitor area/understand the land	7
Effective in grasslands	7
Manages stock numbers or timing according to season/fuel/requirements	7
Keeps areas neat and tidy/cleans up forest floor	6
Can be used all year round in all weather conditions	6
Generally low-impact	6

Arguments FOR livestock grazing	Frequency of argument
Safety of property/assets/reduces risk to assets/property	6
Rural livelihood/tradition/culture (e.g. high country)/lifestyle	6
Positive use of resources (natural resources)	6
Can be targeted/contained/planned	6
Doesn't cause health problems/breathing problems	5
Cattle should be used for grazing Snowy Mountains and around Canberra/in parks and reserves	5
Less competition	5
Changes fuel structure, tread on shrubs, reduces undergrowth = cooler burns	5
Intense grazing effective/high grazing pressure (depending on fuel)	4
Light grazing advantageous/in moderation is useful	4
Animals may provide recreation e.g. horses—horses can be kept nearby	4
Less visually damaging than burning	4
NIL	4
Reduces fire likelihood/ease of ignition	4
Livestock grazing (statement)	4
Reduces continuity/run of fire	4
Less destructive	4
Nice to see the animals/visually attractive	3
Protection of farm environments	3
Roadside grazing	3
More appropriate than burning in some cases (e.g. in built-up areas)	3
Allows the livestock to graze/allows roaming of livestock/happy animals	3
Ecosystem constantly changes—can't expect to keep it pristine as it was at a particular time in history/taking stock out won't return it to pre-settlement conditions/ therefore limited environmental damage	3
Safety of lives/reduces risk to life	3
Less labour-intensive	3
Proven method	3
Reduces fire severity	3
Regeneration of veg is quicker/quicker environmental recovery	3
Pest animal control	3
Good use of public areas	3
I agree with grazing	3
Employment (e.g. fencing or better farm production)	3
Reduces undergrowth	3
It should be the primary means of fuel management	2
Less environmental damage/environmentally friendly	2
Reduces fire intensity	2
Assists controllability of wildfires	2
Unsure/no comment/no views	2
Easier fuel management method/easy to control and maintain/easy to arrange	2
Less use of fossil fuels	2
Livestock play a part in the carbon cycle/carbon sequestration (753)	2
Improves pastures/manage for perennial grasses	2

Arguments FOR livestock grazing	**Frequency of argument**
Reduces the need/cost for other methods	2
Soil not exposed/less damage to topsoil	2
Revenue for government/parks (for adjustment)	2
Many areas managed at the same time/large areas	2
Good for community/community involvement	2
Large variety of animals can be used	2
Limit it to cattle	1
Time-efficient/ not time-consuming	1
May thin out forested areas (sheep)	1
Slashing and bailing for livestock feed	1
Allows investment in the environment	1
All useful land should be grazed	1
Increase in human presence increases knowledge of area	1
Not affected or impacted as at date	1
Reduces cost of mowing/slashing/alternative to mowing/doesn't require machinery	1
Reduces flame height	1
Passive form of fuel management	1
Safer environment	1
Essential	1
Grasses spread, reducing erosion	1
See animals in natural habitat	1
Promotes non-fire adapted plants/landscapes	1
Increases with storage	1
Resources can be used on other things	1
Clears areas for stock to shelter	1
Good for rural residential	1
Effective in woodlands/forests	1
Effective in wetlands	1
Places responsibility with private landowners	1
Good clearing of land	1
Reduces impact on environment during wildfire	1
Around plantations	1
Less media attention	1
Greenies don't like it	1
Discourages kangaroos in urban areas	1
Graziers care for bush	1
Introduces animal husbandry to untamed wilderness	1
No need for chemicals	1

Arguments AGAINST livestock grazing	**Frequency of argument**
Soil erosion/degradation/loss of topsoil	67
Overgrazing/overstocking	67
Destruction to native vegetation	62
Spread of weeds/seed/encourages weeds	61
Environmental/biodiversity impact (general)	49
NIL	41
Selective—only fine fuels targeted (no trees or organic matter, tussock grass or long cured grass)	38
Infrastructure & maintenance e.g. fencing/water sources—(costly)	38
Impact on/displacement of/destructive to native wildlife	27
Damage/contamination of water courses/catchments/erodes banks	25
Harsh on the land/land degradation (hooves)	24
Risk of animals going feral/escaping to unintended areas/causing inconvenience/becoming pests	19
Damage to sensitive areas	18
Little impact on wildfire risk/not effective, especially when low stocking or done in isolation/doesn't change how the fire runs	18
Impact on habitat	17
Selective—change in veg structure, desired species eaten	16
Soil compaction	16
Impact on food for wildlife/competition	16
Change ecosystem balance/damage to ecosystems/species composition	15
Animals require management/monitoring	13
Patchy/no uniform/not enough reduction to be effective	12
Animals require care, maintenance (e.g. vaccines, drenching etc.)	11
Don’t allow in national parks/public lands/conservation areas	11
Prevents some vegetation reseeding/threatened extinction/limits regeneration	10
Traffic incidents when escape or unfenced	9
Spread of disease	8
Danger to wellbeing of horses/livestock (e.g. safety issues, terrain, toxic plants)	8
Flies (manure)	8
Reduction in access to public/limit access (recreational areas)	7
Not always enough feed e.g. supplement feed in winter/drought	7
Damage to soil structure/soil profile	7
Ample supply of water needed	7
Needs long forward planning to be effective/takes a long time/slow	7
Non-selective grazing/indiscriminate/uncontrolled	7
Suitable livestock for the area/sufficient livestock for the area to be effective/not all animals are suitable	6
Damage to pasture/native grasses	6
Greenhouse gases/methane	6
Livestock don't eat all weeds	6
Animals at risk if bushfire occurs	5
Damage to national parks/public lands/conservation areas	5
Can’t use in all terrain/areas e.g. steep, dense bush etc.	5
Costly (e.g. transport)	5

Arguments AGAINST livestock grazing	Frequency of argument
Time-consuming/slow reduction	5
Encourages the formation of tracks	5
Not effective in forests	5
Smell (droppings/not nice)	5
Contained to certain areas/appropriate only in certain areas	5
Promotes pest animal species e.g. rabbits/foxes (encourages their habitat)	4
Unsure/no comment/no views	4
Loss of native species (not specified)	4
Should use kangaroos/native animals	4
Require high stocking to be effective	4
Proximity to urban areas	4
Exposes bare soil	4
Needs to be controlled	3
More vigorous growth may follow (fertilise ground)—counter productive	3
No sheep—overgraze	3
Impact on endangered species	3
Difficult to transport animals (labour-intensive)	3
Excessive nutrient run-off	3
Hard to control in steep terrain/bush	2
Creating pasture out of forests/loss of forests	2
Not always practical	2
Variable seasons can alter grazing patterns	2
Political vs. experience decisions	2
Not proven effective	2
Impact of stock (not specified)	2
Safety of users/farmers/graziers	2
Increase fire risk/fire hazard	2
Cow pats increase fire risk	2
Need to fence off sensitive areas	2
Green groups oppose	2
Not as targeted (to high-risk areas)	2
Non-native species not part of the Australian ecosystem	2
Barbed wire fencing causes kangaroo death/fencing impact to wildlife	2
Not as effective as burning	2
When not done properly/responsibly	1
May not have permission by government	1
Planning of subdivisions	1
Destroys native orchids	1
Aesthetics negatively impacted	1
Ideological	1
Salinity	1
Grass fires not as risky anyway	1
No regeneration of plants that require fire	1
No hands-on experience for firefighters	1

Arguments AGAINST livestock grazing	**Frequency of argument**
False sense of security	1
Can't use pregnant of lactating animals	1
Legal issues if something goes wrong	1
Allergies	1
Excuse for hunting/shooting	1
Allocation of grazing land—usually give to mates	1
Disturbs natural balance	1
Dust storms in drought	1
Use more slashing	1
No graze policy	1
Still need to burn left fuel	1
More people involved, meaning more complicated	1
Managing stock levels through changing seasons can be difficult	1
Lack of responsibility/knowledge of graziers	1
Not effective on steep slopes (fire will burn up hill)	1
Methods of herding (bikes, vehicles etc.) harm environment	1
Reduce soil carbon	1
Monoculture	1
Excuse for farming practices	1
Noisy	1
Arguments over who can graze	1
No stock yards	1
Doesn't get rid of all fuel	1
Needs to be done before the grass dries	1
Shouldn't rely on farmers to manage fire	1
Damage to tree stems/ring barking	1
Not all animals can be controlled	1

Arguments FOR mechanical thinning	Frequency of argument
Reduces fuel (general)	129
Reduces fire risk/fire hazard	45
Improves accessibility, especially for firefighting/improves access	40
Reduce fire intensity	34
Reduces competition/allows remaining trees to grow better/creates space for other plants/remaining plants thrive/healthy	33
Targeted approach—specific areas/trees/veg type—selective	25
Doesn't involve burning/less risky/not as destructive/lower impact/better than burning	24
Creates employment/labour-intensive (low/semi-skilled labour)	23
For plantations—used to improve growth/pruning improves timber quality	22
Good for small areas in cities/urban areas/around assets/urban life safer/around homes/farms	22
Reduces risk of crowning/breaks the fuel continuity into canopy/ladder fuels	17
Effective (if done properly)	16
Aesthetically enhances an area/neat and tidy	15
Needs to be removed to be effective	15
Fuel removal is controlled	14
Thinned material to be mulched and chipped, removed and sold	13
Possible income from removed trees/timber/commercial/productive	13
Agree to the practice/no problem/good idea	13
Removes weeds	12
Helps fire controllability/suppression	11
Increases the nutrient of the forest floor/decomposition	11
NIL	11
Minimal environmental impact/ecological impact	10
Good management practice/manages natural environment/proactive management/good housekeeping	9
No pollution/clean (unless material burnt)/no CO_2 release	9
Can create habitat on ground	9
Reduces likelihood of starting/ease of ignition	8
Help protect assets/reduce risk to assets/property	8
Reduces large fuels—trees/shrubs/deadwood/regrowth etc.	7
Low impact on wildlife	7
Allows grasses and understorey to grow/more sunlight for grasses and understorey/better understorey diversity	7
Improves recreation/public access	6
Vegetation break/firebreak/control line	6
Good for environment/environmentally friendly/balanced approach	6
Less damage to flora/veg in wildfire	6
Reduces fire impact	6
A natural process anyway	6
Removes deadwood/encourages new growth	5
Reduces fire speed/rate of spread	5
Unsure/no comment/no views	5
Can be carried out in all seasons/all year/all conditions	5
Use grazing/burning/other methods together. It is another method that can be used	5

Arguments FOR mechanical thinning	**Frequency of argument**
Includes slashing	5
Common sense	5
Changes ecology of the area/enhances ecosystem/peak ecology	5
Better than nothing/any fuel management is good	5
Doesn't cause health problems	4
Thinned wood can be used for heating/energy	4
Sustainable land management	4
Better vision through forests/visibility	4
Reduces risk to life	4
Low risk method/safe	4
Less damage to fauna/wildlife in wildfire	4
Reduces continuity of fires/spread	4
Changes the structure of fuel in a forest	3
Makes sense to remove overgrowth	3
Remove combustible material e.g. pines, dead material	3
Opens up areas/creates space/widens spacing	3
Planned and managed/needs to be maintained/undertaken regularly	3
Peace of mind/makes people think something is being done	2
Better than clear felling	2
Pruning	2
Minimal impact on livestock nearby	2
Should be up to the landholder	2
Depends if forest is native or exotic/depends on area/circumstance	2
Cleans up forest floors	2
Reduces injury risk from falling branches/debris	2
Pest animal control	2
Mechanise it for speed/mechanised method	2
All altered environments should be managed	2
Vegetation thinning (statement)	2
Reduces erosion (floor cover)/low soil impact	2
Preventive measure	2
Familiarises authorities of areas	1
Does not damage plantation timber	1
Effective in heavily wooded areas	1
Safer for firefighters	1
Would not be necessary every year	1
Reduces fire frequency	1
Reduces fire severity	1
Collect dead thinnings	1
Should be left to be done naturally	1
Pastures can be baled for feed	1
Can be scheduled when labour is available	1
A lot of vegetation in Canberra	1
Work for prisoners	1

Arguments FOR mechanical thinning	**Frequency of argument**
Promotes non fire-adapted plants	1
Makes controlled burning easier	1
Good if you can afford it	1
Reduces spot fires	1
Reduces flare ups	1
Gets rid of all pines	1
Done around assets such as power lines/roads	1
Closes forest for short time	1
Reduces variety of fuel types	1
Won't attract media/community attention	1
May help	1
Can see vermin/snakes	1
Mulching increases soil water	1
Low impact on nearby veg	1
Immediate benefit	1
Land husbandry	1

Arguments AGAINST mechanical thinning	Frequency of argument
Costly/high labour cost/not cost-effective/cost of equipment etc.	109
Labour intensive/resource intensive	75
If left on site is counterproductive—more fuel	66
Habitat impact	56
Not a natural process in native forests/disturbs natural balance/changes forest structure	37
NIL	37
Not very effective (particularly large fires, e.g. 2003)/only partially effective	36
Impacts on native flora	18
Negative impact on aesthetics/spoils the landscape/visual impact	17
Impact on native fauna	17
Time-consuming (general)	16
Environmental damage	15
Impractical on large scale	15
Erosion/soil impact	14
Not appropriate for native bushland/national parks/conservation areas/sensitive areas	12
Impact on ecosystems/biodiversity	10
Increased weeds/introduce weeds/promote weeds	9
Machinery (heavy machinery impact soils, damage ground, environment etc.)	8
Unnecessary/waste of time/waste of resources	7
Monocultures	5
Increases exposure to light and wind, leading to dryer environment/open up to fire (heat/wind etc.)	5
Reduces the amount of organic matter being incorporated into the soil	5
Increases pests/unwanted animal species, e.g. rabbits or snakes if material left in place	5
Not as effective as burning/grazing (not as thorough)	5
People who don't know what they're doing/availability of suitable skills/need skilled workforce	5
May impede access (litter/debris)	4
Agree it should be done/something needs to be done	4
Allows sunlight where it would not necessarily go (allowing more growth)	3
Impact on water courses/pollution	3
Pollution if burnt	3
Requires ongoing management/careful management	3
Some vegetation dependent on fire for germination	3
Only works in commercial forests	3
May still need to burn (risk etc.)	3
Community backlash/upset community/community concern	3
Small return for high amount of effort	3
Can’t access many areas/limited by inaccessibility	3
Unsure/no comment/no views	2
More resource-intensive and time-consuming than burning	2
Not useful in grasslands	2
Difficult to implement	2
Should use other alternatives	2
Excuse for harvesting/commercial gain	2

Arguments AGAINST mechanical thinning	**Frequency of argument**
High OHS risk for workers	2
Needs to be carefully understood/limited knowledge on impacts	2
Short-term fix	2
Not enough done in one season/limited quantity to be effective	2
Only concerned with urban boundary/nominal protection	2
Doesn't deal with leaf litter/grass/fine fuels	2
Impact on endangered species	2
Can be indiscriminate	2
Potential spread of disease	1
Could promote forest vandalism	1
Promotes public access to the area, increasing fire risk	1
Change the hydrological characteristics	1
Eucalypt mulching has little value recycled	1
Ideological	1
Need?	1
CO_2 - carbon sequestration	1
Effectiveness limited by vegetation type	1
Machinery can start fires	1
Less up-market suburbs get forgotten	1
Makes tracks in the forest	1
Loss of commercial timber for future	1
Noisy	1
False sense of security	1
Needs to be targeted/range and scope limited	1
Upsets greenies	1
Some shrubs and trees are fuel retardants	1
High administrative overhead (government)	1
Excuse for land clearing	1
Government vegetation controls in place	1
Areas may be opened up for grazing	1
Not appropriate in agricultural areas	1
Impact on the landscape	1
Removal of food source for wildlife	1
Damage infrastructure—roads/crossings etc.	1
Inconvenience along roads (speed limits etc.)	1
Depends on circumstances (where, when, what, how)	1
So harsh on vegetation these days—let them be	1
Better firefighting and warnings should be adequate	1
Requires removal of large material	1
Only useful to preserve forest	1
If it needs pruning it should be cut down	1
Difficult in some terrain	1