Forest disturbances, such as wildfires, pine beetle outbreaks, and floods are important features of many landscapes and ecosystems. Many disturbances are increasing in size, frequency, and intensity due to changing climates and land management decisions. The changing ecological and aesthetic conditions following a disturbance can lead to negative short- and long-term social impacts. This dissertation research examines one aspect of the relationship between people and their environment in the context of forest disturbances and landscape changes. Specifically, it explores how people perceive a changing landscape after a forest disturbance, a trajectory referred to here as landscape recovery.

After describing the larger context of forest disturbances in the introductory chapter, with a focus on wildfires, my second dissertation chapter developed a conceptual framework for understanding how people perceive post-disturbance landscape recovery. It examined the social factors that are most likely to influence those perceptions based on literature from various disciplines. These factors included visual cues and aesthetic preferences, landscape values and connections, and beliefs about the ecological role of disturbances. I described how the concepts and methodological approaches from mental models and social representations traditions help depict and explain how perceptions of landscape recovery can be studied in a way that explores the process shaping the perceptions. I explained how these perceptions likely exist along a spectrum from more simple perceptions focused on aesthetic judgments to more complex perceptions based
more on ecological knowledge. I then proposed a research agenda to further investigate this framework, along with a summary of management considerations.

The third chapter empirically explored the framework from the previous chapter by applying social representations theory (SRT) to qualitative research in Montana about how people perceive post-wildfire landscape recovery. I examined the mechanistic (i.e., anchoring and objectification) and structural (i.e., central core and peripheral elements) aspects of representations by integrating the factors proposed earlier as most influential in affecting perceptions of recovery. Interviews were conducted in 2014 with 30 residents who experienced the 2012 Dahl Fire, near Roundup, MT. Participants were purposively selected to represent a range of the factors described in Chapter 2. The main propositions from Chapter 2 were explored in the data collection and analysis steps. The core of all respondents’ representations was centered on the concept of “Mother Nature.” The factors identified in Chapter 2 further shaped representations uniquely across the two main groups of residents (rural lifestyle and working landscape residents) through the anchoring and objectification processes. People’s representations about recovery were anchored in general beliefs about the past ecological and socio-cultural role of fire in the landscape as influenced by their past experiences and knowledge about ecological disturbances. Interpretations of different aspects of the landscape, including vegetation composition and key ecosystem functions, were filtered through people’s values for the landscape and their specific beliefs about how the fire affected the landscape. This led to variation in specific notions of what constitutes a recovered landscape across the two main social groups there. These findings are discussed in the context of SRT and post-wildfire management.

My fourth chapter took a broader look at the variables that influence perceptions of landscape recovery across different wildfires. Twenty-five fires that occurred in 2011 or 2012 in WA, OR, MT, and ID were selected to represent a range of fire behavior characteristics and landscape impacts. Then, residents who live near each of the 25 fires were randomly selected to receive survey questionnaires which asked about multiple facets of their experiences with the fire, the perceived social impacts from the fire, and
specifically how the landscape had changed/recovered since the fire. Results showed that, overall, perceptions of landscape recovery no more than two years after the fire were positive. Regression analysis suggested that perceptions of recovery can be explained fairly well with several key variables. More negative evaluations of recovery were related to negative impacts to people’s attachment to the landscape, negative perceptions of erosion problems, and longer lasting fires. More positive evaluations of recovery were related to more positive beliefs about the beneficial role of fire in terms of landscape health. Hierarchical Linear Modelling (HLM) analysis showed that these relationships were mostly consistent across fires, though there was some variability in the relationships between perceptions of landscape recovery and the variables that measured perceptions of erosion and beliefs about the ecological role of fire. These findings are discussed in terms of the scope of the study as well as their management implications.

My fifth and concluding chapter summarized the main findings from each chapter and integrated them into a larger social-ecological context. Key limitations, considerations related to the validity and reliability of my research, and future research needs are discussed. My dissertation furthers the conceptual and empirical understanding of how people perceive landscape changes from natural disturbances and how managers can include these social dimensions into future planning and implementation efforts.
Understanding Public Perceptions of Post-Wildfire Landscape Recovery

by
Chad M. Kooistra

A DISSERTATION

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APPROVED:

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Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Chad M. Kooistra, Author
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CONTRIBUTION OF AUTHORS

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Chapter 1. General Introduction
1. Introduction and overview

Forest disturbances, such as wildfires, pine beetle outbreaks, and floods are important features of many landscapes and ecosystems (Turner, 2010). The changing ecological (e.g., erosion, invasive species, or hydrophobic soils) and aesthetic conditions following a disturbance can lead to negative short- and long-term social impacts. Individuals and communities hold a range of values towards any given landscape; those values can be affected by changes to the landscape, which in turn can affect people’s attitudes about managing the landscape on both private and public lands (Burley, Jenkins, Laska, & Davis, 2007; Ryan & Hamin, 2008, 2009). Finding a balance between social values and dynamic ecological processes requires understanding the relationships between them. Conceptual frameworks like social ecological systems (SES) and coupled human-natural systems (CHANS) describe the highly connected and interactive nature of the relationships between people and the ecological and biophysical environment (Moritz et al., 2014; Ostrom, 2009; Smith et al., 2016; Spies et al., 2014). My dissertation examined one aspect of the relationship between people and their environment in the context of forest disturbances and landscape changes. Specifically, it explored how people perceive a changing landscape after a wildfire, a trajectory referred to here as landscape recovery. First, I developed a conceptual framework for understanding people’s perceptions of post-disturbance landscape recovery. Then, focusing on perceptions of post-wildfire landscape recovery, I used qualitative and quantitative empirical research to better understand the structure of those perceptions, the factors that influence those perceptions, and the pertinent management implications.

Next, I discuss the general context of the empirical research of my dissertation related to wildfires in more detail, followed by an overview of each remaining

---

1 Landscape recovery refers to the changes in ecosystem functions, processes, and appearances after a disturbance. Though rarely defined in empirical studies, investigations tend to focus on vegetation composition and diversity, and nutrient and hydrologic cycles to measure recovery.
dissertation chapter. A description of the considerations and steps taken to ensure the ethical integrity of the research presented here concludes this introductory chapter.

1.1 Perceptions of post-wildfire landscape recovery amidst increasing wildfire activity in expanding and socially diverse communities

Wildfire activity in much of the U.S. is expected to increase, largely due to past suppression and projected climatic changes, and many of these fires will occur in the wildland-urban interface (WUI) (Barbero, Abatzoglou, Larkin, Kolden, & Stocks, 2015; Donovan & Brown, 2007; Westerling et al., 2011). Dense fuels and longer, drier fire seasons are leading to more fires that burn hotter, longer, and larger than previously (Hessburg & Agee, 2003; Hessburg, Agee, & Franklin, 2005; Westerling, Hidalgo, Cayan, & Swetnam, 2006). Biophysical research continues to explore the role of wildfire in an ecosystem and how to reintroduce wildfire across landscapes that depend on it. Social science research investigates the effects of experiencing wildfires on individuals and communities, how to mitigate negative social impacts from wildfires, and how to increase social acceptance of wildfires and disturbance-based management strategies on public and private lands (McCaffrey & Olsen, 2012; Toman, Stidham, McCaffrey, & Shindler, 2013). These are especially important goals considering that the population of people who live in the WUI, arguably the population most immediately affected by wildfires, is increasing both in size and diversity at the same time the likelihood of wildfire activity is increasing (Paveglio et al., 2015; Theobald & Romme, 2007). People who live in the WUI hold a range of values towards the landscape and those values can affect how they perceive changes to the landscape after a wildfire (Burns, Taylor, & Hogan, 2008; Kent et al., 2003; Ryan & Hamin, 2008). An important component of creating adaptive and resilient communities and landscapes in the face of disturbances is understanding how people perceive changes to the landscape, because those perceptions can affect future mitigation behaviors (Brenkert-Smith, 2006; Paveglio, Carroll, Jakes, & Prato, 2012; Paveglio et al., 2015). Investigating perceptions of post-fire landscape recovery provides insights into how to manage people and dynamic landscapes in ways that minimize negative social impacts that may result from disturbance-induced changes to the landscape.
As both wildfire occurrences and human development in the WUI continue to increase throughout much of the western U.S., there is a growing need to understand how WUI populations are affected by these disturbances so that social and ecological values can be considered in land management decisions. The WUI population is diverse, exhibiting a wide range of values for the landscape and expectations about forest and fire management in the surrounding ecosystem. Paveglio et al. (2015) developed a classification system of WUI communities and residents that identifies and describes them using four main groups or archetypes: formalized suburban communities, amenity-based communities, rural lifestyle communities, and working landscape communities. Compared to the first two archetypes, the latter two archetypes are characterized by the following:

- less formal community units (e.g., classified by watersheds rather than formal subdivisions or gated communities),
- less trust of the government and fewer collaborations with land management agencies,
- lower expectations of firefighting services (and/or higher expectations of personal responsibility),
- informal communication networks,
- minimal or no standards for mitigation efforts,
- a stronger preference to do things themselves,
- less financial resources than more formal suburban communities, and
- place attachment tied to rural nature or working the land.

Individuals and communities across these archetypes are likely to react differently to wildfires and post-fire landscape changes due to a range of factors discussed throughout my dissertation. It is important to explore these different reactions so managers can shape communication and management strategies in a way that addresses diverse concerns, values, and needs. I explored these differences in-depth in the third chapter by focusing on WUI residents in rural Montana who can be classified by the rural lifestyle and working landscape archetypes. Given the diversity among WUI residents and how they experience wildfires, it is also important to explore the factors that affect people’s perceptions of post-fire landscape recovery across different communities and wildfire events. My fourth dissertation chapter addressed these aspects using quantitative
survey techniques across 25 different wildfires in the western U.S. to permit insights across a broader context.

1.2 Overview of dissertation chapters

This section provides an overview of each of the three main chapters of my dissertation, as well as the fifth and concluding chapter. There is some overlap in the introductory and concluding sections of each chapter given their related focus on disturbances and people’s perceptions of post-disturbance landscape recovery. Each of the three main chapters will be submitted as a manuscript to different peer-reviewed journals, as indicated on the respective chapter title pages.

1.2.1. Chapter 2: Developing a Conceptual Framework for Understanding People’s Perceptions and Evaluations of Landscape Recovery after Natural Disturbances

My second dissertation chapter develops a conceptual framework for understanding how people perceive post-disturbance landscape recovery by first examining the factors most likely to influence those perceptions, based on a review of literature across various disciplines. These factors include three main categories: 1) visual and aesthetic considerations, 2) people’s values and connections to the landscape, and 3) beliefs about the ecological role of disturbances. The concepts and methodological approaches described by the theoretical traditions of mental models and social representations theory (SRT) help organize these factors in terms of the processes and structures of people’s perceptions of landscape recovery. Exploring these processes gives land managers an indication of where and how misperceptions of forest processes and management responses develop and how communication efforts can resolve those issues.

The theoretical underpinnings of mental models and SRT are pertinent because they help explain how people make sense of a new phenomenon (Buijs et al., 2012; Jones, Ross, Lynam, Perez, & Leitch, 2011). The landscape recovery process will be a new phenomenon for many people affected by ecological disturbances if they have not previously experienced a similar disturbance and the resulting landscape changes. Even people who have experienced disturbances may be faced with novel landscape conditions and trajectories that could result from interactions between climate and management
decisions (Morse et al., 2014; Sheehan, Bachelet, & Ferschweiler, 2015). Thus, applying key concepts and propositions from SRT and mental models theory facilitates theoretical and empirical explorations of how people perceive landscape recovery. After discussing these potential applications, I propose that perceptions of recovery likely exist along a spectrum. The spectrum is anchored by two endpoints of simple and complex perceptions of landscape recovery. Simpler representations are based primarily on visible features and aesthetic judgments, whereas more complex representations are based on deeper understandings of ecological processes and functions. After presenting the spectrum, I then discuss a research agenda to further conceptually and empirically explore the relationships described in this chapter.

While the second chapter is aimed broadly at forest disturbances in general, chapters three and four focus on empirical investigations of people’s perceptions of landscape recovery following wildfires.

1.2.2 Chapter 3: Applying Social Representations Theory to Understand Wildland-Urban Interface Residents’ Perceptions of Wildfire and Post-Wildfire Landscape Recovery

My third dissertation chapter applies SRT in qualitative research in Montana to provide an in-depth analysis of how people perceive post-wildfire landscape recovery. SRT uses the term representations to describe how people understand new phenomena (Moscovici, 1984), in this case the changed landscape after a 2012 wildfire. I chose to use SRT, as opposed to related frameworks like mental models, because of the added utility of SRT. Specifically, it specifies mechanistic processes (anchoring and objectification) and structural elements (central core and peripheral elements) of people’s representations of a phenomenon (Abric, 2001; Moscovici, 1984). SRT also emphasizes the importance of social context and discourse in developing an individual’s representation. Mental models research is well suited for illustrating the connections people make between different aspects of a phenomenon to make sense of it (Jones et al., 2011). However, while SRT can accomplish this objective as well, it places more emphasis on explaining how perceptions or representations develop (i.e., anchoring and objectification). Understanding those developmental processes can help managers shape communication
and management strategies by including the different factors that affect perceptions in their efforts, rather than focusing on the end result (i.e., attitudes).

Furthermore, SRT’s acknowledgement of the role of social context is relevant in socially diverse areas like the WUI. Residents in different WUI archetypes may have different representations based on their backgrounds, knowledge and experience with fire, and reasons for living in the WUI. Comparing representations of different social groups, in this case WUI archetypes, provides key insights into how varying attitudes develop so that potential conflict can be addressed while considering how to manage a post-fire landscape to protect a range of values among different WUI constituencies.

Procedural (i.e., anchoring and objectification) and structural (i.e., central core and peripheral elements) aspects of people’s representations about post-fire landscape recovery are explored by integrating the factors proposed in my second chapter. These considerations help frame the findings in a way that offers theoretical and managerially relevant insights. Interviews were conducted in 2014 with 30 residents who experienced the 2012 Dahl Fire. Participants were purposively selected to represent a range of the factors described in Chapter 2 across residents in the two main WUI archetypes present in the community affected by the fire. Interviews were analyzed with a SRT lens that integrates the main factors and propositions from the first chapter to begin applying the proposed framework. This chapter provides an in-depth examination of how people perceive landscape recovery by understanding what landscape recovery means to different people and how different factors influence those perceptions and meanings.

1.2.3. Chapter 4: Quantifying Factors that Predict Perceptions of Post-wildfire Landscape Recovery

While the third chapter offers depth and exploration by studying the structural and procedural aspects of people’s representations of landscape recovery after a wildfire, the fourth chapter takes a broader look at which variables or factors influence perception of recovery across landscapes and communities. Twenty-five fires that occurred in 2011 or 2012 in WA, OR, MT, and ID were selected to represent a range of fire behavior characteristics and landscape impacts. Then, residents who live near each of the 25 fires
were randomly selected to receive survey questionnaires that asked about multiple facets of their experiences with the fire, the perceived social impacts from the fire, and specifically how the landscape had changed/recovered since the fire.

Statistical procedures including linear regression and hierarchical linear modeling (HLM) were used to reveal which factors are most likely to influence perceptions of landscape recovery across different wildfires. The potential predictor variables included landscape attachment, beliefs about the ecological role of the fire, evaluations of erosion impacts from the fire, perceptions of the typicality of the fire behavior, the duration of the fire, the distance of one’s property from the fire perimeter, whether or not the participant had experienced fire before, the length of time the participant had lived in the area affected by the fire, whether or not their income was connected to the forest, and socio-demographic variables. Linear regression revealed the strength of the influence of these variables in predicting perceptions of recovery, as well as the percent of variance in landscape recovery perceptions explained by the statistically significant predictor variables. The HLM analysis then provided insights about the consistency of the relationships revealed in the regression analysis across the fires. It revealed which relationships are present at the individual household level as well as at the wildfire level. This fourth chapter allows more generalizable insights that can be difficult to achieve with in-depth, qualitative research.

1.2.4 General conclusion

The fifth and concluding chapter summarizes the major findings from the previous chapters and discusses them in broader social, ecological, and managerial contexts. I also discuss limitations of my research, considerations related to the validity and reliability of my research, as well as future research potential.

1.3 Ethical considerations

Several steps were taken throughout the research process to ensure the ethical integrity of the research conducted for my dissertation. Approval was obtained by the Institutional Review Boards (IRB) at the University of Idaho (UI) (where I began my doctoral program) and Oregon State University (OSU) (see Appendix A for initial UI
approval and OSU approval). I clearly explained to participants the purpose of the research, the confidentiality of their participation, and their right to end participation at any time. The names and other information of participants were stored electronically in a password protected computer with access limited to myself, Dr. Hall, Dr. Paveglio, and a graduate student assisting with data collection. The names of participants were then identified by unique numerical codes so that no responses could be linked to any participant by anyone other than the individuals listed above. Hard copies of the questionnaires used in the fourth chapter were kept in a secure location with access limited to myself and the graduate student assistant. They will be destroyed in accordance with IRB requirements when no longer needed.

Asking people to describe and reflect on their experiences with wildfires can be particularly sensitive. Many people experienced significant personal impacts related to the fires examined in my research. This includes loss of personal property, emotional stress, health issues from smoke, and in some rare cases, the loss of lives of loved ones or friends. The potential for this research to result in further psychological distress to participants was taken very seriously. It could also negatively impact ourselves as researchers. We were aware of departments at either university that could provide support to participants and ourselves if needed. When conducting the interviews for the third chapter, I also relied extensively on my committee member, Dr. Paveglio, who was in the field with me and provided tremendous support and guidance. He and Dr. Hall have extensive experience conducting social science research around sensitive topics. We discussed how to foster this sensitivity before and during data collection. This primarily included carefully wording questions and maintaining a professional, yet supportive demeanor when communicating orally and in written correspondence with participants. I learned a great deal from following their lead in terms of gauging when and how to ask follow-up questions in an appropriate manner.

I am not aware of any significant issues related to potential psychological impacts on anyone who participated in my research. The people we interviewed were generally pleased to speak with us and welcomed a wide range of discussions about their
experiences with the fire. If we felt the conversation leading to an overly distressing topic, we steered it in a different direction. People who received the questionnaires were also generally receptive and appreciative of our efforts to record their experiences in hopes of improving forest and wildfire management by applying key lessons learned from our research. Thus, I fully believe that the research conducted here was done in an ethically responsible manner.
2. References


Chapter 2. Developing a Conceptual Framework for Understanding People’s Perceptions and Evaluations of Landscape Recovery after Natural Disturbances

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1. Introduction

Ecological disturbances are an integral part of many landscapes. They induce short- and long-term changes to landscape composition, structure, function, and appearance, and many factors affect the post-disturbance recovery process and trajectory. Individuals and communities hold a range of values towards any given landscape, and those values can be affected by changes to the landscape, which in turn can affect people’s attitudes about managing the landscape. While an extensive body of research continues to explore people’s responses to landscape change due to anthropogenic causes, less attention has been given to understanding perceptions of landscape change due to natural disturbances. Another extensive body of research has explored people’s preferences for landscapes, but has rarely explored perceptions beyond immediate aesthetic reactions. There have been numerous calls to further explore the relationships between people and ecological processes (Burtz & Bright 2014; Gobster, Nassauer, Daniel, & Fry, 2007; Gordon, Gruver, Flint, & Luloff, 2013; Spies, Lindenmayer, Gill, Stephens, & Agee, 2012). Examining people’s perceptions of post-disturbance landscape recovery offers one such opportunity.

The purpose of this paper is to synthesize relevant literature to explore the cognitive practices and factors most influential to people’s perceptions of post-disturbance landscape recovery. This leads to the initial development of a framework for theoretically and empirically exploring these perceptions. The conceptual framework consists of a discussion of plausible relationships between different theoretical concepts that best explain perceptions of landscape recovery. It is further informed by the methodological and theoretical underpinnings of mental models traditions and Social Representations Theory. This discussion leads to the development of a spectrum upon which perceptions are posited to exist, ranging from lesser to greater complexity and varying emphasis on aesthetic and ecological aspects of landscape recovery.

We first present definitions of key terms used throughout this paper. The next section articulates the importance of understanding people’s perceptions of landscape recovery after natural disturbances, followed by a discussion of major factors we expect
to influence those perceptions. Then we articulate how the concepts of mental models and social representations can organize our understanding of the factors shaping perceptions of landscape recovery. This leads to a presentation of a spectrum that can guide future efforts to empirically explore of perceptions of post-disturbance landscape recovery.

1.1 Definitions of disturbances, landscape recovery, and perceptions

A disturbance in forest ecosystems can be defined as “any relatively discrete event that disrupts the structure of an ecosystem, community, or population, and changes resource availability or the physical environment” (White & Pickett, 1985, p. 7). The most common forest disturbances relevant to this paper are wildfires, insect and disease outbreaks, landslides, blowdowns, and flooding. We use the term landscape recovery to describe the post-disturbance trajectory of landscape changes, including biophysical characteristics (e.g., ecosystem functions and processes) and appearances. While recovery can be a value-laden term, we do not imply that change is either good or bad. Moreover, we recognize that it does not necessarily mean returning to pre-disturbance conditions. Nevertheless, the term is used here because it reflects a process that shapes landscape characteristics over time, and it is used by other disciplines to describe post-disturbance trajectories. Though recovery is rarely defined in empirical studies, investigations tend to focus on vegetation composition and diversity, soil nutrient cycling, and hydrologic processes (e.g., Chazdon, 2003; Chen et al., 2011; Everham & Brokaw, 1996; Mitchell, & Yuan, 2010; Quintero-Gradilla et al., 2015; Thornton et al., 2002; White, Ryan, Key, & Running, 1996).

A working definition of perceptions for this paper is “the process by which people interpret and organize sensation to produce a meaningful experience of the world” (Pickens, 2005, p. 52, adapted from Lindsay & Norman, 1977). Thus, perception is an umbrella term for cognitive processes involved in evaluating phenomena. We argue that people’s perceptions of landscape recovery after natural disturbances can be best understood within a conceptual framework structured by mental models and social representations traditions. These traditions explain how people’s perceptions of a landscape changed by a disturbance result from cognitive processes and mental structures.
shaped by environmental, personal, and social characteristics that help them understand the phenomenon of landscape recovery.

2. Natural disturbances, perceptions of recovery, and the gap between aesthetics and ecology

2.1 Natural disturbances and landscape recovery in forest ecosystems

There is increasing interest in the social dimensions of natural disturbances, as well as the interactions between social and ecological components (Moritz et al., 2014; Spies et al., 2014). The spatial and temporal heterogeneity resulting from disturbances is recognized as an important component of resilient landscapes (Pickett & Cadenasso, 1995; Turner, 2010). In fact, scholars and land managers are exploring options for managing forests in a way that mimics the ecological effects of disturbances to ameliorate effects of past suppression of some disturbances (e.g., fuels thinning to mimic wildfire effects) and to mitigate negative impacts of future disturbances (Drever, Peterson, Messier, Bergeron, & Flannigan, 2006; Olsen, Mallon, & Shindler, 2012; Scrimgeour, Tonn, Paszkowski, & Aku, 2000). As the ecological importance of disturbances is becoming better known, it will be imperative to include human aspects in managing disturbances because the social context influences management possibilities.

Many forest disturbances are now increasing in spatial and temporal extent due to interactions between climate and land management (Dale, Joyce, McNulty, & Neilson, 2000; Hessburg, Agee, & Franklin, 2005; Raffa et al., 2008; Westerling, Hidalgo, Cayan, & Swetnam, 2006; Wimberly & Liu, 2014). Tree mortality rates are also expected to increase in the western United States, and many other parts of the world, due to warming climates and drought (Allen, Breshears, & McDowell, 2015; Van Mantgjem et al., 2009). Perhaps one of the most challenging aspects of increased disturbances is that climate change affects both disturbance regime characteristics (e.g., timing, location, intensity) and the way landscapes react to disturbances (Dale et al., 2001). Moreover, interactions between climate change and other disturbances can lead to novel ecosystem configurations and make preserving current ecosystem conditions increasingly challenging (Dale et al., 2000). These landscape changes could fall outside the historic range of variability (HRV) in many ecosystems, forcing managers to prepare for
uncertainty when managing post-disturbance landscapes (Millar, Stephenson, & Stephens, 2007; Moritz, Hurteau, Suding, & D'Antonio, 2013). Many of the changes from disturbances are viewed negatively by society, at least in the short term (Flint, McFarlane, & Müller, 2009), and managers are increasingly interested in understanding how people perceive landscape changes as they seek to balance social and ecological goals.

The trajectory of post-disturbance recovery is influenced by many factors, including climate (pre- and post-disturbance), disturbance characteristics (intensity, frequency, and severity), and management activities (pre-disturbance mitigation, as well as post-disturbance actions like planting trees) (e.g., Turner, Baker, Peterson, & Peet, 1998). Landscapes characterized by dynamic ecological processes present a challenge for people who value stability and the current condition of the landscape (Reeves & Duncan, 2009; Spies et al., 2014). Perceptions of landscape recovery are important because many forest disturbances are occurring in areas increasingly occupied, utilized, and valued by people for a wide variety of reasons or purposes (Hammer, Stewart, & Radeloff, 2009; Martinuzzi et al., 2015; Paveglio, Moseley, Carroll, Williams, Davis, & Fischer, 2015; Stein et al., 2013). As discussed in more detail in Section 3, understanding these different values towards the landscape is important to understanding how people perceive post-disturbance landscape recovery. Although public attitudes towards forest conditions and management have been the focus of considerable research in the past, perceptions of recovery from disturbances have received minimal attention.

2.2 Importance of understanding perceptions of environmental issues

People’s perceptions of environmental issues continue to be an important area of research because perceptions are key factors in understanding people’s behaviors. For example, natural resource managers and researchers often seek to identify any discrepancies between perceived and actual conditions, and then shape and target communication strategies to correct misperceptions in an attempt to garner support for a particular set of actions or policies (e.g., Fischer, Kline, Ager, Charnley, & Olsen, 2014; Jiang, 2013; Zaksek & Arvai, 2004). A perceived loss of important landscape features
can lead people to reconsider their values for the area and even decide to relocate (Burley, Jenkins, Laska, & Davis, 2007). Similarly, perceptions of landscape impacts, such as aesthetic changes, can be a factor in deciding whether or not to rebuild after a wildfire (Mockrin, Stewart, Radeloff, Hammer, & Alexandre, 2015). These changing behaviors can affect land use and development patterns, which can affect key landscape features like habitat connectivity, fuels connectivity, or water flow. Thus, perceptions of environmental change can lead to behaviors that result in further changes in environmental conditions.

Understanding the influential factors of landscape recovery perceptions, as well as the process by which those perceptions are formed, can help land managers and community leaders include public concerns and attitudes in the pre-, during, and post-disturbance stages. Understanding perceptions can also inform public communication strategies to address gaps in understanding, as well as ensuring that public values for a landscape are considered when deciding how to manage the post-disturbance landscape.

### 2.3 Moving beyond aesthetics

Research on people’s perceptions of landscape recovery presents an opportunity to explore how people understand complex, dynamic ecological processes. Given the well-recognized importance of aesthetic judgements of visual features on people’s attitudes about natural resource management issues (see Section 3.1), scholars have been calling for integrating aesthetics into ecological management and monitoring. For example, Fry, Tveit, Ode, and Velarde (2009) presented a framework highlighting overlap and divergence between ecological indicators (e.g., ecological complexity, including biodiversity and heterogeneity) and aesthetic indicators (e.g., visual complexity that signals possibilities for exploration) as a means of incorporating aesthetics into ecological management. The model of human-environmental interactions (see Figure 2.1) presented by Gobster et al. (2007) is useful in the context of understanding perceptions of landscape recovery. It emphasizes the scale of what humans perceive in the landscapes around them in relation to the scale of ecological processes, and how that scale affects human actions and impacts to the landscape. They described the perceptible realm as the
space where people experience aesthetic qualities of the landscape and where intentional actions towards the landscape occur. In other words, the characteristics of a landscape that we can see (e.g., landforms, vegetation, bodies of water, or human developments like suburbs) tend to have a greater impact on our actions than characteristics of landscape we cannot see (e.g., long-term geological or climatic processes). These visible features of the landscape act as a potential source of information about ecological processes for people, and they are often better understood by the public than the less visible features (Wagner, 2007). However, many important ecological processes or phenomena are not readily visible, such as nutrient cycling, other soil-chemical processes, or macro-scale climatic patterns. Evaluations of landscape recovery based on visible features may therefore overlook important recovery elements, which could lead to misguided conclusions about the recovery process (e.g., over- or under-estimating return to pre-disturbance conditions) and negative attitudes towards management actions that embrace ecological disturbances as a natural part of ecosystem processes.

**Figure 2.1** Model of human-environmental interactions in the landscape (Gobster et al., 2007)

Given the potential disconnect between perceptions of disturbances, positive and negative social and ecological impacts from disturbances, and attitudes towards management that favors ecological integrity, a research agenda is needed for
investigating how people cognitively process information, including but not limited to visual features, about disturbances as a part of an ecosystem. Exploring how perceptions of post-disturbance landscape recovery are developed across different individuals and contexts assists management and communication efforts aimed at achieving a balance between social and ecological considerations of disturbances. The following section describes the factors influential to perceptions of recovery, then Sections 4 and 5 discuss the utility of applying a framework organized around the concepts of mental models and social representations to better understand those perceptions.

3. Review of factors most likely to influence perceptions of recovery

Many factors affect how people perceive landscape changes. These include visible, physical changes in the landscape, how these changes are interpreted through past experiences, and individual and socio-cultural factors (Bell, 2001). Table 2.1 summarizes the three main categories of factors we expect to be most influential to people’s perceptions of landscape recovery. They range from instinctive to more affective and cognitive-based evaluations. These factors were developed based on a careful review of the scientific literature related to human dimensions of natural disturbances or hazards. This body of literature includes a range of disciplines, from landscape architecture to human geography, psychology, and sociology. Searches were conducted in Google Scholar and Web of Science using a combination of terms, including perceptions of landscape change, human dimensions of natural hazards or disturbances (and specific disturbances like wildfire and insect outbreaks) and landscape recovery. These searches revealed a large breadth of research that was reviewed to identify key factors that might affect perceptions of landscape recovery. While much of the landscape architecture literature focuses on perceptions of landscape changes due to anthropogenic changes (e.g., urban sprawl), some general insights about landscape perceptions were helpful. Literature focused more on human dimensions of natural disturbances, especially in terms of psychological and sociological influences on perceptions, provided significant insight into the factors and processes that likely shape people’s perceptions of post-disturbance landscape recovery. This section describes the three main categories of factors: visual cues, connections to the landscape, and beliefs about the role of ecological disturbances.
Table 2.1 Factors most likely to influence people’s perceptions of post-disturbance landscape recovery

<table>
<thead>
<tr>
<th>Factor</th>
<th>Basis for impacting recovery perceptions</th>
<th>Potential impact on perceptions of recovery</th>
<th>Example</th>
<th>Key citations</th>
</tr>
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<tbody>
<tr>
<td>1. Visual cues</td>
<td></td>
<td></td>
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<tr>
<td>Automatic landscape preferences</td>
<td>Some preferences for landscape characteristics derive from humans’ evolution with landscapes based on basic needs like shelter and mobility. These preferences could direct attention to the elements of recovering landscapes most preferred from an evolutionary perspective.</td>
<td>There could be an innate tendency to focus attention on elements related to survival (such as savannah-like conditions), and react positively to changes that create such conditions during the landscape recovery process.</td>
<td>Attention might be drawn towards specific landscape features, such as openness and arrangement of vegetation to meet basic needs like safety and line of sight for hunting. A landscape with such features may be preferred and if these features disappear, the landscape may not be perceived as recovering.</td>
<td>Gobster, 1994; Kaplan, 1987.</td>
</tr>
<tr>
<td>Aesthetically-based preferences</td>
<td>People focus on visual cues when assessing landscape recovery, and their aesthetic reactions to such cues may affect how they perceive and evaluate recovery.</td>
<td>Perceptions may be shaped by the extent to which visible and aesthetically pleasing features of the landscape are seen as altered and (not) recovering.</td>
<td>Visible presence of the disturbance impacts (such as charred trees) might be perceived as aesthetically undesirable. The landscape is perceived as recovering to the extent that charred trees, or other signs of the disturbance, become less visible over time.</td>
<td>Anderson, 1978; Brenkert-Smith, 2006; Brush, 1979; Hull, Robertson, &amp; Kendra, 2001; Magill, 1990, 1994; Mockrin et al., 2015; Nassauer, 1995a; Ribe, 1989; Ryan, 2005.</td>
</tr>
<tr>
<td>2. Connections to the landscape</td>
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<tr>
<td>Place meanings or values</td>
<td>Landscapes have meanings to people, and changes to the landscape can affect those meanings.</td>
<td>Perceptions of recovery may be influenced by the degree to which people’s meanings and values for a landscape are adversely affected by a disturbance. There may be great variability in whether these features can recover.</td>
<td>A rancher might value a landscape for its production qualities, while others might value a stand of trees as culturally important. The rancher may believe recovery is occurring if production returns, whereas the cultural value of trees may be lost forever.</td>
<td>Burley et al., 2007; Burns, Taylor, &amp; Hogan, 2008; Cheng, Kruger, &amp; Daniels, 2003; Davenport &amp; Anderson, 2005; Gunderson &amp; Watson, 2007; Kent et al., 2003; Reid &amp; Beilin, 2015; Sieber, Medeiros, &amp; Albuquerque, 2011; Smaldone, Harris, &amp; Sanyal, 2005; Stokowski, 2008; Tuan 1974; 1977; Williams &amp; Stewart, 1998.</td>
</tr>
</tbody>
</table>
### 3. Beliefs and knowledge of ecological processes and disturbances

| Beliefs about forest processes | Perceptions of landscape recovery are affected by knowledge about ecological processes, specifically the role and necessity of disturbances in many ecosystems. | People with more knowledge about ecological processes are likely to have more nuanced perceptions of recovery and a more developed understanding of how disturbances could lead to different recovery trajectories. They may focus on more than just visible changes and may interpret visible changes for more than just their aesthetic qualities. | People who believe disturbances to be part of a dynamic forest ecosystem are more likely to understand that landscapes may not return to previous conditions than people who believe disturbances are not part of the landscape and want it to return back to “normal.” They are more likely to understand the dynamic nature of ecosystems, disturbances, and recovery than people who believe ecosystems are static and disturbances are ecologically detrimental. |
| Past experiences with disturbances | People with more experience with disturbances and recovery processes may have developed perceptions based on more than immediate visual cues because experiencing disturbance can lead to more knowledge about ecological processes. They also have more frames of reference on which to base expectations of the recovery process. | Past experiences serve as a reference for recovery trajectories and are a major influence on beliefs about the disturbance process. People with experience with the recovery process might focus more on the dynamic nature of the process, rather than a static point in time characterized by a single aspect like visual impacts. | People who previously witnessed the loss of forest to beetle kill, but then saw trees return, might perceive a newly burned landscape as recovering, even though the appearance is very different from the pre-disturbance forest; they expect the trees to come back based on knowledge gained about ecological processes while experiencing other disturbances. |


3.1 Visual Cues

Visual cues are usually the first thing people notice in a landscape (Gobster & Westphal, 2004). They serve a primary role in helping people understand landscape changes due to disturbances (Wagner & Gobster, 2007). Here, we focus on how visual cues of landscape changes due to natural disturbances can immediately affect aesthetic evaluations of that landscape, which in turn could affect people’s perceptions of landscape recovery (Gobster, 1994; Kaplan, 1987). The importance of visual appearance of landscapes has received a great deal of attention for several decades. Land management agencies and researchers have invested considerable effort in describing how forest management practices affect aesthetic evaluations, and then how those evaluations affect attitudes towards specific forest management strategies (Ryan, 2005, 2012; Tveit, Ode, & Fry, 2006). We chose not review the breadth of research related to aesthetics and forest management, as this has been done already (see Ryan, 2005). The purpose here is to highlight the importance of visual cues to people’s perceptions of landscape recovery and summarize the visual landscape features that people notice as a forest recovers from a disturbance. Some of these judgements are thought to be innate and mostly automatic, while others are more affective or emotionally-based and reflect cognitive reactions to symbolic meanings.

3.1.1 Automatic aesthetic preferences

One focus of research related to human experiences with the natural environment emphasizes a relationship between physical features of landscapes in which humans evolved and present-day preferences for particular scenes (Kaplan, 1987). As Gobster (1994) summarized, preferred landscapes can generally be characterized by large trees, herbaceous, smooth groundcover, open mid-story canopy, and vistas with distant views and high topographic relief. Such preferences are posited to derive from basic human needs, such as safety, where savanna-type landscapes offered both protection from predators and the ability to detect prey without being noticed. Numerous studies have illustrated that these preferences influence attitudes about forest management (see Ribe, 1989, and Ryan, 2005), with support leaning towards activities that produce preferred
visual settings. These preferred settings, based on an evolutionary or instinctual foundation, are likely types of features that people will notice when evaluating landscape recovery, especially if any of those features are affected by the disturbance. Examples of these features include open line of sight, ample spacing between vegetation (enough space to facilitate movement, but dense enough for cover or protection), and the composition of vegetation at different vertical levels (e.g., ground level vs. canopy level). Assuming these desirable conditions were present before a disturbance, the evolutionary perspective would posit that landscapes would be perceived as recovering when these conditions are restored over time. Perceptions as explained by the evolutionary theory are largely automatic reactions, and most people likely do not recognize that their perceptions are being influenced by this evolutionary process when it happens.

3.1.2 Visual preferences and aesthetic judgements

Aesthetic values -- beyond those associated with innate preferences -- are often among the most important forest values for many people (Bengston, Webb, & Fan, 2004; Lim, Innes, & Sheppard, 2015). Disturbances that alter aesthetically preferred features can affect attitudes related to forest disturbance management (Brenkert-Smith, 2006; Nelson, Monroe, & Johnson, 2005), as well as post-disturbance behaviors, such as people’s decision to stay or leave after a wildfire (Mockrin et al., 2015). In general people prefer green, live trees as a perceived sign of a healthy forest. Dead or downed trees are typically not preferred and may be perceived as messy and an indication of an unhealthy forest (Hull et al., 2001; Nassauer, 1995a; Ryan, 2005). Other research has shown that vegetation regrowth increases visual preferences for managed scenes, and preferences tend to increase as stand maturity increases (Anderson, 1978; Brush, 1979; Magill, 1994; Ryan, 2005). The point here is that visual qualities, and specifically aesthetic judgments of those qualities, are central to people’s perceptions of landscape recovery because those aspects are important to many people and are often affected by the disturbance. Thus, perceptions of the landscape recovering may depend on evaluations of how the visual aspects of the landscape appear over time. Evaluations will vary to the extent that people expect it to return to pre-disturbance conditions or when certain visible features (e.g.,
regeneration of green vegetation, removal of dead trees or other aspects affected by the disturbance) move toward aesthetically preferred conditions.

3.2 Connections to the landscape

People respond to the immediately visible impacts from disturbances. However, landscapes are often important for reasons beyond aesthetics. Places have meanings for people that are developed through personal experiences, symbolic interpretations, and social interactions that reinforce certain meanings through discourse. An extensive review of the concept of place is beyond the scope of this study (see Lewicka, 2011). The purpose here is to highlight the role played by people’s values for the landscape in their perceptions of landscape recovery, which reflects the affective nature of perceptions of landscape changes.

Places develop meanings when people internalize something important about them through lived experiences and interaction with a specific locale (Cheng et al., 2003; Tuan, 1974, 1977). One’s sense of place may be centered on the specific features of a place or on broad landscapes to which people attach meaning or value (Stedman, 2003; Stokowski, 2008). The meanings that individuals, communities, and cultures attach to a place are often so deep-rooted that any changes to that place may be seen as a threat to their values, and even their identity, thus causing conflict and unrest (Davenport & Anderson, 2005; Gunderson & Watson, 2007; Nassauer, 1995b; Rikoon, 2006). By understanding the specific characteristics of a landscape to which people attach meaning, as well as the process that leads to the formation of meaning, we can better anticipate how changes to those places might affect their perceptions of landscape recovery.

The meanings someone has for a place are formed through both individual and social processes. Studies of individual processes focus on people’s cognitive ability to interpret phenomena as meanings (Stokowski, 2008). This cognitive orientation is useful for understanding internal processes (such as attitudes, motives, preferences, and emotions) that lead people to assign meanings to places. These meanings can be derived from experiences or memories associated with a certain place, or from symbolic interpretations that make a place important for some reason. For example, someone may
feel connected to a particular landscape because of memories related to experiences during childhood visits with family. Other meanings may be symbolic; for example, a particular wilderness landscape could represent the wild west and a sense of freedom to one person, but to another person it might have a deeply spiritual meaning representing a sense of a greater being or purpose in life beyond the human-scale.

While a person must generate these meanings internally (i.e., cognitively), by forming some sort of belief, attitude, or affective response in order to personally form a relationship with a place, that process is itself socially constructed (Stokowski, 2008). Social constructivist traditions explain that landscapes are cultural expressions used to define individuals and communities (Greider & Garkovich, 1994). Social discourses and shared experiences and values help develop and reinforce the meanings one holds for a landscape. Many landscape values and meanings are shared across individuals associated with that landscape.

Thus, changes to a landscape, such as recovery after a forest disturbance, will be interpreted through both individual and social processes. Those interpretations depend in part on the meanings and values individuals and groups of people have towards the landscape (Bell, 2001). Some values arise from individuals’ dependence on specific landscape components; if so, perceptions of changes to the landscape may focus on those components. For example, a rancher might focus on how a wildfire affects the quality of forage after a fire, a timber producer will focus on the timber quality and availability after a blowdown, and a homeowner might focus on the changes to wildlife habitat on her or his property (Gobster, 1999; Lewis, 2008; Sieber et al., 2011; Wagner & Gobster, 2007). Others’ perceptions of recovery may be drawn towards landscape features important to a certain memory or set of experiences involving that landscape. Indeed, disturbances may lead to a renegotiation of place, or place disruption, based on a heightened awareness of the changes to landscape attributes important to individuals or groups (Burley et al., 2007; Stedman, 2003).

In the case of forest disturbances, the impact to physical features of the landscape, particularly trees and other vegetation, can lead to a loss of landscape attachment and
negatively impact one’s connection to that specific place (Burns et al., 2008; Kent et al., 2003; Reid & Beilin, 2015). These connections may have to be restored to some extent in order for the landscape to be considered recovered from the disturbance. On the other hand, perceiving the landscape as recovering is also influential in affecting those connections (i.e., connections are not restored until landscape is perceived as recovering). In this way, the relationship between perceptions of recovery and connections to the landscape could be reciprocal. Whether people’s connections to the landscape are based in livelihood dependence, emotional connections, or aesthetic preferences, the degree to which the features of importance change in the post-disturbance trajectory will likely influence overall perceptions and evaluations of landscape recovery.

3.3 Beliefs about ecological processes and disturbances

The third main category of factors to affect perceptions of landscape recovery includes beliefs about the ecological role of disturbances in the landscape. Most landscapes are dynamic and experience periodic changes in composition (e.g., vegetation) and function (e.g., nutrient and hydrological cycles). However, many people may prefer a particular set of landscape characteristics or conditions, and they may react negatively to changes in those conditions. However, a deeper understanding about the ecological necessity of disturbances may temper negative perceptions of the disturbance (Carroll & Bright, 2009). For example, people are more likely to support forest management decisions if they believe those decisions support natural events and processes and will lead to improved forest or ecosystem health (Burns & Cheng, 2007; Manfredo, Fishbein, Haas, & Watson, 1990; McCaffrey, 2006; McCaffrey & Olsen, 2012).

Beliefs about the importance of disturbance as a natural landscape process should influence how the recovery trajectory is perceived. For example, people who believe disturbances and the resulting changes are important to maintain ecologically desirable landscape features may have nuanced perceptions of how the landscape is recovering. Their perceptions of recovery are likely to include more ecological considerations (such as nutrient cycling or potential for regrowth), in addition to strictly visual or aesthetic
elements. Conversely, someone who believes the landscape should be more static (e.g., preserving certain visual features) may believe that the disturbance completely changed it forever. People with less nuanced beliefs about the ecological role of disturbances may focus on the most visibly salient aspects of the recovery process (such as burned trees, invasive species, or obstructed recreation access from fallen trees), rather than ecological considerations.

Beliefs related to forest disturbances are developed from many different sources, including conversations with neighbors and land managers, informational materials, media coverage, and formal education. A prominent source of information is people’s own direct experiences. People experience a forest disturbance in many different ways based on individual circumstances (e.g., access to resources like insurance for post-disturbance management actions) and social factors (e.g., conflicts between law enforcement and landowners surrounding fire suppression) (Hodgson, 2007; Lindell, 2012; Paveglio, Carroll, Hall, & Brenkert-Smith, 2015). Any such past experiences with a disturbance can influence beliefs about the role of disturbances in forest ecosystems and also serve as frame of reference for post-disturbance change.

A consistent finding in research related to human dimensions of forest disturbances is that personally experiencing a disturbance event can lead to a more complex understanding of the social and ecological factors that led to the disturbance, the various impacts from the disturbance, and the post-disturbance recovery trajectory (Gordon et al., 2013; Toman et al., 2013; Wagner, 2007). This deeper knowledge may come from firsthand observations or from other sources of information. Disturbances near communities are a salient topic among people directly affected by the disturbance (Flint, 2006; Flint, 2007; Flint et al., 2009; Gordon et al., 2013; Lewis, 2008). For example, pine beetle outbreaks or wildfires have direct implications for a wide range of industries upon which communities depend, including timber, ranching, recreation, and tourism. Thus, residents are likely to seek information to understand the impacts and landscape changes, especially how they and the community could be affected in the short- and long-term. Through these experiences and different sources of information,
they learn more about the disturbance and understand it from multiple perspectives. This knowledge translates to their beliefs about the landscape recovery process, including the potential impact and role of future disturbances on the recovery trajectory. Thus, it seems reasonable to think that their expectations for the post-disturbance landscape would be based on those beliefs. People with fewer previous experiences will rely more on other sources to understand their perceptions of the recovery trajectory as it unfolds, such as seeking input from experts or neighbors.

People with multiple experiences of disturbances are more accustomed to seeing the changes in the landscape and likely have expectations of the recovery process that reflect its dynamic nature. Evaluations of landscape impacts in the years immediately after a forest disturbance are likely to be negative towards certain aspects of the landscape, especially visibly dying trees. The initial shock of the landscape changes seems to wear off within a few years after the disturbance, as people grow accustomed to the altered landscape (Flint et al., 2009; Gordon et al., 2013; Kooistra & Hall, 2014). Seeing vegetation regeneration and noticing positive aspects, such as more openness leading to better views and more wildflowers, help ameliorate people’s emotional reactions over time as they become more accustomed to the changes. (Flint, 2006, 2007; Flint et al., 2009; Kooistra & Hall, 2014). People with more experiences with disturbances and the recovery trajectory are likely to have more developed or specific expectations about what will happen after the next disturbance. They are likely less surprised by the initial changes and may expect new vegetation growth and any other changes, such as different birds and wildlife species. They are more likely to accept the changes as part of a dynamic process, rather than focusing on lost conditions that may never return.

As this section has shown, many factors shape perceptions of recovery. Existing theoretical frameworks can help conceptually organize them and facilitate empirical exploration of how they interact to influence perceptions of landscape recovery. The following section discusses how mental models and social representations traditions can be applied in these efforts.
4. Applying mental models and social representations traditions to explore perceptions of landscape recovery

The post-disturbance landscape is a new phenomenon to many people. Even people who have witnessed disturbances may still find novelties in the recovery process because of the complex and often unpredictable interaction of climatic, ecological, and management considerations that affect recovery. The concepts of mental models and social representations provide a useful framework for integrating the factors discussed in Section 3 towards a comprehensive understanding of how people perceive post-disturbance landscape recovery. Mental models tradition and social representations theory (SRT) offer related and complementary explanations of how people make sense of new phenomena, in this case a recovering landscape. They explain how people come to understand a phenomenon and how attitudes towards that phenomenon develop. Land managers and community leaders can use this information to inform communication and management strategies that may be intended to influence people’s attitudes in a way that helps achieve management goals. Rather than focusing on the end result (i.e., the attitude), they can understand how attitudes develop.

This section first provides an overview of the mental models concept, then it presents SRT and how it can complement and strengthen the mental models approach. Then we discuss how these concepts and approaches can help organize the factors involved in perceiving landscape recovery (see Table 2.2 in Section 4.3), which leads to development of a spectrum (Section 5) within which we expect perceptions of landscape recovery to exist across a population or community.

4.1 Mental models of landscape recovery

Researchers have explored the concept of mental models across a wide variety of environmental contexts to understand the connections people make between different elements of a phenomenon to produce an overall understanding of it (Jones, Ross, Lynam, Perez, & Leitch, 2011; Newell, McDonald, Brewer, & Hayes, 2014). Mental models are simplifications that people use to make sense of something new and/or complex (Craik, 1943; Johnson-Laird, 1983). They are developed by taking information
from existing knowledge and applying it to understand the current phenomenon with which they are less familiar. For example, people may try to understand the dynamics of climate change by focusing on temperature or precipitation patterns, rather than the underlying processes that are more complicated and involve gas exchanges and other biogeochemical processes. One’s mental model of a phenomenon affects how that person thinks about and plans for future situations and related behaviors. For example, the accuracy and complexity of one’s mental model about the causes and effects of climate change are important predictors of concern about negative impacts, support for policies to mitigate negative impacts, and engagement in climate-friendly behaviors (Bostrom et al., 2012; Spence, Poortinga, Butler, & Pidgeon, 2011). Different mental models of disturbances and the landscape recovery process could lead to different attitudes towards forest and disturbance management intended to mitigate social and ecological risks from future disturbances, as well as management and mitigation behaviors on people’s own property.

A typical application is to extract mental models of experts and the general public using a range of quantitative and qualitative techniques to understand and visualize how people think about an issue. This involves asking them to describe different components of an issue or phenomenon and how those components interact (Jones et al., 2011). Scholars and practitioners use mental model extraction techniques to shape communication and management strategies to addresses any misleading perceptions that shape attitudes and behaviors. The goal is to target important aspects of people’s cognitive processes and understandings to make sure they accurately understand the complexity and potential outcomes of a given situation in a way that encourages them to minimize or mitigate risky or negative outcomes (Morgan, Fischhoff, Bostrom, & Atman, 2001).

To understand post-disturbance landscape recovery, people will engage in a process of understanding the causes (e.g., the intensity or severity of the disturbance, or climatic factors) and effects (e.g., vegetation regeneration or water and nutrient cycling) related to the disturbance and the landscape recovery process. If they desire a certain
recovery trajectory, which could be influenced by the factors presented in Section 3, then they may support policies and management decisions that they believe will satisfy their desires. It will be important to identify any inaccuracies or misperceptions in people’s mental models to encourage support for socially and ecologically sound management decisions. Thus, mental models are appropriate frameworks for researching perceptions of landscape recovery after disturbances. Mental models research applied to people’s cognition regarding disturbances has revealed several key findings that can be applied here.

First, the general public tends to have more simplistic understandings about the disturbance process than experts (Chowdhury, Haque, & Driedger, 2012). For example, Lazo, Kinnell, Bussa, and Fisher (1999) set out to illustrate how people understood the concept of ecosystems using focus groups and one-on-one interviews with experts and members of the general public (i.e., non-experts). Experts had a much more sophisticated understanding of ecosystems in terms of definitions, key concepts, and relationships than did the general public. Figure 2.2 illustrates these differences in the form of cognitive mapping outputs for both groups. However, the public group did generally recognize the importance of relationships among ecosystem components, including that disturbances to one part of the system can disrupt other parts or the entire system.

Figure 2.2 Expert (left) and non-expert (right) mental models of ecosystems (Lazo et al., 1999)
Another study found that experts’ understanding of wildfires was significantly more sophisticated and thorough than that of non-experts (Zaksek & Arvai, 2004; see Figures 2.3 and 2.4). Very few non-expert subjects had very developed knowledge of the beneficial implications of fire for forest health, such as its role in promoting successional trajectories. This finding reinforces the proposition that some people, especially those who prefer and expect a certain, static set of landscape conditions, will perceive a recovered landscape as one that looks and functions like it did before the disturbance. People who recognize more connections between ecological processes in the recovery process will likely have more nuanced perceptions of recovery that consider more landscape elements and leave room for more interpretations of what constitutes a recovered landscape. Those people will see change as an important part of the landscape and recognize that recovery is dynamic and based on many factors.

Figure 2.3 Example of an expert mental model of wildfire (Zaksek & Arvai, 2004)
Another key finding from mental models research related to disturbances is that some ecological disturbances are easier to understand than others because of seemingly less complex underlying processes. Many people have simplistic understandings of the relationships between environmental processes and ecological components, especially in terms of how they change over time (Sterman, 2011). For example, Wagner (2007) found that people had a more developed understanding of flash floods than landslides because the underlying biophysical processes for floods are more immediately recognizable than for landslides. These findings suggest that some people may connect more parts of the ecosystem than other people when trying to understand landscape recovery. In other words, some people will focus on visible features affected by the disturbance, such as vegetation composition, but others may recognize connections between the disturbance and other processes like nutrient cycling that affect the recovery trajectory. To some extent, this represents a potential form of selection bias, where people focus solely on the aspects of the landscape that they already understand to explain a larger phenomenon. They might focus their evaluations of landscape recovery primarily on the color of trees
or other vegetation (i.e., green instead of charred), instead of recognizing underlying processes and the dynamic nature of landscape recovery beyond visual and aesthetic considerations. These beliefs could be quite stable over time, presenting challenges to land managers seeking to manage for goals other than aesthetic appeal (Reynolds, Bostrom, Read, & Morgan, 2010).

As discussed in Section 3, personal experiences with a disturbance can lead to an enhanced understanding about the underlying processes and dynamic nature of natural ecosystems. Experiencing an environmental phenomenon and the resulting changes typically leads to more complex mental models regarding those changes and the processes influencing them (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013; Newell et al., 2014). People with these experiences are then more aware of risks and benefits associated with similar disturbances in the future, and they are more likely to support actions meant to mitigate negative impacts (Newell et al., 2014; Spence et al., 2011). In terms of mental models, the knowledge gained during past experiences serves as an important frame of reference for understanding future events. People draw on their prior mental models of disturbances and recovery to help them understand new events.

The key insight about mental models is that they elucidate and visualize the primary elements of a phenomenon, and connections people make between different elements, to make sense of it. Depicting people’s understandings about a phenomenon or situation can reveal key erroneous inferences or points of contention between different stakeholders. Incomplete and/or varying mental models can make it difficult for land managers to communicate with the public and garner support for their decisions and plans. Decision makers or managers can focus on misperceptions or contentious points to find solutions to contentious issues.

Research about people’s perceptions of landscape recovery should employ a mental models approach to help visualize and understand the associations people make between social and ecological factors involved in landscape recovery. Focusing on the post-disturbance phenomenon can give insight into how people will react to future disturbances and related management issues like restoration activities. Revealing the
connections people make between different ecological, social, and managerial elements of the post-disturbance landscape recovery trajectory will help managers tailor communication, outreach, and decision making efforts to address any misperceptions about the recovery process. It may also help managers avoid socially undesirable trajectories after future disturbances through proactive mitigation and preparation.

While the mental models approach is very useful for understanding how people perceive and make sense of landscape recovery, Social Representations Theory (SRT) offers a more specific framework and description of the mechanisms underlying the structure and development of mental models. It also bridges the gap between sociological and cognitivist approaches, with an emphasis on social discourse and interaction in mental model development.

4.2 Social representations of landscape recovery

The concept of social representations, introduced by Moscovici (1984, 1988), was developed in the constructivist sociological scholarly tradition. Representations are “an encoding of some information, which an individual can construct, retain in memory, access, and use in various ways” (Smith, 1998, p. 391). Buijs et al. (2012) referenced Moscovici and Duveen (2000) when they defined social representations as “socially elaborated (thus culturally and historically contingent) systems of values, ideas, and practices that are used by social groups to understand a phenomenon” (p. 1168). This definition is quite similar to the definition of mental models, and indeed representations and models are largely the same.

Importantly, a social representation is both a product and a process (Anderson, Williams, & Ford, 2013; Breakwell, 2001; Moscovici, 1988). As a product, a social representation is a shared set of information, beliefs, opinions, attitudes, and explanations about some phenomenon (Aric, 2001). As a process, social representations include various forms of communication and discourse to make sense of new or unfamiliar situations. While mental models research tends to focus more on the structure and content of the product, SRT emphasizes the role of social interaction in forming representations.
Forest disturbances are an ideal context to investigate the social representation process because post-disturbance landscapes are unfamiliar to many people, triggering a need to engage in a process of sense-making individually and as a community (Breakwell, 2001). Furthermore, landscape recovery occurs in a social-ecological context, and SRT accounts for that context more explicitly than most mental models approaches.

In addition to the emphasis on social discourse and shared representations among social groups, SRT traditionally specifies two mechanisms responsible for generating representations, anchoring and objectification. Recent scholars have elaborated on the original SRT propositions by explaining that the structural nature of representations contains a central core that serves as a basis for the representations, which are further organized and specified by more concrete peripheral elements (Abric, 2001; Moliner & Abric, 2015). However, Moscovici did not directly incorporate the concept of central cores and peripheral elements into his original theory and SRT research tends to only focus on either the structural elements or mechanistic aspects, not both. As will be explained below, there seems to be strong complementarity between notion of structure (i.e., the central core and the peripheral elements) and the development mechanisms described (i.e., objectification and anchoring). Examining both the structural and mechanistic aspects of people’s representations, as well as the relationships between them, will provide insights beyond those provided by the mental models approach by examining how perceptions develop. These insights help identify aspects of that development process that should be targeted for the greatest likelihood of increasing the accuracy and depth of people’s understandings of ecological processes related to landscape recovery.

The following sections discuss the mechanisms involved in representation development as proposed by Moscovici, the structural aspects more recently proposed, and relationships between the structural and mechanistic aspects. Then, we briefly discuss how interaction among and between social groups influences people’s representations of landscape recovery.
4.2.1. Representation mechanisms: Anchoring and objectification

SRT posits two primary mechanisms in the development of representations. Anchoring and objectification describe how new information is assimilated into current knowledge. Anchoring refers to how new ideas become associated with existing concepts, as people categorize new information into pre-existing cognitive frameworks to make them more familiar (Breakwell, 2001; Sammut, Andreouli, Gaskell, & Valsiner, 2015; Wagner & Hayes, 2005). Similar to mental models, elements from existing representations are used to help understand a new phenomenon. Some anchors may be more abstract, such as anchoring a representation of biodiversity in the abstract concept of balance in nature (Buijs, Fischer, Rink, & Young, 2008). Others may be more specific. For example, a study about people’s representations of biological invasions found that people who were unfamiliar with the phenomenon anchored their representations of biological invasions to the spread of a fungus (Selge & Fischer, 2011). Smith and Joffe (2013) found many people anchored representations of climate change in their understanding of a hole in the ozone layer. At any level of specification, the anchoring process essentially involves using representations of other phenomena, already understood by the individual, to shape representations of the new phenomenon. Thus, anchoring related to representations of landscape recovery is likely to involve broader notions about the natural or ecological role of disturbances and the recovery process, based on previous experiences with other disturbances and recovery.

The second process, objectification, entails making something abstract become more concrete (Moscovici, 1984; Wagner & Hayes, 2005). It allows the more abstract concepts associated with the anchor to be translated to tangible objects or beings to help the person make sense of the new situation. Filtering occurs through perceptual selection so that only the elements of the representation most relevant to the values of one’s social group (as defined by the context of the situation and goals of the research) are used to construct the overall representation. For example, a study about representations of climate change illustrated the variation in anchors used among groups, as well as the connection between anchoring and objectification (Smith & Joffe, 2013). The study
found that people made the possible impacts of climate change more concrete through objectification by linking the anchor (i.e., the ozone hole) to skin cancer and sunburn. In doing so, people transferred their understanding of the outcomes of ozone depletion to climate change. The phenomenon of climate change was thereby made concrete through objectifying the effects as more tangible outcomes that were personally important. In terms of landscape recovery, objectification will likely involve the visual, tangible aspects of the landscape (such as vegetation, line of sight, soil or erosion) that people use to describe and evaluate the recovery process (e.g., referring to an area burned by a wildfire as a moonscape). The specific objects or targets in the objectification process will be influenced by people’s values and connections to the landscape.

4.2.2 Structural considerations in social representations

Jean-Claude Abric (2001) articulated the notion of “central core” and “peripheral elements” as the structural basis that organizes the different elements of representations (i.e., values, beliefs, emotions, and attitudes). Representations can be thought of as having a hierarchical structure with a foundation of generally unchanging core ideas about a phenomenon shared by many people, to peripheral components that can vary across individuals or across contexts (Buijs et al., 2012).

The central core is the common foundation upon which all representations of a phenomenon exist among a social group, consisting of fewer, yet more stable, beliefs. The main functions of the central core are to provide meaning, organization, and stabilization to representations (Abric, 2001; Moliner & Abric, 2015). The central core essentially determines the overall meaning of the representation by generating the meaning of all other elements of the representation (Moliner & Abric, 2015). For example, core elements of some representations of “nature” are that nature is fragile (Buijs, Fischer, Rink, & Young, 2008). These general beliefs could lead to attitudes that support limited manipulation of nature so as not to disrupt natural processes (Buijs et al., 2008). By playing an organizational role, the central core determines the nature of the relationships among the other elements of the representation because these peripheral elements depend on the central core for meaning. Lastly, the central core ensures the
stability of the overall representation because those core beliefs are commonly shared and reinforced within social groups. SRT assumes there will be strong resistance to change one’s core representation because of a desire to maintain social cohesion or status and fundamental values.

Central core elements are generally expressed in an abstract fashion. For example, in a study about representations of wolves, Figari and Skogen (2011) found that the core of most representations centered on the notion of wilderness, with the wolf representing wild or wilderness, even among different social groups. Regardless of the nuances of people’s individual representation of the wolf, most representations, at the core, were centered on the notion of wild.

Abric (2001) contended that identifying the central core permits comparison among different representations, and the peripheral elements help understand how differences develop. The peripheral elements provide and account for flexibility among different representations based on context and heterogeneity among members of a particular social group. Peripheral elements express more specific, concrete, and contextualized experiences that are associated with objects related to the representation (Abric, 2001). Abric explained how their influences are revealed throughout the anchoring and objectification process as they connect the abstract central core to the specific phenomenon, ultimately shaping representations uniquely based on the nature of the different elements.

Figari and Skogen (2011) illustrated the importance of peripheral elements in shaping the overall representations of wolves. Divergence between social groups depended on representations of the environment within which the wolf occurs. Farmers and hunters saw nature or the environment for its sustained utilitarian purposes. But wolves crossed a symbolic boundary by being in the managed landscapes. For farmers, the wolves represented wild nature, but they saw their own landscapes as managed nature to be used for utilitarian purposes. Wolves did not belong in their managed landscapes because the landscape was not perceived as being wild and because the presence of wolves posed a possible threat to human safety and well-being. But for wolf supporters,
wolves still belonged in the managed landscape because they are a natural part of all landscapes; people should learn to respect and tolerate wolves regardless of human management for utilitarian purposes. In this sense, the peripheral elements consisted of the different values, beliefs, and experiences people have towards wolves and the landscapes around them (i.e., the context), despite agreeing that, at the core, the wolf represented wildness. Peripheral elements related to perceptions of landscape recovery will involve the factors described in Section 3, which vary across social groups and individuals in communities affected by disturbances and may lead to different representations of recovery.

4.2.3 Social groups in SRT

The tradition of social representations emphasizes that interpretations of phenomena not only happen in individuals’ minds, but are embedded and constructed within a social environment. This emphasis on social groups in developing and adjusting representations is an addition SRT offers to mental models. Moscovici (1988) pointed out that any information we receive, or any phenomenon we experience, happens in a social context. The people around us influence how we interpret these phenomena and experiences. Similar to the social construction of landscapes (Greider & Garkovich, 1994), we construct shared meanings of the phenomena within those landscapes, such as landscape recovery.

As one might expect, revealing the socially constructed aspect of representations is rather difficult. Researchers generally use qualitative methods (usually interviews) to understand the meanings and representations of individuals and groups concerning a certain phenomenon, given the ability to probe and reveal the depth of how people understand or represent a phenomenon. The terms, concepts, and relationships that individuals use are often compared among groups of people to reveal the socially constructed nature of those representations. Groups often emerge logically (such as loggers, farmers, rural/urban residents, experts/non-experts, or recreationists), depending on the context and nature of the study. The key point is that each group most likely shares similar values to some extent, and thus the central core of a given representation will be
similar. The individuals within the group may differ more in terms of the peripheral elements that shape the representation, as well as the target of the objectification and anchoring process, but those differences are likely to be greater across different groups than within similar groups (Abric, 2001).

This social aspect of representations is particularly relevant in the context of forest disturbances because of the wide range of stakeholder groups with different values and meanings for the landscape affected by disturbance (e.g., land managers, community leaders, recreationists, outfitters, schools, farmers, or loggers), as well as different prior experiences with disturbances and recovery. Thus, identifying the different social groups in a given location, and exploring the representations of recovery within and between groups, can reveal shared and differing representations. Understanding the differences and similarities of perceptions of landscape recovery within and between stakeholder groups will be key for collaboratively managing the recovery landscape in the future. These efforts can direct managers and community leaders to the most important aspects of recovery for mitigating negative impacts from future disturbances, as well as minimizing conflict between different groups throughout the landscape recovery process.

4.3 Towards applying SRT and mental models traditions to understand perceptions of landscape recovery

The mental models and SRT traditions provide an organizing framework to structure the factors that affect perceptions of landscape recovery. Table 2.2 presents an initial summary of this application of mental models and social representations. A discussion of the table with examples follows.
Table 2.2 Definitions and applications of mental models and social representations to understand perceptions of landscape recovery

<table>
<thead>
<tr>
<th>Term/concept</th>
<th>Definition</th>
<th>Application</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mental models</strong></td>
<td>Mental models are simplifications people use to make sense of something new and/or complex. They describe and often illustrate visually how people make connections between different elements of a phenomenon, including stored knowledge, to understand it.</td>
<td>Mental models can be deconstructed to depict the connections between different elements that comprise people’s understanding of landscape recovery, including social and ecological aspects of how the disturbance acts as an ecological process.</td>
<td>Vegetation regeneration is likely an important aspect of a recovered landscape for some people. Their mental models of landscape recovery process may include connections between managerial actions (e.g., salvage logging) and ecological processes (e.g., regeneration). People may support post-disturbance salvage logging if they think it will lead to quicker regeneration, thus furthering the recovery process (Ryan &amp; Hanin, 2009).</td>
</tr>
<tr>
<td><strong>Social representations in SRT</strong></td>
<td>A representation is similar to a mental model, and the terms are used interchangeably here. SRT elaborates on the concept by describing the structural aspects (core and peripheral elements) and mechanistic processes (anchoring and objectification) that people use to create representations to understand a phenomenon. SRT also emphasizes the socio-cultural influences on representations.</td>
<td>Examining the structural and mechanistic properties of representations of recovery reveals how they develop and how they vary across social groups.</td>
<td>The factors from Table 2.1 will be important aspects of the structure of representations, as well as the processes that develop the representation. Representations of landscape recovery may vary between social groups, depending on factors like connections to the landscape, resource dependency, and previous experiences with disturbances (e.g., amenity-based 2nd home owners vs. multi-generational landowners dependent on the landscape for resource utilization).</td>
</tr>
<tr>
<td><strong>Mechanistic considerations in SRT</strong></td>
<td><strong>Anchoring</strong> Anchoring describes how new ideas are associated with existing concepts understood by the person or group. Anchoring often entails the use of metaphors or general attributes from related abstract concepts. The process likely reflects the central core of the representations.</td>
<td>Anchors provide the basis upon which the factors suggested in Table 2.1 broadly influence perceptions of recovery. They will generally reflect the nature of the central core, such as more abstract beliefs related to natural disturbances. The level of abstraction may vary.</td>
<td>Anchoring invokes metaphors like the balance of nature to help explain recovery. People with more personal experience with disturbances and recovery will anchor perceptions of current recovery in abstractions developed through those experiences and resulting beliefs about the recovery process. Others will rely on beliefs about the recovery process related to well-known events (e.g., 1988 Yellowstone fires) to help them understand recovery. An example of an abstraction could be references to a fire ‘cleaning’ up the forest.</td>
</tr>
<tr>
<td></td>
<td><strong>Objectification</strong> Objectification is a cognitive process that translates the more abstract</td>
<td>The factors presented in Table 2.1 are important in the objectification</td>
<td>Visual cues will be an important element of the objectification process. References to them will</td>
</tr>
</tbody>
</table>
concepts associated with the anchor to tangible objects to help the person make sense of the new situation. Filtering occurs through selection so that only the elements of the representation most relevant to the values of the group are used to construct the overall representation. Reflect the peripheral elements, like specific values towards the landscape. For example, a homeowner who values scenic aspects of the landscape might consider a landscape recovered when the visual aspects are acceptable. A logger might focus on when the timber quality is acceptable. Both representations could be anchored in beliefs about natural processes, but the logger objectifies natural processes by focusing on timber to explain recovery, whereas a homeowner might focus on vegetation density for privacy and wildlife habitat.

<table>
<thead>
<tr>
<th>Structural considerations in SRT</th>
<th>Central core</th>
<th>Peripheral elements</th>
</tr>
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<tbody>
<tr>
<td><strong>The central core</strong></td>
<td>The central core is the common foundation upon which all representations of a phenomenon or object exist within a social group, consisting of fewer, yet more stable, beliefs. The main functions of the central core are to provide meaning, organization, and stabilization to representations. Central core elements are generally expressed in an abstract fashion.</td>
<td>The factors presented in section 3 and Table 2.1 will be especially important as peripheral elements in shaping representations of landscape recovery uniquely based on the core. Peripheral elements are specific and contextualized values, beliefs, and experiences that help people interpret the different targets or objects in the objectification process. The core of people’s representations of the landscape recovery process may be based in abstract concepts like balance in nature, dynamic natural processes, and how people affect those processes through their interactions with the land. Representations of recovery, at the core, reflect general notions of natural processes.</td>
</tr>
<tr>
<td><strong>Peripheral elements</strong></td>
<td>The peripheral elements provide and account for flexibility among different representations based on context and heterogeneity of social groups. Peripheral elements express specific, concrete, and contextualized experiences and specific beliefs that are associated with the object of the representation. They are the evolving aspects of the representation and affect the adaptability of the representation.</td>
<td>Peripheral elements guide the interpretation of the targets in the objectification process. Specific values for the landscape, such as timber or scenic quality, affect how people interpret the more tangible aspects of recovery like vegetation impacts.</td>
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</table>
4.3.1 Mental models of landscape recovery

The mental models approach to understanding people’s perceptions of post-disturbance landscape recovery is most useful to visually display how people organize and connect different elements of the landscape and the disturbance to explain the landscape recovery process. A range of cognitive mapping techniques based on interviews or questionnaires could be used to illustrate the specific connections made between different factors when discussing landscape recovery. Researchers could compare mental models of the general public to those of experts to identify key differences or misperceptions. For example, Figures 2.5 and 2.6 show a hypothetical mental model of the post-wildfire landscape recovery process for non-experts (i.e., the general public) and experts, respectively.

**Figure 2.5 Hypothetical non-expert mental model of post-fire recovery**

In the public mental model, the wildfire leads to ecological impacts, such as charred and dead trees. Many people, especially those with less experience with wildfire, believe that all burned trees die in a fire (Brunson & Shindler, 2004). Much of the public will support salvage logging to remove the dead trees for economic purposes, as well as ecological purposes (Ryan & Hamin, 2009). The ecological reasons for supporting salvage logging derive from a belief that removing the dead trees will lead to more sunlight and water, enabling vegetation to regrow (Kooistra & Hall, 2014; Olsen & Shindler, 2010; Ryan & Hamin, 2008; Toman, Shindler, Absher, & McCaffrey, 2008).
As vegetation returns, people will likely consider the landscape to be recovering from the fire.

**Figure 2.6** Hypothetical expert mental model of post-fire recovery

The expert mental model (Figure 2.6) features more connections between different parts of the process, including visible aspects and aspects not visible to the naked eye. Experts are likely to characterize the ecological impacts from the fire based on concepts like fire intensity (i.e., energy output from the fire) and fire severity (i.e., impacts to organic matter above and below ground) (Keeley, 2009). Common ecological elements impacted by the fire that researchers investigate typically include soils, seed sources, and vegetation. Soil impacts include creation of hydrophobic soils that repel water, inhibit vegetation growth, and lead to significant erosion problems, or other impacts to the soil’s nutrient properties; however, soil productivity can also benefit from fires through nutrient cycling processes (DeBano, 2000; Moody, Shakesby, Robichaud, Cannon, & Martin, 2013; Quintero-Gradilla et al., 2015). Experts will recognize that, depending on factors such as fire history and fire intensity, some vegetation will survive the fire, some seeds will be consumed in the fire, and other seeds will germinate and take hold if soil and water conditions allow (Schoennagel, Turner, & Romme, 2003; Verkaik
& Espelta, 2006). They also see the dead vegetation as a future source of nutrients (through decomposition) and a necessary component of bird habitat (especially tree snags). Furthermore, they may include a range of management activities, including no action, salvage logging, erosion control, and planting native seeds and trees. They recognize that the type and extent of management actions will influence the post-fire vegetation composition and distribution by affecting the availability of sunlight, water, and nutrients (Lentile et al., 2007; Morgan et al., 2015). The presence of native vs. invasive species of vegetation will be especially important in determining recovery, especially through impacts to wildlife habitat and key soil and hydrological cycles.

The point here is that mental model illustrations help identify connections people make between different elements of the landscape recovery process. Non-experts with more knowledge about the disturbance and recovery process will have mental models more similar to experts than those with less developed knowledge. Extracting mental models helps managers target any misperceptions among the public, such as that all trees will die in wildfires, which could affect attitudes towards future management options.

4.3.2 Social representations of landscape recovery

SRT furthers the understanding of the structural and mechanistic aspects of people’s mental models of disturbances. Using the same example of wildfires, SRT can be applied, typically using in-depth interviews or focus groups, to interpret the mental models more thoroughly. Specifically, SRT helps to understand the meanings underlying the mental models, how the mental models develop, and why they may differ among different social groups. Keeping in line with SRT, this illustration will focus on different social groups, instead of highlighting differences between the general public and technical experts. The factors identified in Section 3 are especially important for exploring people’s representations of disturbances. Figure 2.7 shows the general organization of the key structural and mechanistic aspects of representations in a hypothetical example.
The central core of people’s representations is abstract and broad in nature. In the case of wildfires, a natural process, the central core of representations of recovery is likely to reflect broader worldviews about the importance of natural processes (Hull et al., 2003; Pyne, 1997). People generally recognize wildfire as a natural process and will therefore see the recovery process as largely a natural phenomenon (McCaffrey & Olsen, 2012). This core is posited to be shared across social groups, such as ranchers, recreationists, and seasonal residents. Specific or unique representations of landscape recovery may begin to emerge during the anchoring process. Although the anchoring process reflects the central core, it also begins to highlight key differences among different social groups and individuals, largely due to the role of peripheral elements.

Beliefs about the ecological role of fire play a key role in people’s representations of landscape recovery. To understand the ecological role of fire and the recovery process, people often reference previous fires they have experienced, or well-known fire events, such as the 1988 Yellowstone fires, and how the landscape has recovered since those fires (Paveglio, Carroll, Absher, & Robinson, 2010). Having seen or learned about the recovery process in those fires shapes their beliefs about the recovery process for the
current fire. That is, they anchor their understanding of the recovery process in their previous experiences and general beliefs about the ecological role of fire. Some people will explain the process in more detail based on their levels of previous knowledge, such as the relationship between fire intensity and severity, ecological impacts, and post-fire vegetation regrowth. Others will express a more basic and abstract relationship between the fire and impacts, due to different beliefs or less developed understanding of the relationship between fire severity and impacts (e.g., all vegetation dies).

Objectification takes different forms for different individuals and groups to make their beliefs more concrete and tangible. Visual aspects of the landscape, as well as one’s values for the landscape, are important in the objectification process (Anderson et al., 2013; Buijs et al., 2008). People who primarily value the aesthetic aspects of the landscape, such as vegetation density, composition, and appearance, will use objects like trees and other vegetation to explain recovery (Islas & Vergara, 2012). Others may focus on the emotional meanings and memories associated with the landscape; restoring those meanings will be an important part of a recovered landscape. People who value other elements more than the aesthetic aspects, like range or timber, are likely to focus on those aspects to discuss a recovered landscape, including the ecological processes (e.g., nutrient cycling) that influence them (Lewis, 2008; Sieber et al., 2011).

The degree to which people focus on aesthetic or scenic aspects versus more complex underlying ecological processes will depend on their ecological knowledge as well as their values for the landscape (i.e., peripheral elements). People who place more value on natural processes than other aspects will likely consider a landscape as recovering when natural processes like vegetation regeneration and key soil and hydrological cycles are functioning according to the parameters of that particular ecosystem. Their values and connections to the landscape will also direct the objectification process by highlighting the specific landscape elements most important to them for the landscape to be considered recovered (e.g., forage quality or scenic quality). As described by Moscovici and other SRT scholars, representations are developed and reinforced through social interactions and discourse. People generally prefer to reinforce
their existing beliefs and values, and will thus selectively filter information about the recovery process that aligns with their current beliefs and representations. It is likely that people in a similar social group will share similar values, beliefs, and thus, representations of recovery to a greater extent than people in different social groups. Therefore, despite sharing a common central core centered on the idea of natural processes, the peripheral elements influence the anchoring and objectification processes that lead to unique representations of recovery across different groups.

5. A spectrum of perceptions of post-disturbance landscape recovery

In this section we present a spectrum that integrates the factors from Section 3, and key concepts from mental models theory and social representations theory to illustrate the range of perceptions to be expected across a population (Table 2.3). We focus on representations because the mental models components are embedded throughout the spectrum within the connections that people make between different landscape elements and previous knowledge about disturbances and recovery. The two columns represent endpoints of the spectrum; moving from left to right, people’s perceptions become increasingly developed or complex, indicating that more factors are affecting perceptions and/or more interactions between those factors are occurring to influence perceptions. Simpler representations are based primarily on visible features and aesthetic judgments, whereas more complex representations are based on deeper understandings of ecological processes and functions. An individual could, of course, fall at any point along the spectrum depending on the salience of the different influencing factors (Table 2.1) and cognitive processes (Table 2.2).

Researchers use the concept of integrative complexity to describe the complexity of the structure of someone’s thoughts or perceptions in terms of differentiation (the range of factors considered in explaining a phenomenon) and integration (how well the relationships among the different factors are understood and articulated). In applications to wildfire, for example, higher levels of integrative complexity are associated with acknowledgement of different perspectives related to wildfire and its management (Burtz & Bright, 2014; Carroll & Bright, 2010). Mental models research illustrates this variation
in complexity of cognitive maps or models generated by experts and lay people (Lazo et al., 1999; Zaksek & Arvai, 2004). Thus, people who have more experience with disturbances, and more beliefs about the different social and ecological factors that affect recovery, should have more complex representations about landscape recovery.

The far left of the spectrum depicts perceptions based primarily on the immediately visible features of the landscape, including aesthetic evaluations of those visible features. If people see a landscape in passing and have no local meanings and no real understanding of ecosystem processes, then their perceptions are almost exclusively a function of scenic qualities. Further to the right are people who live near the disturbed landscape, value its aesthetic aspects and have meanings connected to those aspects, but who have limited past experience and knowledge about disturbances and landscape recovery. At the farthest right will be those who have experienced or studied ecosystem change, who have more past experiences with disturbances. Their representations of recovery are the most complex because they involve more peripheral elements to explain the ecological role of disturbances in the landscape. They are also more likely to understand the different factors and complex relationships between them that uniquely affect the recovery trajectory. In other words, they may see the landscape as dynamic and be willing to accept a range of management activities that support that dynamic nature, instead of seeking a static endpoint.

The next section describes a research agenda to further our understanding of the relationships and propositions presented throughout this paper.
Table 2.3 A proposed spectrum to characterize people’s perceptions of post-disturbance landscape recovery

<table>
<thead>
<tr>
<th>Factor</th>
<th>Aesthetics emphasis</th>
<th>Ecological emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complexity of perceptions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Aesthetics emphasis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ecological emphasis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Factor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Automatic reactions</strong></td>
<td>Evolutionarily important elements of the landscape (large trees, herbaceous, smooth groundcover, open mid-story canopy, and vistas with distant views and high topographic relief) are primary considerations.</td>
<td>Automatic focus on evolutionarily important elements may be overridden by other factors like beliefs about ecological processes and previous experiences.</td>
</tr>
<tr>
<td><strong>Connections to the landscape</strong></td>
<td>People who primarily value the aesthetic aspects of the landscape, such as vegetation density, composition, and appearance, will use objects like trees and other vegetation to evaluate recovery.</td>
<td>People who value other elements more than the aesthetic aspects, like range or timber, may focus on those aspects to discuss a recovered landscape, including the ecological processes (e.g., nutrient cycling) that influence them.</td>
</tr>
<tr>
<td><strong>Beliefs about ecological processes</strong></td>
<td>Beliefs about disturbances and factors that affect recovery process are relatively simple (i.e., less understanding about the connections between different ecological elements that affect recovery).</td>
<td>More developed and complex beliefs about disturbances and interactions between the factors that affect the recovery process, including a relatively sophisticated understanding of the less visible aspects (like nutrient cycling)</td>
</tr>
<tr>
<td><strong>Past experiences</strong></td>
<td>Limited past experience with disturbance and landscape recovery process.</td>
<td>Many experiences with past disturbances and landscape recovery processes, which inform the objectification process for understanding future recovery processes</td>
</tr>
<tr>
<td><strong>SRT constructs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Central Core</strong></td>
<td>Central core revolves around notion of nature or natural processes</td>
<td>Central core revolves around notion of nature or natural processes</td>
</tr>
<tr>
<td><strong>Anchoring</strong></td>
<td>Anchoring is informed by limited past experiences and simplistic beliefs about the ecological role of disturbances and the recovery process</td>
<td>Anchoring is informed by many past experiences with disturbances and more developed beliefs about the ecological role of disturbance and the recovery process</td>
</tr>
<tr>
<td><strong>Peripheral elements and objectification</strong></td>
<td>Visual cues are especially important to objectification (e.g., scenic beauty or specific elements like flowers, birds, and vegetation color) and are interpreted through peripheral elements characterized by the importance of aesthetic factors as reasons for living in the area.</td>
<td>Visual cues are important to perceptions of recovery as potential objectification targets, interpreted through the peripheral elements, but not as important as other aspects like timber or range quality and the ecological processes that affect those aspects and depend on disturbances.</td>
</tr>
<tr>
<td><strong>Defining a recovered landscape</strong></td>
<td>A recovered landscape is relatively static and resembles pre-disturbance conditions; evaluations focus on preferred visual and scenic elements.</td>
<td>A recovered landscape is dynamic and includes natural features and ecological processes functioning within a normal range of variability, which includes periodic disturbances</td>
</tr>
</tbody>
</table>
6. Research agenda

Research is needed to explore and test the hypotheses embedded in the spectrum we proposed (Table 2.3). One important aspect of further research is to explore the stability of one’s perceptions and factors that may affect one’s movement across the spectrum. Not only do the biophysical conditions of the landscape change over the recovery process, but so do the social dimensions (Stidham, Olsen, Toman, Frederick, McCaffrey, & Shindler, 2014). Specifically, the factors that affect perceptions of recovery (Table 2.1) may also change over time for any given individual, which could lead to changes in how the process is perceived. For example, repeated disturbances not only affect the recovery process, but also mean a person may develop more experience and a better understanding of the disturbance and recovery process over time, causing that person to move towards the right side. Another person may relocate after a disturbance because of negative visual impacts and would then have a less rich experience with the recovering landscape, which could lead to more static perceptions of recovery and no shift across the spectrum. There is very little longitudinal research on how individuals’ perceptions change over time. We would expect that individuals would move from left to right -- depending on experience, social learning, and other factors discussed in this paper -- but that remains to be empirically established. Conversely, we think it is unlikely that one would move from right to left.

Longitudinal research should also investigate perceptions of recovery at different temporal and spatial scales. Some people’s perceptions of landscape recovery may focus on specific locations in a landscape, while others may be based on larger landscapes (e.g., a mountain range or watershed) (Cacciapaglia, Yung, & Patterson, 2012; Mitchell, Force, Carroll, & McLaughlin, 1993; Ryan & Hamin, 2008). Knowing how important specific sites are will help ensure consideration of the appropriate scales and spaces in planning efforts.

Furthermore, biophysical conditions will change over time in the recovery process. Repeated investigations in the same communities will provide insights into relationships between observed and perceived changes in the landscape. These
investigations could be fruitfully informed through interdisciplinary efforts that combine on-the-ground field measurements, remotely sensed data, and social. Characterizing the recovery trajectory using on-the-ground and remotely sensed measurements can help identify discrepancies between perceived and actual changes and trajectories (e.g., Kennedy et al., 2014; Mitchell & Yuan, 2010; White et al., 1996), which might inform educational programs and management actions to align perceptions with projected trajectories of change and mitigate unwanted trajectories. Using these different perspectives provides a more comprehensive understanding of landscape changes over time and the factors that influence perceptions of those changes, especially the interrelated nature of social and biophysical landscape considerations (Dennis et al., 2005; Jiang, 2003; Liverman, Moran, Rindfuss, & Stern, 1998).

The relationships between social and ecological aspects of disturbances and the recovery process could be a productive area of future research related to other important and related topics like biodiversity. For example, considerable efforts are placed into understanding ecological factors that influence biodiversity, especially in the context of disturbances (Loreau et al., 2001; Spies et al., 2012). Understanding people’s knowledge of biodiversity and their attitudes about management related to promoting or protecting species is also a focus of some social science research (Buijs et al., 2008; Escobar, 1998; Furze, Lacy, & Birckhead, 1996; McSweeney, 2005). The diversity of species in a landscape may be an important part of people’s perceptions of landscape recovery, especially if that is of particular value to an individual or group. This provides an opportunity to compare and integrate theories from social and ecological disciplines. For example, the Intermediate Disturbance Hypothesis suggests that, in some disturbance-dependent ecosystems, disturbances of moderate frequency and intensity will maximize the biodiversity in that landscape (Wilkinson, 1999). If people prefer more biodiversity, then managers could communicate the benefits of allowing or encouraging (i.e., not suppressing) some level of disturbance either through decreasing suppression efforts or increasing management-induced disturbance like prescribed burns (Drever et al., 2006). These efforts, along with other considerations like actively engaging the public and fostering a trusting relationship between the public and land managers, could lead to
more public support for disturbance-based management and promoting natural, dynamic systems (Olsen et al., 2012). This type of support could allow managers to let natural processes affect the recovery process in some areas, while focusing more intensive management efforts in other areas according to social and ecological managerial goals (Spies et al., 2012).

Different types of disturbances (e.g., wildfire or landslides) have different spatial extent, frequency, timing, and duration. The underlying processes of some disturbances are easier to understand than others, which may suggest that people have better understandings of the recovery process for some disturbances than others. This possibility is especially important given the likelihood of altered disturbance regimes and characteristics in the future. Researchers are beginning to explore the ecological aspects of landscape recovery after multiple disturbances in more detail (Agne, Woolley, & Fitzgerald, 2016; Bigler, Kulakowski, & Veblen, 2005; Harvey, Donato, Romme, & Turner, 2014). Research about the social dimensions of experiencing different types of disturbances should investigate which aspects of the disturbances and people’s experiences with them affect perceptions of recovery. Experiencing less frequent, yet extreme, disturbances may not result in more developed mental models about the role of disturbances in ecosystems (Weber & Stern, 2011). Infrequent extreme events may be seen less as natural processes and more as chance occurrences. On the other hand, repeated exposure may lead to more information seeking and more knowledge development. Thus, research should explore the extent to which perceptions of landscape recovery vary across different disturbances with different characteristics (i.e., frequency, intensity, and severity).

We have also highlighted a gap in the SRT literature that could be addressed in the context of landscape recovery. Research should empirically explore the relationships between the structural (i.e., central core and peripheral elements) and mechanistic (i.e., anchoring and objectification) aspects of people’s representations. We have posited such relationships in the context of landscape recovery in this paper. As discussed earlier, many studies that incorporate SRT focus on either the structural perspective or the
process perspective without linking the two. However, investigating them simultaneously can lead to a more comprehensive understanding of how a representation is formed and how it can change over time.

7. Management implications

Understanding the cognitive processes involved in perceptions of landscape recovery will help focus public communication strategies by land managers seeking to minimize negative impacts from disturbances. For example, where the content and structure of people’s representations of landscape recovery are due to social factors, like connections with the landscape, then communication and management efforts can focus on rebuilding and maintaining those connections. Alternatively, if the biophysical factors (e.g., processes like nutrient cycling) are more important to how people perceive recovery after wildfires, then communication and management efforts can focus on these factors. Mental models will reveal how people process information about landscape change, which social and biophysical factors influence perceptions of change, whether those perceptions are positive or negative, and where communication and management efforts should be focused to minimize negative social impacts from post-disturbance landscape changes.

Many resources are invested in restoring these landscapes to some desired condition, and on public lands it is imperative to incorporate public interests and concerns. In the context of landscape recovery, for example, if people expect a specific type of vegetation to return within a certain time after the disturbance, they may blame land managers if that does not happen. Land managers can help explain the factors that influence recovery trajectories, and they can engage the community in discussions about planting and seeding efforts that might lead to a certain type of recovered landscape. Using mental models and social representations traditions to elucidate and understand how people perceive recovery can ensure that managers address key misperceptions while tailoring messages according to different influential factors that affect perceptions. Understanding how these perceptions develop, such as through objectification and anchoring, helps managers predict -- to some degree -- how people might react to
different management actions that affect disturbance regimes and subsequent recovery trajectories.

8. Conclusion

Forest disturbances are an important part of social-ecological systems. Factors related to climate change and land management decisions are affecting the frequency, severity, and extent of disturbances, as well as the landscape recovery trajectory. Many factors affect the landscape recovery process, and public perceptions of the process have yet to be a focus of concerted research efforts. The framework discussed in this paper is an initial attempt to explore these important social dimensions of the landscape disturbance and recovery process. It sets the foundation for empirical research to validate and refine our understanding of how people perceive landscape recovery, as well as providing insights to guide land managers as they engage the public around disturbance management.
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Chapter 3. Applying Social Representations Theory to Understand Wildland-Urban Interface Residents’ Perceptions of Wildfire and Post-Wildfire Landscape Recovery

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Expected journal submission: Journal of Rural Studies, Rural Sociology, or Society and Natural Resources
1. Introduction

Wildfires are an important component of many ecosystems. As a natural disturbance, they affect the appearance, function, and composition of many landscapes. Complex interactions between pre-fire ecological conditions, shifting climatic conditions, and fire behavior could lead to novel ecological and biophysical responses from fires (Millar, Stephenson, & Stephens, 2007; Moritz, Hurteau, Suding, & D'Antonio, 2013; Sheehan, Bachelet, & Ferschweiler, 2015). Thus, changes to the landscape after the fire, referred throughout here as the post-wildfire landscape recovery trajectory, are dynamic and could represent an unfamiliar phenomenon to many people who live in the wildland-urban interface (WUI). Many WUI residents value certain landscape characteristics, such as the type and distribution of vegetation and associated amenities like scenic views and privacy. Wildfires can change these characteristics, which can have diverse effects on WUI residents. While research on post-fire landscape recovery tends to focus on changes in vegetation, soil conditions, and nutrient and hydrological cycles, much less is known about the social aspects. The research presented here applies social representations theory (SRT) to explore how different groups of WUI residents understand wildfires and the post-fire landscape recovery process. These insights will be useful for future efforts to integrate and balance ecological and social aspects of wildfire and forest management.

SRT uses the term representations to describe the cognitive process and structures involved in how individuals of different social groups use existing knowledge, beliefs, and other information to better understand an unfamiliar phenomenon (Moscovici, 1988, 2000). When faced with novel or unfamiliar phenomena, people seek to understand the situation in a way that helps inform their future decisions and actions. Applying SRT to understand perceptions of post-disturbance landscape recovery is appropriate, given that people will be faced with making sense of a changing landscape. Millions of dollars are spent each year on post-fire recovery and restoration efforts without a strong understanding of the public’s perceptions of recovery and attitudes about management. Understanding representations of recovery can help managers tailor their communication and management efforts to better include public interests and concerns.
Researchers have identified different categories, or archetypes, of WUI residents to help explain different motivations for living in the WUI, as well as varied responses to wildfire events and other forest management issues (Paveglio et al., 2015). Changes to important landscape characteristics from wildfires can negatively impact WUI residents, including their psychological well-being, motivations for living there or decisions to stay or relocate after a fire (Eisenman, McCaffrey, Donatello, & Marshal, 2015; Mockrin et al., 2015; Paveglio, Kooistra, Hall, & Pickering, 2016). Given the diverse characteristics, motivations, and values of WUI residents across the archetypes, it is important to understand similarities and differences in how they perceive these landscape changes over time. By exploring the development and structure of people’s understanding of wildfire and post-fire landscape recovery, managers can identify any misperceptions in people’s attitudes about fire and forest management.

The research presented here uses qualitative interviews with WUI residents in a rural Montana town two years after a significant fire to understand their perceptions of post-fire landscape recovery, the factors that influence those perceptions, and the implications of their perceptions for management. The following discusses the importance of considering post-fire landscape recovery among different WUI populations, and how applying SRT can help identify similarities and differences in representations of fire and recovery among different WUI archetypes.

2. Perceptions of landscape recovery in the context of increasing wildfire activity and expanding WUI populations

2.1 Increasing wildfire activity and WUI expansion

Wildfire activity in the U.S. is expected to increase, due largely to past suppression and projected climatic changes, and many future fires will occur in the WUI (Barbero et al., 2015; Donovan & Brown, 2007; Hessburg, Agee, & Franklin, 2003; Westerling, Hidalgo, Cayan, & Swetnam, 2006; Westerling et al., 2011; Wimberly & Liu, 2014). The WUI encompasses residences in areas with undeveloped wildlands (Radeloff et al., 2005; Stewart, Radeloff, Hammer, & Hawbaker, 2007). Nearly 10% of the conterminous land in the U.S. is classified as WUI, and it contains at least 44 million houses and 99 million people (Martinuzzi et al., 2015). These numbers are likely to
continue rising in the future (Theobald & Romme, 2007). People move to the WUI for reasons ranging from a desire to be near outdoor recreation to a preference for a rural lifestyle (Paveglio, Jakes, Carroll, & Williams, 2009; Paveglio et al., 2015).

Wildfires cause short- and long-term changes to aspects of landscapes that people value. These changes can impact WUI residents’ attitudes towards post-fire landscape management, as well as behaviors, including recreation activities and decisions of whether or not to relocate after experiencing a wildfire (Borrie, McCool, & Whitmore, 2006; Ryan & Hamin, 2009; Mockrin et al., 2015; Schroeder, & Schneider, 2010; Toman, Stidham, McCaffrey, & Shindler, 2013). Furthermore, the interaction between changing climate regimes and expanded WUI development is likely to lead to increased social and ecological risks from wildfires, including changes to many WUI landscapes (Liu et al., 2015). To enhance the resilience and adaptive capacity of WUI residents, it is imperative to understand how they respond to landscape changes over time from natural processes like wildfires (Moritz et al., 2014; Paveglio, Carroll, Jakes, & Prato, 2012; Smith et al., 2016; Spies et al., 2014). Land managers are faced with balancing a wide range of social and ecological values in their decisions. They are increasingly interested in developing communication and engagement strategies to explain the risks and benefits from wildfires, including the landscape recovery process, to help them achieve different objectives like biodiversity management by allowing natural processes like wildfires to occur (Spies et al., 2012).

The concept of post-fire landscape recovery reflects the dynamic relationship between social and ecological aspects of the WUI. It requires examining the different people in WUI and what changes to the landscape mean to them. Knowing which factors lead to negative social impacts from wildfires is important for managers to be able to anticipate, mitigate, and react to those impacts as effectively as possible. Examining perceptions of post-fire landscape recovery can help researchers, community leaders, and managers identify and address those factors to prevent further negative impacts.
2.2 WUI Archetypes

The WUI population is diverse, exhibiting a wide range of values for the landscape and expectations about forest and fire management in the surrounding ecosystem. Paveglio et al. (2015) developed a classification system of WUI communities and residents that describes four main “archetypes.” The archetypes are formalized suburban communities, amenity-based communities, rural lifestyle communities, and working landscape communities. Compared to the first two archetypes, the latter two archetypes are characterized by less formal community units (e.g., classifying a community based on a drainage as opposed to a formal, gated community or subdivision), less trust of the government, and fewer collaborations with land management agencies. They also have lower expectations of firefighting services (and/or higher expectations of personal responsibility), use informal communication networks, adopt few formal guidelines for fire mitigation efforts on private lands, prefer to do things themselves, have less financial resources, and have place attachment tied to rural nature or working the land. Individuals and communities across these four archetypes are likely to react differently to wildfires and post-fire landscape changes due to a range of factors discussed throughout this paper.

We begin to explore these differences in-depth by focusing on how WUI residents near Roundup, Montana, who can be classified by the rural lifestyle and working landscape archetypes, understand wildfire and the landscape recovery process. These two archetypes are described in more detail in the context of the study site in Section 4. This research adds to wildfire social science research by further exploring similarities and differences among different WUI residents when faced with changing ecological conditions.

2.3 Human dimensions of wildfire research and the post-fire landscape

A growing body of research shows that experiencing a fire can have a range of short- and long-term social impacts depending on characteristics of the individual and community (Daniel, Carroll, & Moseley, 2007; McCaffrey & Olsen, 2012; Toman, Stidham, McCaffrey, & Shindler, 2013). Some of these effects are directly related to
changes in the physical landscape from the fire. For example, recreation behavior may be impacted by post-wildfire landscape changes. In one study, visitors to a recently burned wilderness area characterized the landscape as intriguing (Schroeder & Schneider, 2010). This prompted them to explore the burned area, which led to realizations about the creative yet destructive force of wildfire. Ultimately, though, they spent less time in burned areas than unburned areas and preferred to camp in unburned areas. Brown et al. (2008) also documented reduced recreation levels after a wildfire in Oregon, though the reduction may have been more related to recent fee increases. Another study found similar use levels at a recreation site in a burned area compared to pre-fire levels, though the types of uses changed (e.g., equestrian use increased, while hiking use declined) (Borrie, McCool, & Whitmore, 2006). Another study used economic modelling techniques to predict the impact of fire on recreation, based on cost effectiveness and net benefits of recreating (Hesseln, Loomis, González-Cabán, & Alexander, 2003). The authors suggested that hikers and mountain bikers would visit burned areas less as they recover from wildfires, but that reactions might vary across different user types and different geographic areas. These studies suggest that post-fire landscape changes can affect people’s behaviors based on their perceptions and evaluations of those changes. However, further research is needed to understand which aspects of those landscape changes, and WUI residents themselves, are most important in affecting behaviors and attitudes towards forest and fire management.

Many WUI residents support post-fire management. Actions like erosion control, salvage logging, grass/shrub seeding, and tree planting are typically supported to some degree by most WUI residents if the actions are perceived to mitigate negative post-fire impacts like unwanted visual appearances, erosion, deteriorating water quality, and invasive species (Ryan & Hamin, 2009; Olsen & Shindler, 2010). People’s attitudes towards mitigation and restoration efforts following a disturbance are strongly influenced by perceptions of efficacy of those efforts and associated recovery trajectories. For example, Kneeshaw, Vaske, Bright, and Absher (2004) found that people were more likely to support the use of wildfire as a management tool to restore forest conditions and prevent excessive impacts if the recovery process was quick (no more than a few years);
however, they supported suppression if recovery time was expected to be longer than a few years.

People support actions they think will lead to recovered landscapes. However, little is known about exactly what conditions constitute a recovered landscape to different WUI residents. As discussed in section 3, aesthetic evaluations of visual features of the landscape are likely an important aspect of a recovered landscape. These features are often very important for many WUI residents, and considerable research has explored aesthetic preferences related to forest and fire management (Daniel, 2001; Islas & Vergas, 2012; Ryan, 2005; Taylor & Daniel, 1994). However, because aesthetic features are only partially linked to ecological composition, structure, and function, people’s perceptions may not reflect ecological considerations (Fry, Tveit, Ode, & Velarde, 2009; Gobster, Nassauer, Daniel, & Fry, 2007; Tveit, Ode, & Fry, 2006). Exploring people’s perceptions of landscape recovery from fires beyond strictly a visual perspective provides an opportunity to better understand what it will take to bring individuals and communities to a deeper understanding and appreciation of ecological processes that shape the landscapes on which we depend. Additionally, understanding how perceptions of landscape recovery are related to attitudes about fire and forest management can provide useful direction for engaging with community members in making land management decisions.

3. Applying SRT to understand representations of fire and post-fire landscape recovery

This section first presents an overview of SRT and how it applies to this research, followed by the factors most likely to influence perceptions of landscape recovery in the context of SRT.

3.1 Social Representations Theory

The concept of social representations, introduced by Moscovici (1984, 1988), was developed in the sociological and constructivist scholarly tradition to explain how people make sense of a new, unfamiliar phenomenon. A social representation is an organized set of information, beliefs, opinions, attitudes, and explanations about a phenomenon, which
is shared by social or cultural groups (Abric, 2001). I chose to use SRT, as opposed to related frameworks like Mental Models Theory, because of the added utility SRT provides in studying how people perceive and understand a new phenomenon. Specifically, it specifies mechanistic processes (anchoring and objectification) and structural elements (central core and peripheral elements) of people’s representations of a phenomenon. Mental models research is well-suited for illustrating the connections people make between different aspects of a phenomenon to make sense of it. SRT accomplishes this objective as well, but it places more emphasis on how perceptions or representations develop through anchoring and objectification. Furthermore, SRT’s acknowledgement of the role of social context is relevant in socially diverse areas like the WUI, because residents in different WUI archetypes may have different representations based on their backgrounds, knowledge and experience with fire, and reasons for living in the WUI. Comparing representations of different social groups, in this case WUI archetypes, provides key insights into how varying attitudes develop so that potential conflict can be addressed while considering how to manage a post-fire landscape to protect values important to different WUI archetypes. The following sections discuss the development and structure of representations.

3.1.1 Mechanisms for developing representations: Anchoring and objectification

SRT posits two primary mechanisms in the development of representations: anchoring and objectification. Moscovici (1988, 2000) used these terms to describe how new information is assimilated into current knowledge. These processes help explain how representations are shaped by different factors and can lead to divergence of representations between different social groups. Anchoring refers to how new ideas become associated with existing concepts understood by the person or group, as people categorize new information into pre-existing cognitive frameworks to make them more familiar (Breakwell, 2001). In other words, elements from current representations are used to help understand the new concept or phenomenon. Anchoring may entail the use of metaphors of related abstract concepts, for example anchoring a representation of biodiversity in the abstract concept of balance in nature (Buijs et al., 2008). Other anchors may be more specific. For example, a study about people’s representations of
biological invasions found that people who were unfamiliar with the phenomenon anchored their representations of biological invasions to the spread of a fungus (Selge & Fischer, 2011). At any level of specification, the anchoring process essentially involves using representations of other phenomena to create representations of the new phenomenon. In this sense, people may refer to other fires or other familiar natural disturbances to understand how the landscape recovers after wildfire. The anchoring process could also involve beliefs about how fire affects vegetation and soil, as well as other climatic and ecological factors that affect vegetation growth. That is, representations of landscape recovery could be anchored in beliefs about the ecological disturbances and how different landscape elements respond. Once the anchors are set, the objectification process uses these anchors to further specify people’s representations.

Objectification is a cognitive process that allows something abstract to become more concrete through specific examples or traits (Moliner & Abric, 2015). It allows the more abstract concepts associated with the anchor to be translated to tangible objects or beings, with which the person is already familiar, to help the person make sense of the new situation. Filtering occurs through perceptual selection so that only the elements of the representation most relevant to the values of the group are used to construct the overall representation. For example, Smith and Joffe (2013) found that many people used their understanding of the hole in the ozone layer to anchor their representations of climate change. The possible impacts of climate change were then made more concrete through objectification by linking the ozone hole (the anchor) to skin cancer and sunburn. In doing so, people transferred outcomes of ozone depletion to climate change. The phenomenon of climate change was thereby made concrete through objectifying its effects as tangible outcomes. In terms of landscape recovery, objectification is often likely to involve the visual, tangible aspects of the landscape (such as vegetation, line of sight, soil or erosion) that people use to describe and evaluate the recovery process (e.g., referring to an area burned by a wildfire as a moonscape). Understanding the objectification process may reveal key differences in the development of representations because objectification will depend on the values and other aspects most important to people, which likely vary across different WUI residents.
3.1.2 Structural considerations in social representations

Since the initial presentations of SRT by Moscovici, which focused on the mechanistic processes of anchoring and objectification to describe how representations develop, other scholars have contributed to the concept of representation structure. Jean-Claude Abric (2001) articulated the notion of “central core” and “peripheral elements” as the structural basis for representations that help explain the importance of their different cognitive elements. Representations can be thought of as having a hierarchical structure with a foundation of generally unchanging core ideas about a phenomenon shared by many people, to peripheral components that can vary across individuals or across contexts (Buijs et al., 2012). Abric (2001) contended that identifying the central core permits comparison among different representations, and the peripheral elements help understand how differences develop.

The main functions of the central core are to provide meaning, organization, and stabilization to representations (Abric, 2001; Moliner & Abric, 2015). It is the common foundation upon which all representations of a phenomenon exist among a social group. It is made up of a limited number of very general or abstract beliefs that are relatively stable over time. People from different social groups likely share similar central cores. By playing an organizational role, the central core determines the nature of the relationships among the other elements of the representation because these peripheral elements depend on the central core for meaning. Lastly, the central core ensures the stability of the overall representation because those core beliefs are commonly shared and reinforced within social groups. SRT assumes there will be strong resistance to change one’s core representation because of a desire to maintain social cohesion or status and fundamental values.

However, the peripheral elements are highly likely to vary across social groups and will lead to an overall different representation. Peripheral elements express more specific, concrete, and contextualized experiences that are associated with the representation (Abric, 2001). They connect the abstract central core to the specific phenomenon and ultimately shape the representation uniquely because they can vary
widely across different social groups. They involve the most accessible or tangible part of the representation. Peripheral elements are revealed when anchors become more concrete through the objectification process (Moliner & Abric, 2001). As new information enters into the periphery, it is evaluated in terms of its agreement with the central core and can be marginalized or reinterpreted to fit the overall representation. In this way, the peripheral elements are a defense mechanism for resisting change to the central core.

For example, in a study about representations of wolves, Figari and Skogen (2011) found that the central core of people’s representations of wolves consisted of general beliefs about the notion of wilderness, and the wolf symbolized wild or the wilderness, even for different social groups. Regardless of people’s overall representation of the wolf, one could define most representations as, at the core, being centered on the notion of wild. Divergence between social groups depended on the peripheral elements, in this case more specific beliefs based on the context within which the wolf occurs. Farmers and hunters saw nature or the environment for its sustained utilitarian purposes. But wolves crossed a symbolic boundary by being in the managed landscapes. For farmers, the wolves represented wild nature, but they saw their own landscapes as managed nature to be used for utilitarian purposes. Wolves did not belong in their managed landscapes because the landscape was not perceived as being wild and because the presence of wolves posed a possible threat to human safety and well-being. But for wolf supporters, wolves still belonged in the managed landscape because they are a natural part of all landscapes; people should learn to respect and tolerate wolves regardless of human management for utilitarian purposes. In this sense, the peripheral elements consisted of the different values, beliefs, and experiences people had towards wolves and the landscapes around them (i.e., the context), despite agreeing that, at the core, the wolf represented wildness. Different manifestations of these elements led to different evaluations of tangible outcomes, such as the potential threat to safety.

This example highlights the potential sources of conflict among different social groups stemming from unique representations based on different contexts, experiences, and underlying values and motivations. It illustrates the importance of understanding the
different peripheral elements of people’s representations of post-fire landscape recovery. If WUI residents have different representations of landscape recovery, conflicts could arise as these representations may lead to different attitudes about forest and fire management, like whether or not to use prescribed burns or mechanical thinning to mimic the natural effects of wildfire. While representations of landscape recovery are likely to reflect broader notions related to nature or natural processes, the peripheral elements are especially important to consider because they are likely to vary among WUI archetypes and this variation can lead to different representations of recovery. Different representations of recovery could lead to conflict in terms of different attitudes towards post-fire management based on perceptions of recovery. Identifying the peripheral elements most likely to influence recovery perceptions, especially uniquely among different archetypes, can help managers and leaders target those elements to shape management and communication strategies to minimize social conflict and find a balance between different landscape values and needs.

3.2 Contributions to SRT

Our study has important implications for SRT. Research that applies SRT rarely, if ever, explicitly considers both the procedural and structural aspects of representations simultaneously. This reflects the fact that those aspects were developed separately, with the structural aspect being postulated years after the initial development of SRT that focused on the procedural mechanisms of anchoring and objectification. Investigating both aspects in the same study helps reveal how structures and processes relate. For example, the anchoring process and the core structure both reflect broader abstractions or worldviews that people use to make general sense of a phenomenon. The anchors people use to understand something new probably connect the central core to peripheral elements through the objectification process. Objectification and peripheral elements involve specific, tangible aspects that shape representations at a finer scale, and usually highlight where conflicts among representations emerge. The objectification process selects targets or objects that best align with the peripheral elements most important to
that individual and/or group. We explore these relationships and discuss them using empirical research.

3.3 Factors that influence representations of recovery

This section describes the factors that we expect to influence people’s representations of post-wildfire landscape recovery. These are the contextual factors that will most likely vary among WUI archetypes to uniquely shape perceptions of recovery. Thus, they are hypothesized to influence the anchoring and objectification processes, as well as the peripheral elements in terms of representation structure.

Aesthetic values are often among the most important forest values for many people (Lim, Innes, & Sheppard, 2015). Negatively perceiving changes to the visual aspects of a landscape can affect attitudes about forest disturbance management (Brenkert-Smith, 2006; Nelson, Monroe, & Johnson, 2005; Ryan & Hamin, 2008, 2009). People generally prefer green, live trees as a perceived sign of a healthy forest and they do not like dead or downed trees, which can be seen as messy and an indication of an unhealthy forest (Hull, Robertson, & Kendra, 2001; Nassauer, 1995; Ryan, 2005). Indeed, many people live in the WUI for the scenic and visual elements, but also for considerations like privacy offered by the specific landscape features. The degree to which these features are affected by a fire and have the ability to rebound will likely influence people’s perceptions of recovery. The point is that the visual qualities, specifically aesthetic judgments of those qualities, are likely an important part of people’s perceptions of landscape recovery because those aspects are both important to many people and often affected by the disturbance. Thus, perceptions of the landscape as recovering may depend on evaluations of how the visual aspects of the landscape appear over time. Evaluations will vary to the extent that people expect a return of pre-disturbance conditions or when certain visible features move toward aesthetically preferred conditions.

Landscapes are places that have meanings for people. Those meanings represent connections based on emotional or cognitive processes, which are at their foundation developed and shared by socio-cultural groups (Greider & Garkovich, 1994; Tuan, 1977).
These connections are what researchers refer to as sense of place. Beyond visual cues and aesthetic features that may be present in any landscape, there are specific places to which people attach meaning based psychological and sociological processes (Cheng, Kruger, & Daniels, 2003). Changes to these places from disturbances may lead to a renegotiation of place, or place disruption (Philips & Stukes, 2003). For example, in the case of wildfires, the impact to trees and other vegetation in a special place can lead to a sense of loss if those elements were important aspects of one’s values for the landscape (Burns, Taylor, & Hogan, 2008; Kent et al., 2003; Reid & Beilin, 2015). Perceptions of landscape recovery are filtered through the values one holds for the affected landscape. The degree to which those values are perceived to be impacted by the wildfire will have an important bearing on perceptions of landscape recovery. In terms of SRT, those features important to one’s connection to a landscape could serve as targets in the process by which the abstract idea of recovery becomes objectified and attached to tangible elements of the landscape.

The third main category of factors most likely to affect perceptions of landscape recovery includes beliefs about the role of disturbances in the landscape. The degree to which people believe that wildfire is a natural, ecologically beneficial component of the landscape could serve as an anchor to further shape the objectification process (Buijs, 2009). For example, people with less developed knowledge about the ecological role of disturbances may focus on the most visibly salient aspects of the recovery process (such as burned trees, invasive species, or obstructed recreation access from fallen trees), while people with more developed knowledge may think about more ecological, but less visual elements (such as nutrient cycling or potential for regrowth).

Furthermore, one important source of knowledge is a person’s past experiences with a disturbance and the landscape recovery process. People who have experienced a disturbance tend to have more developed knowledge about the disturbance because they likely sought more information about it, engaged in discussions with other community members about it, and lived through it (Wagner, 2007; Gordon et al., 2013). These more developed beliefs, based on previous experiences, could shape expectations and
evaluations about the landscape recovery process. In terms of SRT, people with more experience and knowledge about the ecological role of a disturbance in the landscape will likely make more connections between different elements of the recovery process and rely on their experiences to inform the anchoring and objectification processes in SRT as they make sense of the recovery landscape.

3.4 Research questions for applying SRT to understand perceptions of landscape recovery

Based on the above review of the importance of landscape recovery perceptions, key constructs from SRT, and factors most likely to influence perceptions of recovery, the following questions guide this research effort:

- What are people’s representations of landscape recovery in two different WUI archetypes?
  - In terms of structural aspects of representations of landscape recovery, how is the central core of those representations characterized?
  - What are the peripheral elements that people use to connect the central core to the specific situation of landscape recovery in the study site?
  - What roles do the proposed factors (visual aspects of the landscape, individuals’ connections with the landscape, and one’s understanding of wildfire as an ecological component of the landscape) serve in the anchoring and objectification process?

4. Research methods

4.1 Study site selection and characteristics

The study site for this research is in central Montana in the Bull Mountains WUI near the town of Roundup, MT, in Musselshell County, approximately 50 miles north of Billings, MT. The primary focus of the research was on the landscape impacted by the 2012 lightning-ignited Dahl Fire that burned 22,000 acres in the Bull Mountains, including 73 homes and more than 200 outbuildings. It was contained in less than a week, but most movement and damage occurred in the first 48 hours after ignition. The fire was
characterized by fast moving, unpredictable flame fronts that generated significant heat energy; it was a stand replacing fire in most areas. Before the fire, much of the forest was more dense than usually found in this region because of fire suppression and lack of high quality timber sought by timber operations.

This site was selected for two primary reasons. First, the Bull Mountains are a fire-dependent landscape with a typical fire regime characterized by high frequency, low intensity fires. Preliminary analysis of wildfire records using the Monitoring Trends in Burn Severity (MTBS) data base, followed by contacting local officials, revealed a history of wildfires in the past several decades that exhibited a wide range of fire behavior, intensity, and severity. Past fire events range from a few thousand acres to more than 150,000 acres (see Appendix B for a map of five significant fires since 1984). Most importantly for this study, the landscape also exhibited a wide range of recovery trajectories after these fires. Some areas returned to pre-fire ecological conditions in terms of vegetation type and density, while others remained quite different. For example, in some areas, especially in drier areas with shallow, rocky soils that experienced high intensity fires, even decades after the fire only grasses and some shrubs had returned to what had been a ponderosa pine dominant mixed conifer forest before the fire. The difference in recovery trajectories presents an ideal situation to investigate the extent to which WUI residents recognize and understand these differences. Applying SRT can help reveal which characteristics of the recovery process are most important to shaping people’s representations of landscape recovery.

The other reason for selecting the Bull Mountains WUI is that we suspected its residents could be classified into different WUI resident archetypes whose experiences with wildfires varied. Whereas some WUI areas may fit well into a single archetype, preliminary analysis of census records and discussions with local officials indicated that Bull Mountain residents could be classified as representing one of two WUI archetypes: rural lifestyle (RL) WUI individuals and working landscape (WL) individuals. Residents classified in the working landscape archetype are primarily ranchers and foresters. Many of them are from families that have lived in the Bull Mountains and Roundup area for
several generations, and they comprised roughly one third of the residents in the study. As described by Paveglio et al. (2015), these are permanent residents who can be characterized as having place connections tied to working the land, more developed local ecological knowledge and ability to reduce fuels, high awareness of resource management issues, and informal social networks. Conversely, many of the RL residents moved to the Bull Mountains around or after the 1970s for reasons including the desire to live privately in a natural setting away from a major city. Sections of the Bull Mountains had been informally subdivided to accommodate these residents, many of whom are retired, work in town, or telecommute. There is no homeowner association, and development was mostly unregulated. Their connections to the landscape are tied to a sense of living in rural nature and wildlands. They generally have less extensive local ecological knowledge than WL residents, and they are mostly permanent residents.

It became clear early in the interviews that representations varied between the two archetypes. The different characteristics of residents in each archetype are discussed throughout the remainder of this paper in relation to SRT constructs and representations of post-fire landscape recovery.

The population of Musselshell County in 2010 was 4,538, with 1,788 in Roundup (US Census Bureau, 2010). Informal estimates suggest that approximately 300-500 people live in the Bull Mountains WUI itself. The mountain range is roughly 900 square miles (60 miles in length and 15 miles in width), or approximately 576,000 acres in size. The elevation in Roundup is 3,215 feet, while the highest peak in the Bull Mountains is 4,700 feet. The topography is characterized by rolling hills with moderate slopes mixed with some steeper coulees or drainages in certain areas.

The USGS GAP Analysis Program characterizes the Bull Mountains as predominantly Northwestern Great Plains – Black Hills Ponderosa Pine Woodland and Savanna, but the area also includes Northern Rocky Mountain Foothill Conifer Wooded Steppe, and Northwestern Great Plains Mixed Grass Prairie (US Geological Survey GAP, 2011). The dominant trees in the Bull Mountains are ponderosa pines (*Pinus ponderosa*), jack pines (*Pinus banksiana*), other conifers and junipers. Areas with less dense tree
canopy, or no trees, are dominated by mixed grasses (especially bunchgrasses), shrubs, and forbs. Bare soil is more prevalent in areas with rockier, drier soil, and extensive cattle grazing. The soils in the Bull Mountains vary with topography, but tend to be shallow, dry, and rocky. Musselshell County receives an average of 14 inches of rain per year and about 22 inches of snow (US Climate Data, 2015).

The majority of land in Musselshell County is privately owned, often consisting of entire sections of land and thousands of acres owned by a family or real estate investment group (Montana Cadastral, 2015). A few tracts of land are owned by the state and the Bureau of Land Management (BLM). The dominant land uses in Musselshell County are grazing, agriculture, timber, and mining. The town is named after a historic cattle roundup, and many residents pride themselves on the role ranching has played for many generations. Since the 1970s, many of the large tracts of private land in the Bull Mountains have been subdivided into parcels of 20 acres or less. These were mostly purchased by people from Billings and other more urban areas, attracted to the Bull Mountains for its privacy, topography, climate, scenic vistas, and vegetation. These residents are classified as representing the RL archetype.

4.2 Data Collection

Qualitative research methods were used to develop an in-depth understanding of people’s perceptions of landscape recovery and the factors most likely to influence those perceptions. Semi-structured in-person interviews were conducted in the summer of 2014 with residents in the Bull Mountains WUI. Purposive sampling with a maximum variation approach to selecting participants ensured that themes were explored broadly, and a review of interviews, as they occurred, ensured that theoretical saturation was reached (Boeije, 2002; Palys, 2008; Tongco, 2007). This approach ensured that themes within and across the two different WUI archetype groups, as well as individuals representing the range of the different factors (i.e., peripheral elements identified in Section 3), were thoroughly considered and explored. Specifically, residents from each archetype were interviewed until themes related to SRT constructs in terms of
representations of landscape recovery reached saturation. This led to a distribution of interviewees roughly proportionate to the two WUI archetypes.

Participant selection followed a logical path and was also assisted by referrals. We approached ranches and the one remaining timber mill to contact people in the WL archetype. The ranches are easy to identify because they are typically near the intersection of the forest and rangeland in the Bull Mountains. They are also considerably larger than the subdivided properties where RL residents live, which are typically smaller than a few acres in size. To contact RL residents, we initially used maps of the Dahl Fire to identify roads in burn perimeters. Then we used the phone book to identify and contact people who lived on those roads. Considering the minimal development in the Bull Mountains compared to other sites like in southern California, anyone who lived on a road that was in or near the Dahl Fire perimeter was closely familiar with the fire (i.e., the roads are not very extensive or long). We also drove through the burned areas and spoke to as many residents as we could locate. This latter approach was challenging because many of the homes within the burn perimeter were destroyed in the fire and many people had relocated to another part of the Bull Mountains, closer to town, or even to a different state. Once we contacted and interviewed residents from both archetypes, we asked them to recommend anyone else with whom we should speak who has similar or different perspectives than them regarding the Dahl Fire and post-fire landscape recovery. Across either archetype, every participant was very familiar with the 2012 Dahl Fire, as it burned on or very close to nearly every participant's property.

A total of 30 semi-structured interviews were conducted with 39 people (19 women and 20 men). Of the 30 interviews, 17 were with people classified in the rural landscape archetype and 10 in the working landscape archetype. The remaining three interviews were with a county assessor and two employees of a local branch of the U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) who were interviewed to verify social impacts of the fire (e.g., the number of residents who rebuild a home lost in the fire) and post-fire management actions like seeding and erosion.
control. Interview length averaged 40 minutes and ranged from 10 to 65 minutes. No one we asked for an interview refused to be interviewed.

Participants were asked the same questions in a similar order, with some variation depending on follow-up questions to responses. Questions reflected the focus of this research on how people understood post-fire landscape recovery as informed by SRT. First, we asked participants to describe how long they had lived in the Bull Mountains and the most important reasons for living there. This helped reveal the peripheral elements of representations because it led to people explaining their values for and connections to the landscape, including aesthetic considerations (e.g., preferring trees and privacy), as well as resource dependency like ranching. We then asked them to describe their experience with the Dahl Fire, which typically led to discussions about how it compared to other fires they had experienced, what they expected in terms of fire behavior, and impacts to the landscape. Then, we asked them to describe the role of fire in the Bull Mountains, how it compared to other areas like wilderness areas and national parks without people, and how future fires in the Bull Mountains should be managed (i.e., suppression vs. let burn). These last two sets of questions revealed the anchoring process and the central core of their representations of recovery, and sometimes of wildfire in general, because it illustrated people’s beliefs about the natural, ecological role of fire and how that related to people living among these types of natural disturbances and processes. We then asked directly what it meant for the landscape to be recovered from wildfire, or what it would take for the landscape to be considered recovered. Responses to this question were obviously important in understanding participants’ representations of recovery overall, but also illustrated the objectification process and the influence of the peripheral elements in that process, based on the different targets or objects they used to describe recovery.

To further explore people’s representations of landscape recovery, specifically the objectification process, we then used a simplified photo elicitation to encourage participants to clarify specific elements of a recovered landscape (Harper, 2002). We did this after talking about landscape impacts and recovery perceptions to minimize a
priming effect or bias due to the images. After taking more than 1,500 photos of different parts of the 2012 Dahl Fire burn area in 2013 and in 2014, as well as areas burned in previous fires, we consulted with a fire ecologist to select photos that illustrated the range of recovery trajectories for the Bull Mountains region (mixed conifer, ponderosa forests). We selected six photos (see Appendix C) identified with the letters A-F), printed them professionally on 8.5” x 11” paper and had them laminated. Two photos (A and B) from 2013 highlighted the dense pre-fire forest conditions, expansive tree mortality from the fire, bare ground, some early vegetation regrowth, and erosion issues. We asked if they noticed similar impacts and if they felt those impacts were typical from a fire in the area. The 2 photos (C and D) from 2014 showed varying degrees of recovery. These were not taken from the same places as the 2013 photos because they were selected to represent the range of recovery trajectories. One of these photos (C) showed an area with rather dense trees (all dead/burned from the fire) but with substantial vegetation growth in the understory, mostly clover or alfalfa. It had received minimal treatment before the fire. Photos A, B, and C highlighted the unnaturally dense pre-fire stand conditions due to decades of fire suppression. They reflected a low frequency, high intensity fire that resulted in complete vegetation mortality, unlike the typical fire regime/characteristics for the area. The other 2014 photo (D) showed an area that had been thinned before the fire specifically for fire mitigation purposes. It featured predominantly live, well-spaced trees and healthy but not overgrown grass. This picture was selected as a good example of how pre-fire mitigation tactics like thinning can lead to less tree mortality, reduce soil impacts, and enhance vegetation regeneration. The fire ecologist we consulted, as well as experts in the area, suggested that this photo best represented what they would consider a recovered landscape in this type of ecosystem because it mimicked natural, historical park-like conditions that reflected high frequency, low intensity fire.

Considering the saliency of the topic of wildfires in the Bull Mountains, we also wanted to discuss past fires in the area because they exhibited different recovery trajectories over longer periods of time than the two years after the Dahl Fire. We selected two photos taken in 2014 (E and F) from an area burned by the 1984 Hawk Creek Fire. One photo (E) showed a landscape that only had a few small live pine trees,
some bare ground, a mix of grass and shrubs, and some standing and fallen dead trees from the fire. This area was the result of a high severity fire that consumed the majority of the seed source for tree regeneration. It also had particularly rocky, shallow soils as it was near a crest in the Bull Mountains known as the divide. The other photo (F) showed an area where some trees had survived the 1984 fire, which led to visibly dense tree regrowth as of 2014 due to seed availability. This photo highlighted the effects of fire suppression because the dense stands are uncharacteristic an area that should have frequent fires.

The photos were not the focus of the interviews, but helped guide the conversation particularly in terms of which features of the landscape were important to the respondent’s representation of landscape recovery. The photos particularly helped illustrate the objectification process because people could discuss specific elements of the landscape, such as bare soil, erosion, dead trees, grass, weeds, and range quality.

4.3 Data analysis

Interviews were digitally recorded and then transcribed verbatim. They were analyzed through a process of open and axial coding to identify themes related to the research questions (Ryan & Bernard, 2003). The codebook (see Appendix D) was initially developed by identifying broad themes from summaries of each interview, then further refined using the verbatim text to expand and specify different themes as they emerged (MacQueen, McLellan, Kay, & Milstein, 2002; Ryan & Bernard, 2003). Iterations of coding were conducted until an acceptable level of reliability (Cohen’s Kappa > .80) was reached (Krippendorff, 2004; Kurasaki, 2000). Three people helped in this process. All interviews were then coded using NVIVO software to select and organize thematic elements across the interviews. We looked for any common, underlying themes or concepts across all participants to identify the central core of representations of recovery (Moliner & Abric, 2015). These efforts focused on extracting the abstract elements of the interviews, as when people made general statements about nature. We continued to look at abstract notions and metaphors to identify the anchoring process. We paid special attention to any mentions of the factors described in Section 3,
and how they influenced anchoring, objectification, and the peripheral elements. These factors were the aspects that were most likely to vary across different participants, especially in different archetypes. They also helped explain the connection between the central core and the peripheral elements, which were the specific and often tangible objects that people referenced when discussing landscape recovery (e.g., trees, grass, or scenic view). The photo elicitation process was particularly useful in identifying and describing the objectification process because it encouraged people to identify specific elements of the landscape that were important to their representations of recovery.

5. Results

This section first presents overall findings about participants’ representations of post-fire landscape recovery, followed by a more detailed presentation of those findings in terms of SRT constructs. Direct quotes from participants are included throughout in italics. Following each quotation in parentheses is a reference number to identify first the interviewee (1-39), then the gender of the participant, and lastly the archetype that best characterizes them (interviewee number; F= female or M = Male; WL = working landscape or RL = rural lifestyle). Figure 3.1 illustrates the social representations evident from the interviews in terms of SRT constructs and propositions. This figure is explained briefly next, and in more detail in the Discussion Section.

Generally, the central core of representations of recovery across residents in both archetypes was characterized by the concept of Mother Nature. However, respondents used beliefs about fire and ecological process to varying degrees to understand recovery. Peripheral elements consisting of variations in specific aspects of these beliefs, as well as different values for the landscape, filtered their interpretation of different landscape features used as targets in the objectification process to refine, contextualize, and specify their representations of recovery. These unique representations led to different attitudes about future forest and fire management.
The interviews revealed that many people had difficulty describing a recovered landscape. When asked to describe what it meant for the landscape to be recovered from the Dahl Fire, one respondent said, “I don’t know, it’s hard for me to define what recovered means. Putting it back the way it was before is not necessarily recovered. It’s just different” (1, M, RL). This sentiment was shared widely across participants and reflects the dynamic process of landscape recovery itself, as well as people’s representation of it. A recovered landscape means different things to different people, though some important similarities emerged.

The most salient similarity across participants was that vegetation changes over time were a predominant focus for people’s discussions about post-fire landscape recovery. The majority of respondents shared the sentiment that trees would “come back
by themselves” (26, M, WL), but “not in my lifetime” (2, M, RL). Another person said, “You’re not going to have trees come back for another 100 years, but they will come back” (14, F, RL). Others, especially those in the WL group, described the regeneration process in more detail. One rancher explained that “most of the seed lies dormant for years before anything comes up in the pines; cones and seeds are there, it’s just going to take time. Whenever they are ready to come out they will” (27, M, WL). Every respondent referred in some way to vegetation when discussing landscape recovery. Examining the more abstract aspects of those representations provided insights into the central core in terms of structure, and the anchoring process in terms of how the representations were developed. Findings related to those aspects are presented next, followed by the role of peripheral elements and objectification in further developing recovery representations based on more tangible aspects of landscape recovery.

5.1 A similar central core among different groups’ representations

Participants’ representations of the post-fire landscape recovery process, and wildfire in general, shared a common central core. Specifically, across both archetypes in this study, representations about post-fire landscape recovery were centered on the concept of “Mother Nature.” These representations were closely related to people’s beliefs about fire behavior and the broader role of fire in the landscape. They recognized that fire is a part of nature and not always controllable by people. Nearly every participant noted the uncontrollable behavior of the Dahl Fire. One person stated, “you always hear later on if they would have done this or that [to suppress the fire]. But when it’s said and done, it’s Mother Nature. We had wind, nobody was going to stop it” (13, F, RL). Fire is something that people cannot always control because it is a natural process dependent on many different factors. The core of people’s representation of landscape recovery reflected a similar sentiment; landscape recovery is a natural process that is not entirely controlled by people.

The majority of respondents understood that fire was a natural part of the landscape. Representations of landscape recovery were anchored in these beliefs about the natural role of fire in the landscape in terms of forest health:
I think it [wildfire] is a great thing. It’s Mother Nature’s way of cleaning [the forest] out. The areas that have not had fires or have not been logged, the forest there is in poor condition. To keep a healthy forest, you either need to log it or have a fire. (29, M, WL)

Honestly, it’s Mother Nature doing her thing. We just happen to be in her path, you know. Getting rid of a lot of dead [trees], there was a lot of dead through here. Laying on the ground everywhere. It’s sad that it happened, [but] at the same time it is what it is. (23, F, RL)

Respondents generally understood that fires serve important roles, which were characterized here broadly as helping rejuvenate and “clean” the forest from predominantly dense, overgrown vegetation. Understanding the fire generally as a natural part of the landscape helped them interpret the impacts from the fire on the vegetation. Indeed, representations of the landscape recovery process are informed by perceptions of the impacts from the fire. One person referred directly to Mother Nature when discussing fire impacts and recovery:

Mother Nature in the raw can be pretty ugly. The first [heavy rain] that came down after the fire brought all the ash and black and crap. Then the next one that came through brought a lot of sticks, not big logs, down and it was muddier and a lot of silt, and the third gully wash, that one just cleaned it, took everything clear down and left the most horrendous mess up against the highway you ever saw. But it was, after that it was done it was kind of like Mother Nature knew, and how she cleaned that... Mother Nature cleans herself up in her own way, and now she’s letting things grow back, and the timing of moisture has been good. (9, F, RL)

This example illustrates the core of the speaker’s representation of recovery centered on the notion of Mother Nature, influenced by her beliefs about the role of fire and possible impacts, like runoff and erosion, in creating a healthier landscape. The post-fire impacts are an important part of the recovery process. Erosion and the subsequent runoff removed signs of the fire, like ash and sticks. The language she used to describe the impacts (e.g., ash, black, sticks, crap, mess) implies negative evaluations of them and she spoke positively of them being removed from the landscape through run-off events (e.g., “cleaning”). Part of the post-fire landscape recovery process involves getting rid of the mess left by the fire because the landscape needed it and nature took care of it.
Most participants noted that problems associated with erosion primarily occurred within the first year after the fire. Although it was still a concern two years after the fire, as it always is in steep, rocky areas like the Bull Mountains, unusual types of erosion were seen to have run their course in terms of post-fire effects. Excessive flooding in the first months after the fire was associated with erosion impacts:

*Right after the fire this road would flood, there would be a river going down here twice as wide as the road. But it’s much better now, look at how the vegetation has come back.* (3, M, RL)

For the most part, the erosion impacts from the fire were considered fairly well recovered. This evaluation was generally understood or explained by noticing vegetation regeneration, especially in areas prone to erosion:

*I don’t think there’s been hardly any erosion this year, there’s been enough grass and weeds and so forth that it’s been very limited and not a real issue.* (32, M, WL)

*Well, grass and stuff has come back. The trees [before the fire] actually slowed the moisture down and allowed it to soak into the soils. We need the trees in this country to act as a natural control for the erosion and for the water and stuff. It makes it [water] soak into the soil better.* (33, F, WL)

To explain recovery, people connected the erosion impacts from the fire to vegetation regrowth. Returning vegetation helped to mitigate erosion, which furthered the recovery process. The landscape would not be considered recovered until there were trees to help control erosion and improve soil retention.

In addition to erosion impacts, the effects of the fire directly on vegetation were an important part of representations of recovery. In other words, the characteristics of the fire itself affected representations of recovery. Many people connected recovery to the fire’s intensity and severity, noting how variable fire behavior had different effects on vegetation responses:

*The pattern of it moving was crazy… On the south side where it was scorched so bad, there’s some vegetation, but you can still see a lot of the bare ground. In other places, there’s still a lot of the growth coming back. I was surprised, considering as black as it was [after the fire].* (13, F, RL)
The Dahl Fire took the trees only if it was in a hot spot... Otherwise the trees will come back. (29, M, WL)

People recognized that landscape recovery was in part dependent on the variable impacts resulting from different fire characteristics. Hotter fires led to more severe impacts on the soil, which they believed slowed vegetation regrowth, based on their initial observations. However, their observations of vegetation growth two years after the fire helped them understand the variable relationship between fire behavior, impacts, and recovery. This couple’s discussion illustrates these beliefs and reflects an understanding of fire-adapted vegetation responses to fire:

When fire goes through open range without any trees it doesn’t burn as hot; therefore the ground doesn’t burn nearly as bad and it will recover a lot quicker (16, M, RL). Then it’s popping the seeds open and bringing back the natural grasses that are there (17, F, RL). It’s going to take time. I won’t see trees here, it’s going to take 25, 30 years. I am not going to see it (17, F, RL). It all depends on Mother Nature (16, M, RL).

These examples show that beliefs about the relationship between fire characteristics and ecological impacts influenced representations of how vegetation will recover and change. In other words, core representations of landscape recovery are anchored in beliefs about the relationship between fire characteristics and ecological impacts. People use their understanding of this relationship to describe the landscape recovery process.

The anchoring process also relied on beliefs about the historical use of fire by Native Americans. These anchors helped respondents understand the natural role of fire in the landscape, as well as the landscape recovery process:

Way back when, you can still see places when the Indians were travelling through here. They used to set the area on fire to keep grass going for their animals and whatever. Basically set fires going for the idea of burning everything off so the grass burns back, because the grass will come back. (11, M, RL)

They [Native Americans] would do controlled burns, where they burn out the understory so it allows new trees to come in. It also brings the grasses back for the grazing animals. The deer, the elk, and all that. (17, F, RL)

[Native Americans] had a time of the year that they called the replenishing time. They set fire to everything. (16, M, RL)
The Indians used to burn all this. For hundreds of years they burned it. That’s why they call it the Bull Mountains, there’s always bulls up there, bull elk and bull buffalo [to eat the grass]. They burned it. They burned it all the time. This always burned. (35, M, WL)

Participants used their knowledge of the historical role of fire in the Bull Mountains to understand the use and effects of fire on the landscape today. That is, their representations of recovery were anchored in their understandings of how the vegetation in the landscape responds to burning based on their knowledge about the historical use of fire in the landscape. Most interviewees focused on the anthropogenic use of fire in the past. However, fire was also perceived as a natural process leading to vegetation regeneration. A couple respondents, mostly in the WL archetype, referred specifically to fire as a natural cycle that was interrupted by western settlers. One multi-generational WL resident articulated this when shown the photo (D) of minimal mortality from the fire, well-spaced trees, and healthy grass:

That to me is paradise. I don’t know how anybody, whether you have an ag degree or a forestry degree, could look at that and say that you, you can’t get that any better. That’s very nice... I think the earliest pictures we have I think is 1909, looking at the ridge behind the house, and that’s what it looked like... It was before the homesteader period so it was burning on a natural cycle until the homesteaders came in. Then the homesteaders were like well we can’t, they couldn’t lose their grass for a year ‘cause there wasn’t enough. So they kept putting it out and pretty soon they put it out put it, then that fucking smoky the bear showed up. He put the last nail in the coffin. He bit us all in the ass, it was a terrible idea. Everybody should say, “save the forest” and throw a cigarette butt out. (36, M, WL)

These statements reflect the core of the speaker’s representation of recovery centered on the notion of Mother Nature, or maintaining natural conditions and practices. As discussed more in Section 5.2, this statement also demonstrates how valuing the landscape for its range and timber uses directed the objectification process to focus on landscape features (i.e., targets) related to these values. His representation was anchored in his beliefs about the importance of natural cycles. To him, the landscape in photo D was recovered because it reflected natural conditions, including signs of a recent fire (e.g., minimal understory growth and some char marks on trees) and tree density and spacing that matched his notion of a healthy landscape. Historical photos were part of the
anchoring process in shaping beliefs about what the fire-dependent landscape looked like when it still experienced somewhat regular fire activity. Indeed, other respondents noted seeing similar photographs or hearing stories that led them to believe that fire had always been a part of the landscape, especially before European settlers:

*I met a guy once, his great granddad homesteaded this area. This is way back in the century when he came up here. He told me that his granddad told him that there wasn’t hardly a tree in these Bull Mountains because the Indians burned it off. Every time they leave they set a fire to it, because they knew it would be better next year with new growth and stuff. He said there was hardly a pine tree up here, but when the white man settled they quit burning and the pine trees kept growing, and you look around, so these pine trees are so thick, you know where it had never burned, it was so thick, choked all the grass and everything out. (27, M, WL)*

*I’ve seen old photographs of the Bull Mountains taken back in the teens and there were no trees, very few trees. The Indians would come in here, set fire to it, to move the elk, the bison, whatever. And they would burn it off. And the grass would come back in time, and the elk and the trees would start again. That’s nature. And when people built homes in those days they built them out here in the open where they could fight [fire]. I love trees, they’re nice to have around. But pine trees burn really easy. (34, F, WL)*

Regardless of whether or not they referenced natural fire or anthropogenic fire, nearly everyone recognized that fire was “part of the scheme of things until [white] people moved up here and made it their back yard” (1, M, RL). Although the presence of people changed the frequency of fires in the area, fire was still recognized as something that shapes the landscape and the post-fire recovery process was considered a natural phenomenon. They recognized that “when you’re in an areas like this, you’re never out of fire country” (26, M, WL) and “it’s [fire] supposed to be here” (35, M, WL). Their representations of landscape recovery are anchored in beliefs that fires are a part of the landscape and have been used for centuries to maintain healthy ecosystems. Through stories passed on to them, and seeing pictures, they believed that there are too many trees in the landscape due to past fire suppression. Part of a recovered landscape therefore meant restoring conditions that match their understanding of how the landscape should look and function. In this case, those conditions are a result of fire.
Another common type of anchor that shaped representations of recovery was specific fire events or other disturbances. One person explained that he “would expect to see [dead trees and charred ground] because I went through Yellowstone one time right after a fire down there and it was on both sides of the road. It was just like black, black like Mt. Saint Helens, [but] trees weren’t tipped over” (3, M, RL). He used his personal experience and understanding of other disturbances to help develop his representation of the impacts from the Dahl Fire. Many people referenced the 1988 fires in Yellowstone National Park; when discussing landscape recovery, they anchored their representations in beliefs that had been shaped seeing or hearing about the trajectory after other fires:

*I know they’ve come down with the policy, and they’ve done this with the park [Yellowstone] because of the fire in ‘88, let it burn, and they’re doing that to rejuvenate the forest. I can understand them doing that, I can see it’s beneficial especially if nobody lives around it or can be affected by it. I can see the point of it. It’s done wonders in the park where they had the fire... It’s healthier for the forest. The forest is heathy and the animals are going to be healthier.* (11, M, RL)

*I was talking to some guys at a wedding reception just after the fire in ‘88 had got going pretty good in Yellowstone. They said they didn’t know the last time it burned, but it’s gonna make quite a scar in there probably. I says, any damn fool knows that it burned before. They thought I was the dumbest bastard to think Yellowstone Park burned before. You know it had too, holy Christ. Now they are waking up. Since ‘88 they are talking about how good it is now. I told them it will be back in 4 or 5 years, there will be trees out there, I’ll bet you 2 to 3 feet tall. Well, they are thicker than thick. Well the wildlife done better and the whole kabootle. (31, M, WL)*

*You drive through Yellowstone Park and you see the fires they had and it’s really growing back fast in a lot of it.* (1, M, RL)

These participants’ representations included the belief that fire creates healthier forest conditions, based on how they had seen other forests respond over time. Thus, an important aspect of recovering landscapes is if the landscape is perceived to be healthier after the fire.

People’s experience of past fires specifically in the Bull Mountains also played an important role in the anchoring process for their representations of landscape recovery.
when discussing the potential landscape recovery of the Dahl Fire. Many participants spontaneously referenced previous fires in terms of fire behavior and impacts:

*Everybody keeps telling me, “oh it’s going to come back, it will come back.” Not in our lifetime probably, but up on the top of the divide when the fire went through there in ‘84, there’s still no trees. It’s still barren. And you can still see the dead trees standing there. So everyone is trying to tell me they [the trees] will come back and I says, “oh maybe”... it’s just going to take time, a lot of time (23, F, RL)*

*The Hawk Creek Fire burnt pretty much everything. This [Dahl Fire] didn’t -- this left a lot of trees and left trees here and there. So no, it won’t quite look as bad. Pretty decent I think. (35, M, WL).*

*I think it [Dahl Fire landscape] will come back better [than the Hawk Creek Fire]. The reason I say that is because the wind was blowing and it blew through so fast I don’t think the whole ground was as hot. (5, F, RL)*

*There was a fire back in ’58 a couple years before we came, farther up here. I think that was a really hot, bad fire, and some of the trees have not returned to some of that area yet. It’s still bare. If you know what happened there you can see, yeah fire went through there and that was over 50 years ago. (34, F, WL)*

These examples show how respondents observed vegetation responses to varying fire intensities in the past and used those observations to infer how the Dahl Fire would (or would not) recover.

Respondents’ beliefs about the role of climate also shaped their representation of recovery as a long process dependent on climatic factors:

*Well it’s coming back and it’s [the forest] probably going to be thicker than fleas on a dog’s back in the end. If they get enough moisture and what not, that’s just nature. (34, F, WL)*

*I think, we’ve got more moisture this spring, so more grass coming back, of course all the dead trees out there, but that can’t last, it will rot off. (27, M, WL)*

*What happened to these trees is they were still green after the fire went through and they died from lack of moisture. It got so hot and it was so long before they got some moisture. If it would have gotten 2 or 3 inches of slow rain and really soaked that ground up there, those trees never would have died. It never did get any soil moisture built up, it was low anyway, subsurface moisture was short and we didn’t get rain. There was*
a lot of trees that died. There was also some that died later on from bugs. If it is reasonably wet, ponderosa will bleed out, if it has enough pitch, it will bleed out and the bugs won’t hardly kill it, you can’t punch enough holes to keep it from sealing itself up and surviving. Might set it back a little bit, but it will survive. (32, M, WL).

Nothing ever comes back. I mean this is called high plains desert, that’s what this area is. They don’t get a lot of moisture. Sometimes they get it in great big gobs all at once but it don’t do you any good, it runs off; goes right down to Musselshell River and out of here. So we don’t get much use of it, it runs away. So it’s, no it’s not like the Cabinet Mountains where they got trees... they call this a forest but this is, understory compared to the Cabinet Mountains or the Rocky Mountains. (16, M, RL)

Most participants felt forest recovery would follow a general trajectory if left unmanaged: another fire would come through and remove the standing and fallen dead timber, then vegetation would remain sparse until a seed source developed. 

Like on the Hawk Creek Fire, the trees fell down and it’s just slowly going through the natural process of rotting away. (33, F, WL)

We’ll just let nature take its course and it will eventually rot over time and we will have good grass and everything else. (22, F, RL).

The fire opened it up so you can see. It will give it more growing power. (19, F, RL).

As the above examples show, participants core representations of landscape recovery were centered on the idea of Mother Nature and natural processes. Beliefs about the historical role of fire in the area, and the influence of fire behavior and climatic factors, were developed from discussions with other people in the area, as well as their own observations and experiences. These beliefs were reflected in the anchoring process to understand landscape recovery from the 2012 Dahl Fire. That is, their beliefs were anchors to help them describe the recovery process with varying degrees of abstraction.

However, whereas the central core was fairly consistent across both archetypes, some differences in representations were identified by examining how different peripheral elements influenced the objectification process. The following section discusses these differences and other commonalities between archetypes related to the objectification process and peripheral elements.
5.2 Peripheral elements and objectification shape representations

Different objectification processes used by WL and RL residents showed that they valued different aspects of the landscape and that their specific beliefs about the importance of the ecological role of fire in the landscape varied. The landscape features that served as targets in the objectification process, like the grass, trees, or wildlife, were used to describe tangible aspects of landscape recovery to help connect the abstract anchoring process to more concrete aspects of recovery. Interpretation of these features were filtered through their values for the landscape and specific beliefs about the ecological importance of fire in the landscape. This led to different interpretations of recovery. These peripheral elements related to various landscape features were especially evident in discussions about post-fire management activities.

Overall, it was clear that people preferred removing the dead trees because it would help the landscape recover from the fire, specifically so that “new growth can start” (23, F, RL). As explained later, different values related to aesthetics and utilitarian purposes affected evaluations of this regrowth differently in the two archetypes. In terms of removing the dead trees, those trees and the resulting grass regrowth were landscape features or objects used in the objectification process. Interpretations of them reflected people’s representations as anchored in their beliefs about fire behavior. About half of the participants in either archetype mentioned that removing the dead trees would reduce the future fire hazard because the dead trees and accumulating grasses represented more fuel. One person articulated it this way:

*There is an overabundance of grass. Hopefully it don’t dry out and catch fire because these trees will go like match sticks then, you know, they are totally dry and then the ground will be totally torn to shreds, will be no roots rotting away down there or nothing, cause you know when they burn they even burn down the roots and go underground, take it all out (1, M, RL)*

He believed that accumulated fuels could lead to another fire and further landscape impacts, thus negatively affect the recovery process. The grasses, dead trees, and roots were specific targets that connected the Dahl Fire impacts to the landscape recovery process in terms of future fires. For many people, especially in the RL archetype, future
fire was not a positive aspect of a recovered or healthy landscape. When shown photo C of the Dahl Fire, and asked if it was healthy, another respondent said “No. Isn’t that a hazard if lightning strikes one of those dead trees that are all dried out? To me, that’s what I think” (5, F, RL). To her, a healthy landscape would not be susceptible to a wildfire. Removing the dead trees, which she did on her own property, is therefore an important part of post-fire landscape recovery because it reduces future fire potential. Thus, while vegetation returning to the landscape after the fire is an important part of landscape recovery, the possible risks associated with that vegetation also present concerns. In this case, the objectification process is influenced by the peripheral elements. People in the RL archetype honed in on the targets of dead trees and dry grass as targets to explain that another fire would cause more damage to the landscape and negatively affect the landscape recovery process, both ecologically and aesthetically. Even though fire and recovery are natural processes there, their concerns about safety and further negative impacts to the landscape lead to perceptions of recovery that depend on continued fire suppression. Several WL residents shared similar concern about future fires, but their concern was more related to the landscape values most important to them—the immediate loss of range production for their cattle. As discussed later, some WL ranchers were supportive of actively using prescribed fire several reasons, an attitude that was not shared by any RL residents.

The downed trees also presented hazards for cattle and horses traversing the range. This was particularly evident among WL residents because they travel through the landscape off roads or trails more than RL residents, whose properties tend to be much smaller. In this sense, part of a recovered landscape meant being able to safely use it again, either for recreational horse riding or grazing cattle. WL residents supported post-fire tree removal:

*It just makes a big mess when all those trees fall down. You can barely walk through it. When they start falling, and they will break off about half way. Then you got a big mess all around for years and years.* (35, M, WL)

*What’s going to be bad now is these trees will take a number of years to fall and most will fall, there will be a few dead snags left up there. And it makes it tough to travel through.* (29, M, WL)
It’s going to come back anyway... I’d rather see it burn up completely, not leave a bunch of dead trees. We ride in the hills all the time, we raise horses here and train colts and stuff. We were riding one day and we missed it by about 2 seconds, pretty good sized snag, my wife and I, fell right between us. (26, M, WL)

These examples illustrate the role of the peripheral elements (i.e., values for the landscape) in shaping representations of recovery. While the central core reflected the abstract notion of fire and landscape recovery as a natural process, people still preferred management intervention rather than letting nature take its course for reasons related to their values for using the landscape. A recovered landscape was one that they could use safely for recreation or extraction purposes, as well as to enjoy visually.

The visible reminders of the fire triggered negative emotional responses for a couple participants in either archetype. They wanted the dead trees removed so they didn’t have to think about the fear and anxiety associated with evacuation and losing everything they owned. One person explained her support for removing the charred trees:

The [charred trees] invoke a memory that was not fun to go through. When we left I couldn’t get the pickup in gear, and all I saw was these little balls. The pine cones were exploding and hitting the truck. I wasn’t sure we were going to make it out of there. It petrified my granddaughter, so that’s not a good memory. It’s a reminder every day. (28, F, WL)

Her representation of a recovered landscape included removing reminders of the horrors associated with the fire, so she supported active removal of the dead, burned trees. Dead tree removal was connected to an emotional healing process and landscape recovery.

Aside from memories associated with directly experiencing the fire, the visual aspects of the Bull Mountains are important to residents, especially those in the RL archetype. The aesthetic values they have for the landscape served as filters for interpreting different landscape features or components, which tended to shape the representation of landscape recovery differently across the two archetypes. For RL residents, trees were a primary reason why they lived there, and so healthy trees were part of their representations of a recovered landscape. As one person noted, “I don’t want to live on a prairie, thank you. That’s why I moved here, because of the trees” (21, F, RL).
Another simply stated that she moved there “because I’m a tree person” (10, F, RL). Others in this group described the physical landscape in terms of scenic qualities and other benefits of trees:

We liked the hills and the trees and you know the seclusion, your trees kind of, you don’t see your neighbor that way and that’s what we liked... it was flat in Texas and a fast pace. We didn’t want that for the kids so we moved up here, we had four kids and they’re all grown and married... stuck around, they liked it up here. (15, F, RL)

I’m a hermit... I like the Bull Mountains and that’s what drew me to here. The community is ok, I’m just not a fan of a lot of people. My husband lives in Billings and it’s just nice to have a place to get away from everything... It was just when I saw it I knew it was mine. I had to have it. It was one of those you just knew you had to have it, just so many trees, it was beautiful. (23, F, RL)

These strong connections to the physical aspects of the landscape affected by the Dahl Fire were important peripheral elements that shaped representations of landscape recovery. Emotional responses from several RL residents illustrated the impact on these connections: “I don’t like the trees being burnt, it’s kind of depressing” (11, M, RL). The loss of trees was perceived as a major impact of the fire because it affected their values towards the landscape, such as privacy or seclusion. “This was a pretty nice little hiding hole when we bought it, you didn’t hear traffic off the highway” (16, M, RL). Restoring these values for the landscape would be necessary for these people to consider the landscape as recovering from the fire. Accordingly, many people overwhelmingly favored active management to remove the dead trees because “until the dead trees are gone it still looks awful... It still looks awful. And those trees are not going to erode [decompose]. How long has it been since the Hawk Creek Fire, ’84? So it’s been 30 years and there’s still a lot of dead stuff out there. I’d like to see them plant some trees” (5, F, RL). With her representations of recovery from the Dahl Fire being anchored in her beliefs about landscape responses after previous fires, this speaker preferred active management to remove the dead trees to speed the process of recovery toward her preferred landscape.
The importance of trees was mentioned consistently by RL residents, but much less by WL residents. Trees affected by the fire were targets in the objectification process and interpreted through people’s connections to the landscape and emotional memories tied to experiencing the fire. The preference for trees, and the emotional aspects of losing them, were an important part of a recovered landscape to them. Removing the dead trees was part of the landscape recovery process because they preferred live trees.

For others in the RL archetype, representations of recovery focused on different objects or targets in the landscape, including the new vegetation growth, better views, and more sightings of birds and wildlife. They were more accepting of the landscape changes, and their responses indicated that they perceived the landscape as in the process of recovering:

*I just look at it like, the trees are gone, you start looking at other... the formation of the rocks and you just start looking for other beauty... This is still pretty in its own way.* (15, F, RL)

*Ecologically it’s really amazing because we’ve seen things that we’ve never seen before... like all this goldenrod. And oh jeez, the birds, first the cowbirds came in, then the woodpeckers, so we’re feeding them off the front porch, and then the pond down below filled up with geese and ducks.* (4, F, RL)

*If you’re going to stay here you’ve got to see the blessings from the fire... it’s still beautiful, you find other things to love... like this crazy alfalfa. It’s good for the soil. Vegetation is a big part of it, what we have for vegetation, to see the life and the growth around here. I don’t like the yellow clover but it’s good for the soil. When it dies it will go into the soil and be good soil, doesn’t always look good necessarily but it’s the best thing. And these birds... we’ve got four families, blue birds and wrens and swallows... whenever things green [after the fire]... they find that the grubs are good in the trees, the woodpeckers go for those big time, that’s why they moved on because they ran out of grubs... If [people] are here for the right reasons they’ll find things to love about it.* (3, M, RL)

For these residents in the examples above, their representations of landscape recovery were informed by a broader array of targets in the landscape that were important to them, beyond the appearance of the trees. However, they are similar to previous examples in so far as they focus on visual aspects of the landscape that are important reasons for living in
the Bull Mountains. Part of recovery is finding new aspects of the landscape to appreciate.

Representations of landscape recovery for residents in the WL archetype were less focused on the scenic or visual aspects of the landscape changes than the rural lifestyle residents, and more about the role of fire in maintaining healthy, productive range for cattle.

_The grass is actually better now than it was. You got rid of a bunch of little trees. Cows get in the pine needles and they abort. Now the bottoms are all burnt off, so that’s kind of a positive._ (24, M, WL)

_As far as impact on the ranch, at the time we thought it was the worst thing that ever happened, [but] 2 or 3 years later, we were very happy. It took the carrying capacity to 1.5 times as much as we carried before... Fires put in some nutrients into the ground so it just made the whole thing better._ (29, M, WL)

_We’ve never had what would be called a regeneration fire. This is our first one. So far it’s the absolute best thing that ever happened to us. It’s a whole new ranch as far as agriculture. The deer and the elk, too, because of the nitrogen in the soil that created those grasses, you can’t hardly keep animals out of there. It’s the most sought after place on this entire ranch. That whole ridge was nothing but weeds and now it’s bared off and running water out of the tops of the hills and the grass is five feet deep._ (36, M, WL)

These examples illustrate how interpretation of different objectification targets, especially the grass, is influenced by a different set of values for the landscape among WL residents. The targets used in their objectification process related to the quality of range for their cattle or of the timber for production, which reflects their utilitarian-based values for the landscape connected to their livelihood. The ability and necessity to earn income from the landscape led them to focus their representations of landscape recovery on objects or features on which their livelihood depends. One rancher stated succinctly that a recovered landscape was one with “_good, usable grass, sustainable, and still a stand of sustainable timber_” (30, M, WL). Another said that a recovered landscape is “_having the grass and you can use it_” (33, F, WL). This is not to say that the visual aspects of the landscape were not important to them. However, compared to RL residents, aspects of the landscape
related to their ability to earn a living were more influential in shaping their representations of recovery.

For example, one multi-generational landowner, who used his land for ranching and timber, but also appreciated the aesthetic aspects, referred to the photos used in the interviews to explain his understanding of a recovered landscape from multiple perspectives. Looking at photo E, from the 1984 Hawk Creek Fire showing minimal tree growth, but fairly open range, he said:

*From a ranching standpoint, there’s grass up in here, yes, it’s recovered. There is a few trees coming, it’s going to be another 10 or 15 years before you’re going to see many trees. From a ranching standpoint, yeah it’s recovered. From a scenic standpoint, no it hasn’t recovered and it’s going to take a lot of years. From ranching yeah, I like it, but from an owner of the land that wants multiple use out of it, I don’t, this isn’t recovered.* (29, M, WL)

But a landscape with too many trees was also not recovered. He referred to the other photo (F) from 30 years after the Hawk Creek Fire that showed dense regeneration of pine trees by saying:

*This one, from a ranching standpoint, is going to be problematic because you won’t have any grazing and you will have some fire danger coming and you don’t have any logging coming because it is too dense to grow big trees.* (29, M, WL)

When referring to photo D, he noted that “this is what I like to see because you got, from visual you still got your big green trees, from a healthy forest you got your big green trees and you’ve got your undergrowth, it is a win. This is recovered” (29, M, WL). He liked the green trees from an aesthetic perspective, but also saw the landscape through a utilitarian lens. A recovered landscape was one that satisfied multiple values, both aesthetic and utilitarian. He referred to different elements in the landscape (grass, timber, and visual appearance) to understand and describe a recovered landscape. Interpretation of these elements reflected his multiple values for the landscape.

Although visual aspects of the landscape tended to be the most important part of RL residents’ representations of recovery, some RL residents also recognized the
importance of being able to utilize the land for grazing and logging. As one noted, “[Fire] makes better feed for the animals and everything else. Gives them a chance to start over (14, F, RL).” For these people, a recovered landscape would still provide these benefits. However, their representations of recovery were more influenced by a preference for visual aspects of the landscape to be restored:

*I’ve watched some things on TV like the redwood forest where a fire would go through there and take up some of the underbrush and they control burn it you know. And they say that’s kind of a natural thing and the limbs and the trunks are so thick that the fire doesn’t hurt the tree. And then the heat helps the pine cones to release their seeds and everything. It’s kind of a natural process. But the trees around here aren’t redwoods, so any little thing comes through it wipes them out. That might enrich the soil here and there or whatever, but I’m not looking at it from nature’s standpoint, I’m looking at it from my own personal standpoint, that’s what we enjoy is the trees. (20, M, RL)*

Even though he learned about the use of fire in other ecosystems, and understood fire and recovery as part of nature, his priority was seeing live trees, not creating an overall healthy landscape that included fire, because that conflicted with his dominant values for living there. The aesthetic evaluation of the landscape was more important to RL residents in what constituted a recovered landscape.

The photo elicitation process illustrated the importance of aesthetic and vegetation features when discussing fire impacts and the recovery process. When shown the photo (E) of the 1984 fire showing minimal tree regeneration, one resident remarked that, “Trees are the main reason I moved out there. I wouldn’t move out to a place like with the one picture (E), I wouldn’t build a house out there.” (11, M, RL). For the same photo, another couple spoke together about how it looked:

*Terrible, infested with weeds, lot of noxious weeds nobody takes care of it…. who would want to build up in sites up there like that, you can always replant [trees] but you’re looking at another 50 years, if you’re going to live that long (7, F, RL)...there are no trees, we like the mountains, we like trees, green, that’s the way we are, I can’t believe the people who do live out there (6, M, RL)... it’s an individual choice, you know if you want to live on barren land, it’s your choice, not me. (7, F, RL)*
Whereas the multi-generational rancher described photo E as recovered from a ranching perspective because it had good grass, the RL residents (6 and 7) referred to the grass as weeds and indicated that green trees are an important part of recovery. They moved there to be in the trees because that was their version of nature, and for them a recovered landscape has trees.

The same participants (6 and 7) quoted immediately above reacted to photo D, which showed effective pre-fire mitigation, green understory, and minimal tree mortality, by again referring to the grass as weeds and speculating that the remaining trees would eventually die because of burn damage from the Dahl Fire. Photo D was the one that the WL rancher from above (29) described as being recovered because it had good understory vegetation (for grazing), good trees, and was scenically appealing. Another RL reaction to photo D suggested a slightly different representation of landscape recovery than RL residents 6 and 7:

*Now that you don’t have all that cover from the trees, the grass comes back exceptionally. They [the trees] were 6 inches away from each other and fighting for sunlight. This is pretty now. At least they still have some decent trees here.* (18, M, RL)

He referred to the understory as grass, reflecting a more positive connotation than weeds. Another person responded to the same photo (D) by saying it “*would be as close to recovered as you could get because you don’t have all the dead trees. Recovered would be that plus new trees coming in.* (13, F, RL). She had a similar perspective to respondent 18. The dominant response by RL residents was that understory vegetation and trees would be necessary for the landscape to be recovered. A few respondents, such as 6 and 7, needed there to be live, green trees and preferred them to be dense. When we asked them if they preferred photo E with no trees or photo F with trees (after the Hawk Creek Fire), they laughed and said “*obviously the one with the trees.*” Even though they had lost their home in the Dahl Fire, they still preferred to live in an area with dense trees, one that others had referred to as still presenting a fire danger. Trees were important to all RL residents, but more important for some in terms of calling it a recovered landscape.
The use of photo D revealed some other interesting insights about representations of recovery. One respondent owned the land in that photo and was quite pleased with the effects of his pre-fire mitigation. He had removed trees before the Dahl Fire for the purpose of “fire management, to clean it up, and give us more grazing, because it was thicker than thick” (30, M, WL). He said he was very pleased by the results of that pre-fire thinning because it removed the dense, small trees, created more grass for grazing, and saved the big ponderosa trees. It was recovered, just as respondent 29 said above, because it met multiple values including scenery, grass, and timber. People in the WL archetype clearly understood these relationships between thinning, fire behavior, fire impacts, and landscape recovery. There was more variation in terms of this understanding than among RL residents, because RL residents tended to focus primarily on the visual and aesthetic elements.

Another interesting finding, evident in some of the previous interview excerpts, was related to the use of the term weeds to describe the post-fire vegetation growth. To RL residents, like 6 and 7, anything other than nice trees was referred to as weeds. They anchored their representations of landscape recovery in their understanding of noxious weeds. Indeed, they discussed efforts to remove noxious weeds from their property so that there would be less competition for trees to grow: “if you don’t, it affects your wildlife habitat, domestic animals, everything, a lot of that stuff is toxic to horses and sheep and cows” (6, M, RL). The owner and manager of the land in photo D referred to the understory as grass that was good for grazing. However, the majority of the respondents differentiated between native grasses, or other understory vegetation, and noxious weeds. One respondent who was actively spraying noxious weeds on his property said that the “regrowth is good, it’s starting to come back a bit, lots of weeds though (2, M, RL). He, as well as most other respondents, was pleased to see vegetation coming up because it holds the soil together, but he also identified noxious weeds as a growing problem. Another resident, with extensive background in vegetation identification and ecology, described the recovery process this way:

Well, the first year after the Dahl Fire, the normal things you’d expect to see came back hard. Anything that was rhizomatous came back real hard.
The Canadian thistle, western wheat grass, all those kinds of things came back. This year we are seeing a few more forbs, a few more natives. I know in my walk this morning right now the horse mint, which is something we had plenty of before, but there was a year or two in there when we didn’t see it, but now I see we’re getting a lot of horse mint back, and so I think it’s moving to the right direction. (8, M, RL)

Like this person, people in the RL archetype who were more knowledgeable of the difference between native and noxious species used that information to understand the recovery process, rather than making general statements about noxious weeds that suggested everything except big green trees were characterized as weeds. Every rancher sprayed and managed noxious weeds, whereas only a few RL residents actively managed them. WL residents had an especially acute understanding of noxious weeds. Noxious weeds negatively affect their livelihood because cows will usually not eat them. They connected the weeds to events like flooding and fires:

Everybody has been commenting on the amount of weeds. The heat from the fire really makes them ready to grow or burst with a little moisture, and they just pop and grow. And down on the river from the flood too. The irrigation ditches are full of weeds. (34, F, WL)

This respondent described areas of her property burned in the 1984 Hawk Creek Fire where they were only recently getting control of the weeds by saying, “Yeah, it’s recovering. But 30 years is a long time if you’re trying to make a living off of it to get it back to the carrying capacity that it had before” (34, F, WL). These examples illustrate how weeds appeared uniquely throughout the anchoring and objectification process across archetypes. The peripheral elements, including one’s values for the landscape and knowledge about weeds, affected the specific representation of recovery based on this target (weeds). Everyone considers weeds, but whether the landscape is recovering (the representation) depends on what one views as a weed and how weeds are believed to affect features of value.

One important difference in representations of recovery between archetypes was that WL residents talked about a recovered landscape more from a perspective of stewardship based on maintaining natural processes. All WL residents identified themselves as stewards of the land, recognizing their responsibilities:
It’s your land and being a steward of the land you know as far as not overgrazing it, allowing the vegetation to come back. (33, F, WL)

Utilitarian values of the landscape helped them interpret the need for stewardship. Additionally, ranchers also expressed the idea of stewardship in terms of maintaining natural processes and conditions that define the landscape. One rancher in particular discussed fairly strong views about the need to understand and appreciate the responsibility of considering natural processes when managing his 20,000 acre ranch:

And owning land generationally it’s not like it’s mine it’s mine it’s mine. It’s like this is my time to care for it so what am I going to do with it? I believe that if I could die at 85 years old or so, and I could look back and say that my forests are beautiful, my grasslands are beautiful and everything has been well managed. And my cattle and my horses and my wildlife all can co-exist without butting heads. That I’ve done a good job. My personal belief is that God perfected it. I don’t care if you believe in God or not, if you need to say Mother Nature, but fact of the matter is that it works perfect if we just leave it the fuck alone. Work with it not against it. Then you won’t have to cuss it and stay up late at night being pissed about it. (36, M, WL)

These statements reflect the core of the speaker’s representation of recovery centered on the notion of Mother Nature, or maintaining natural conditions and processes. He went on to point out that fire is a natural process in the landscape, and people who live there should accept that reality and embrace it by being prepared for future fires. To him, a recovered landscape is one in which natural processes, characterized by wild fires, are not suppressed but are embraced as being a component of that ecosystem:

People don’t live with nature, with fire. I can’t fight it because it’s too big for me. What people don’t understand is because--and it’s getting worse because we need to be self-gratified right now. We need it right now. -- But nature doesn’t work like that, it leaves a great big mess and we’re like, holy cow, that’s a great big mess. But nature doesn’t look at it like it’s a mess. Nature just did what we didn’t so that it can take care of itself. (36, M, WL)

He also recognized the role that visual evidence could play in changing other residents’ attitudes about fire in the area, saying:

The only way to prove that fire is a good thing is to get on board and start. Photos are the best way to prove anything. People can write anything they
want. But when someone sees a photo of this is what was before and this is after, it’s pretty hard to argue. You have to educate your people in the subdivision. People move to Montana and they want their 20 acres in the trees and they love their trees. They love the trees because they like the way it makes them feel. They don’t love the trees because this is the way nature has designed this particular forest, which is usually fire related if it’s really nice. They don’t respect that. We have to educate and continue to burn. We have to allow landowners that have the tools, I’m not patting myself on the back, but you have to have the [courage] to light that fire.

(36, M, WL)

This participant was discussing the challenges to integrating fire, a natural process, back into the landscape. Other WL ranchers discussed how “we would love to burn. We have a bunch of these little regrowth pine tree. But there just isn’t a good time” (30, M, WL).

Any discussions about prescribed fire revealed concerns that it would get out of control due to unexpected wind or dry conditions. In addition to risking unwanted, uncontrolled fire on all of their range, they also realized they could not use fire because “there are too many damn houses here” (26, M, WL). The presence of people was important, as was people’s perspectives about the impacts from fire and the landscape recovery process:

I don’t have anything against fires. It’s supposed to be here. But we live such a short time that people don’t like it. So, 100 years to 200 years for trees to grow back is nothing. But we’re dead and gone twice. (35, M, WL)

Landscape recovery is important to consider because many people prefer particular landscape conditions. Ranchers tend to be more supportive of fire because the recovery process, if managed correctly to control noxious weeds, works in a way that favors their values for the landscape. RL residents lived in the Bull Mountains because the landscape aligned with their idea of nature, particularly from visual perspectives and amenities like privacy. Many of them knew that fire was an important part of the landscape but they still overwhelmingly favored “attack(ing) the fire with everything you got to begin with, don’t screw around with fire” (5, F, RL). Fire threatened their safety, property, and landscape features most important to them. While some RL residents were somewhat supportive of using fire in remote areas without people for natural purposes, the majority had major hesitations because of concerns about the social and ecological impacts and the recovery process. Being a steward for RL residents meant maintaining conditions that met human
values and needs. WL residents understood the role of fire more acutely and that the recovery process in the Bull Mountains took a long time; they accepted this because it was a natural part of the landscape. Fire was actually a part of a recovered landscape for WL residents, but not for most RL residents.

6. Discussion

This research sought to better understand how WUI residents perceive post-wildfire landscape recovery. We used SRT to explore people’s representations in two different groups of WUI residents in the Bull Mountains of Montana. This study advances SRT by looking at both the structure of people’s representations and the processes through which they develop, whereas most SRT studies focus on one or the other. It also provides practical insights into the relatively understudied, yet highly important, post-wildfire phenomenon involving interactions between social and ecological aspects.

In the SRT tradition, social representations reflect people’s values and ideas. The processes of anchoring and objectification manifests those values and ideas in something familiar to help people explain a phenomenon (Moscovici, 2000). Figure 3.1 illustrates the social representations evident from the interviews. Both groups of WUI residents shared a common central core that revolved around the notion of Mother Nature. To help them understand and describe landscape recovery, they anchored their representations in their beliefs about the natural and historical role of fire in the landscape, the effects of fire behavior, and the role of climatic and ecological factors that shape the recovery process. These beliefs were developed through firsthand experiences with other fires and disturbances, as well as by talking with other people. Core beliefs varied to some extent across archetypes and individuals, but were fairly consistent.

The peripheral elements further shaped people’s representations of landscape recovery through the objectification process. Specifically, people’s values for the landscape directed the interpretation of the specific elements that they used to describe landscape recovery. Furthermore, specific beliefs that fire belonged in the landscape shaped representations of recovery differently among the two groups. While residents in
different archetypes shared the same central core, the process described above led to some important differences in representations, as well as similarities, across and within archetypes. These differences ultimately led to different attitudes towards future fire management.

6.1 The central core of representations of recovery and the anchoring process

People’s discussions about wildfire and the post-fire landscape recovery process consistently shared a common core by being rooted in the concepts of Mother Nature and natural processes. Although we never specifically asked about these concepts, they came up in nearly every interview and throughout many of the different parts of the interview process. Nearly everyone discussed their beliefs that fire plays a natural ecological role in leading to a healthy landscape. It was common for people to refer to the fire as cleaning up the landscape in the sense of it being overgrown with unnaturally dense forest due to a century of fire suppression. Wildfire social science is increasingly showing that people have fairly accurate understandings of the ecological role of fire in fire-dependent landscapes (McCaffrey & Olsen, 2012). Our research shows that people’s representations of landscape recovery were anchored in the belief that landscape recovery was part of the natural process of wildfire’s role in creating a healthier landscape.

Other studies have found that people use well-known events like the 1988 Yellowstone Fires to articulate their beliefs about fire being restorative (Paveglio, Carroll, Absher, & Robinson, 2010). We found these past events were especially important in informing people’s representations of post-fire landscape recovery. People understand the post-fire landscape recovery processes from the Dahl Fire by relating it to other fires, either in different geographic locations or in the Bull Mountains. Seeing or learning about the post-fire recovery process in places like Yellowstone and the Bull Mountains, where minimal post-fire restoration actions were taken, has reinforced the core of their representations that recovery is largely a natural process. They typically used the concept of Mother Nature to explain their beliefs about the recovery trajectory of other fires, which helped them understand landscape recovery from the Dahl Fire.
Many people in our study also referred to historical uses of fire by Native Americans in the Bull Mountains to help them articulate the role fire can play in a landscape. For RL residents, that role was no longer relevant in their version of a natural landscape because people lived there permanently and fire threatened values important to them like safety, property, and aesthetics. WL residents interpreted the Native Americans’ use of fire as something that shaped the landscape in the past, but also aligned with their own utilitarian values in terms of improving range quality. People in the WL group saw themselves and their land as a part of nature, sometimes as stewards, but also simply in the sense that fire was a part of the landscape and they needed to learn to live with it if they were going to live there. This acknowledgement reflected more personal experiences with fire, as they had lived there longer and experienced more fires than RL people. For them, a recovered landscape was one in which people lived within their landscape in a way that permitted and even promoted natural processes like wildfire to occur.

Residents in the RL archetype were more likely than the WL archetype to make a distinction between the nature where people live and the nature where people do not live. They lived in the Bull Mountains because they valued the natural features of the landscape, something often noted in studies about WUI residents (e.g., Fried et al., 2006; Nelson et al., 2005; Pavéglia et al., 2015). However, even though wildfire is an important, necessary, and natural component of that landscape, they preferred to see fire suppressed because it threatened the values important to them, such as aesthetics, personal safety, and property. Their descriptions suggested feeling a loss of their landscape connections, which was negligible in interviews with participants in the working landscape group. Such loss of landscape has been increasingly documented in social science research conducted after wildfires (Brenkert-Smith, 2006; Kent, 2003; Pavéglia et al., 2016). Our research suggests that for some people, especially in the RL archetype, the loss of landscape could be complete and permanent after the fire. At least in their lifetimes, the land will never be recovered in their eyes. For them, a recovered landscape was one that looked like it did before the fire and would not be subjected to future fires that would affect those aesthetic qualities negatively.
6.2 Peripheral elements and objectification: Creating unique representations of landscape recovery based on tangible objects and landscape elements

Our research illustrates how the different conceptualizations people have for describing a healthy or recovered landscape depend on how the conditions of different landscape features are interpreted through the peripheral elements in the objectification process. Earlier research has shown that evidence of a fire detracts from scenic preferences and that to some people green vegetation is an important aspect of a healthy landscape (Hull, Robertson, & Kendra, 2001; Islas & Vergas, 2012). Bull Mountain WUI residents who valued the aesthetic aspects invoked targets (throughout the objectification process) like tree color, evidence of charred vegetation, and new birds or flowers to understand landscape recovery. They lived there to be in a natural setting, and until the elements that constituted a natural setting were returned, the landscape was not completely recovered. To them, the landscape in 2014 was in the early stages of recovery.

People in the WL archetype demonstrated a stronger understanding of the ecological role of fire than people in the RL archetype, which shaped their representations of recovery differently. From WL residents’ perspective, most fires that they had experienced led to improved range conditions. They provided more in-depth descriptions of the recovery process, not focusing only on the aesthetic aspects. For instance, several of them described the process of nutrient cycling as a result of fires, as opposed to focusing only on the immediately visible elements like vegetation. On the other hand, RL residents displayed some misperceptions that should be addressed by managers. Some of them expected all trees to die from the fire, even though many will survive. This misperception has been noted by others (Brunson & Shindler, 2004) and offers an important opportunity for managers and community leaders to explain that those effects may not necessarily materialize. Changing people’s perceptions of the impacts, especially among RL residents, could lead to more positive evaluations of the landscape recovery process if they believe that more trees will survive. More positive evaluations of the impacts and recovery process may increase support for fire mitigation and management activities.
For example, photo D was thinned by the landowner for fire mitigation and grazing purposes. He had examined the large trees after the fire and noted that they were alive and appeared healthy. His mitigation actions appeared to have helped reduce the severity of impacts from the fire. Our findings suggest that helping people who aesthetically value the trees understand that natural fire regimes in that specific landscape might actually protect the trees and their aesthetic value. Active fire suppression and minimal thinning lead to unnaturally dense forests which could result in the mortality of most trees.

People who depend on a resource for their livelihood tend to better understand the dynamic nature of that resource and the environment around them (Sieber, Medeiros, & Albuquerque, 2011). In the case of wildfires, they see the landscape as less static than people in the RL archetype who generally prefer a particular aesthetic aspect of the landscape because that is more relevant to them than the timber or forage quality. Residents who depended on features of the landscape like range quality focused on aspects and targets related to forage quality in the objectification process to describe landscape recovery. This was articulated in utilitarian terms describing direct benefits from fires, through regeneration of healthy grass and removing dense stands of trees to create more grazing and resting areas for cattle.

WL residents’ representations of landscape recovery, and wildfire in general, also reflected a sense of stewardship towards the land. These findings are similar to what Cacciapaglia, Yung, and Patterson (2012) found among people in a working landscape. Such people considered stewardship to mean active management that protected the utilitarian aspects of the resource. Since the forage was arguably in better condition two years after the fire than before the fire, as noted by several ranchers, they perceived the landscape to be actively recovering to a much greater degree than the other group because it was meeting their utilitarian needs.

Another finding was the importance of beliefs about forest health as a peripheral element invoked in the objectification process of representation development. People’s evaluations of the impacts of forest management actions on forest health is one of the
most significant elements affecting their attitudes and attitudes toward those actions (Burns & Cheng, 2007; McCaffrey, 2006; McCaffrey & Olsen, 2012). However, research suggests that people’s notions of forest health vary, depending on their values for the landscape and their ecological knowledge of forest dynamics (Abrams et al., 2005; Hull, Robertson, & Kendra, 2001; Shindler, Brunson, & Stankey, 2002). Our research generally supports and adds to these insights. A recovering landscape was one that was healthy. To the majority of residents in the Bull Mountains WUI, fire improved landscape health by clearing out years of dense, accumulated fuels that should have been removed through natural processes (i.e., fire) many years before the 2012 Dahl Fire. However, different definitions of health emerged when discussing the landscape recovery process. A landscape is healthy and recovered after fire when it satisfies the needs and values of the individual. Applying the constructs of SRT to understand representations of landscape recovery helped identify different judgements about forest health. The phenomenon of landscape recovery presents an opportunity for engaging land managers, community leaders, and the public in discussions about a healthy landscape and how to achieve it while protecting a diverse range of social values.

6.3 Insights about SRT: Combining the procedural and structural perspectives

We found it useful to consider both the structural and procedural aspects of people’s representations of landscape recovery in the same study, even though this combined approach has rarely been employed. Examining both aspects together helped reveal commonalities and differences among people’s representations -- nuances that may have been missed had we only considered the structural or procedural elements individually. The common core was shared among all residents, but representations began to diverge during the anchoring process. Our research is consistent with Selge and Fischer’s (2011) finding that anchoring is influenced by subjectively selecting meaning from already familiar ideas. In our context, these a priori anchors were different perceptions of people’s place in nature; WL residents saw themselves more as a part of nature and RL residents were more likely to separate themselves from natural processes. The core of everyone’s representations of recovery reflected Mother Nature, or natural
processes. However, differences in representations of a recovered landscape began to emerge in the anchoring process. Beliefs about the historical and ecological role of fire varied between the two archetypes in that WL residents emphasized the importance to recovery of maintaining those roles, while RL residents placed more value on static, preferred aesthetic values. The peripheral elements, which Abric and others postulate as differentiating the specific structure of representations between different groups (Abric, 2001; Moliner & Abric, 2015), facilitated the link between anchoring and objectification by determining the different target objects and concrete interpretations of the phenomenon. In these ways, there are significant relationships between representation structure and the processes that develop them.

6.4 Limitations

A single case study approach is useful for providing in-depth insights. However, the ability to generalize findings could be limited by a couple key considerations. The study site was characterized by two of the four common WUI archetypes (Paveglio et al., 2015). Different backgrounds, values, and experiences with fires among people in the other two archetypes could lead to different perceptions of landscape recovery. Different types of working landscape communities (e.g., focused on timber instead of ranching) could also have different perceptions of recovery depending on how particular landscape features related to livelihood dependence were affected by the fire and the recovery trajectory. Furthermore, as discussed more in Chapter 2, the ecological and climatic characteristics vary widely across the U.S., which could dramatically affect important aspects related to fire regimes, fire characteristics and impacts, and recovery trajectories. These differences could lead to different perceptions of recovery. Thus, future research should continue to explore perceptions of recovery across different social communities and different ecoregions to gain a more comprehensive understanding of perceptions of landscape recovery, and the factors that shape them, in different contexts.

7. Conclusions

The research presented here adds depth to the understanding of what residents consider to be a recovered landscape after a wildfire event. Significant efforts are often
invested in managing the post-fire landscape, and those efforts rarely consider social aspects beyond safety, infrastructure needs, and potential impacts like invasive species and erosion. We have shown that representations of a recovered landscape share a common core across two different WUI archetypes. However, the representations diverge thru different objectification processes filtered by differences in the peripheral elements.. Community leaders and land managers can engage with the public to identify common concerns and perceptions to incorporate those characteristics into the post-fire management process in a way that meets ecological considerations and societal values and demands.
8. References


Chapter 4. Quantifying Factors that Predict Perceptions of Post-wildfire Landscape Recovery

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1. Introduction

Wildfires are a natural disturbance in many landscapes. They result in short- and long-term changes to ecosystem functions, processes and composition. Researchers and managers use the concept of landscape recovery to describe the trajectory of these changes after the fire. Management efforts after a fire seek to mitigate negative social and ecological impacts from the fire and to shape the recovery trajectory so that post-fire ecological conditions will reflect the natural or historic range of variability (HRV) over time (Keane, Hessburg, Landres, & Swanson, 2009; Robichaud, Beyers, & Neary, 2000). Considerable research continues to explore the biophysical and ecological factors that influence the post-fire landscape recovery trajectory, such as fire intensity, severity of impacts to soil and hydrologic features, drought/precipitation, seed sources for vegetation propagation, and various post-fire activities like salvage logging. But the landscape recovery process also has social implications. These implications are especially important considering the increasing populations of people living in areas affected by wildfire (referred to as the wildland-urban interface, or WUI), as well as the increased likelihood of wildfires in these areas in the future (Theobold & Romme, 2007; Westerling, Hidalgo, Cayan, & Swetnam, 2006).

Wildfires can change elements of the landscape that are important to WUI residents, including visual qualities and utilitarian aspects like range and forest condition. Perceptions of these changes and the recovery process can affect residents’ psychological well-being, motivations to rebuild after experiencing property damage during a fire, and their attitudes towards forest and fire management (Islas & Vergara, 2012; Kneeshaw, Vaske, Bright, & Absher, 2004; Mockrin, Stewart, Radeloff, Hammer, & Alexandre, 2015; Paveglio, Kooistra, Hall, & Pickering, 2016). However, it is still unclear which factors influence perceptions and evaluations of post-fire landscape recovery. Along with projected climate changes, characteristics of wildfire behavior, including frequency, size, duration, and climatic conditions, are expected to change in the future (Westerling et al., 2006). These changes could affect the landscape recovery process in novel ways (Moritz, Hurteau, Suding, & D'Antonio, 2013; Sheehan, Bachelet, & Ferschweiler, 2015). Understanding the factors that influence people’s perceptions of those changes can help
managers incorporate social considerations into post-fire communication and management strategies to mitigate negative social impacts that could result from changes to the landscape after the wildfire. An important component of living in an area characterized by wildfires is learning to adapt to the dynamic nature of landscape (Moritz et al., 2014; Smith et al., 2016). Investigating the factors that influence people’s perceptions of landscape changes after wildfires (i.e., landscape recovery) provides insights that managers and community leaders can use towards creating more resilient and adaptive communities.

The research presented here quantitatively explored how both psychological factors (e.g., attachment to the landscape and beliefs about the ecological role of fire) and physical characteristics of wildfires (i.e., size and duration) influence WUI residents’ perceptions of landscape recovery after wildfires. Questionnaires distributed in 2013 to residents in four Pacific Northwest states who experienced wildfires in 2011 and 2012 were used to determine the effect of social and biophysical factors on people’s evaluations of a recovering landscape. This research covers residents of communities near 25 different wildfires, as opposed to the more typical case study approach of focusing on one fire on one community. People who live in different WUI communities could react differently than people in other WUI communities to post-fire landscape changes based on unique relationships with their local landscapes (Paveglio et al., 2015; Spies et al., 2014). We used hierarchical linear modelling (HLM) to reveal how much of the variation in people’s perceptions of landscape recovery was accounted for at the wildfire level compared to the individual household level. Investigating the relationships between perceptions of recovery and different factors that influence those perceptions across a range of wildfires and communities allows us to explore whether individuals and communities react to a fire differently.
2. Perceptions of post-fire landscape recovery

Social science research conducted after wildfires tends to focus on how people were affected by the event and how their experiences shaped subsequent attitudes and behaviors regarding forest and wildfire management. This body of research has also revealed the importance of understanding people’s perceptions of landscape recovery after a fire. This section first describes pertinent findings that indicate the dimensions of landscape recovery perceptions most important to investigate. Then, the different factors that are mostly likely to influence those perceptions of are discussed.

2.1 Temporal, compositional, and functional aspects of perceptions of post-fire landscape recovery

Wildfires lead to changes in landscape appearance, composition, and functions, and concerns about the temporal aspects of these changes can influence people’s support for management actions before and after fires. For example, Kneeshaw et al. (2004) found that people were more likely to support the use of wildfire as a management tool if the landscape were to recovery quickly rather than taking a long time. In another study, people who visited burned sites a few weeks after the fire were surprised and pleased to see new vegetation growth so quickly (Toman, Shindler, Absher, & McCaffrey, 2008). Seeing new vegetation helped ease their concerns about the short- and long-term impacts on the landscape from the fire. Other research reported that WUI residents in Colorado approximately one year after a fire reported noticing some vegetation (grasses, plants, and aspen) and that they expected the landscape to become more green as vegetation continued to grow over the next 5-10 years (Kent et al., 2003). But they also lamentingly projected that some vegetation in that landscape present before the fire, like bigger trees, would likely not be present again during their lifetimes. Furthermore, Toman et al. (2008) found that people in Oregon overwhelmingly supported active post-fire management to restore forest conditions more quickly than allowing natural processes to occur. Thus, people’s perceptions of the temporal aspects affect their attitudes about post-fire management and can be important in understanding emotional impacts due to the landscape changes after a fire.
The other important aspect of perceptions of landscape recovery relates to the composition and function of different landscape elements, particularly vegetation. Many people have strong preferences for vegetation type and distribution patterns (Gobster, 1994). Indeed, these characteristics are important reasons for many people’s choice to live in the WUI because they provide a sense of the natural environment and other benefits like privacy (Brenkert-Smith, 2006; Nelson, Monroe, & Johnson, 2005). However, many factors can affect whether or not post-fire vegetation resembles pre-fire conditions as the landscape recovers from the fire. Vegetative composition can also be an indication of other functions and processes, as different nutrient and hydrological cycles support different vegetation. Researchers refer to the concept of state change to describe when some event leads to changes in fundamental aspects of an ecosystem so that it no longer has the same composition and functions as the pre-disturbance ecosystem (Briske, Fuhlendorf, & Smeins, 2005). An example would be a high severity fire in a ponderosa pine forest consuming all seed sources, which could eventually lead to different species dominance and alter the landscape to a degree that it now functions as a grassland or juniper forest. While some people prefer active post-fire restoration activities that lead to a specific vegetation composition, others may prefer approaches focused on restoring natural process and ecological functions, regardless of which species take hold (Ryan & Hamin, 2008). Naturally functioning ecosystems may be more important to people’s perceptions of recovery than the types of vegetation present. So, in addition to vegetation composition, the extent to which people know or care about the functional aspects is likely an important element of how people evaluate landscape recovery. People may not consider a landscape recovered until the vegetation looks and functions like it did before the fire. This may include the types of vegetation (e.g., shrubs and trees, or species type) and/or ecosystem functions (e.g., nutrient and hydrological cycles). Others may evaluate landscape recovery more positively as long as some signs of vegetation and essential ecosystem functions are returning, regardless of whether or not the specific characteristics reflect the pre-fire conditions.
2.2 Factors most likely to influence perceptions of recovery

The following sets of factors were developed from existing literature related to wildfires and other natural disturbances.

2.2.1 Beliefs about forest health, the ecological role of fire, and impacts of fire

Ecologists recognize the natural role of wildfires as an important component of a healthy landscape in fire-dependent forests. However, definitions of terms like natural or healthy may vary between experts based on their discipline and interest. For example, a soil scientist could classify a particular post-fire landscape as unhealthy if signs of hydrophobicity exist due to a high intensity fire. But an ornithologist might classify the same landscape as healthy in terms of dead trees providing nesting sites and insects for birds to eat. There is likely even greater variation among the public in terms of the conditions that constitute a healthy or natural landscape (Abrams, Kelly, Shindler, & Wilton, 2005; Hull, Robertson, & Kendra, 2001; Shindler, Brunson, & Stankey, 2002). Forest or landscape health is largely a subjective term depending in part on one’s objectives, for instance whether one values timber or wildlife habitat.

Regardless of different notions of a healthy landscape, research has consistently shown that evaluations of the impacts of forest management actions on forest health is one of the most significant factors affecting attitudes and support for those actions (Burns & Cheng, 2007; McCaffrey, 2006; McCaffrey & Olsen, 2012). People are more supportive of an action, such as using prescribed fire or mechanical thinning of dense vegetation, if they believe those actions will lead to healthier forest conditions (McCaffrey, 2006). Similarly, people’s beliefs about healthy or natural landscapes are likely closely related to evaluations of landscape recovery. Signs of a wildfire like charred vegetation, lack of green vegetation, and absence of wildlife are often described by the public as indicating an unhealthy landscape (Hull et al., 2001; Islas & Vergara, 2012). But these evaluations could vary depending on one’s beliefs about the ecological role of fire in a given landscape. If people believe that wildfire is necessary to foster or restore healthy forest conditions, then they are more likely to positively evaluate the impacts of the fire on forest health (Blanchard & Ryan, 2007; Gobster, 1999). Believing
that forest health conditions are improving, then, would likely lead to positive evaluations of landscape recovery.

2.2.2 Loss of landscape attachment

Landscapes have meanings for people for a wide variety of reasons. For instance, when people see a landscape may be reminded of past experiences or memories there. Landscapes often have shared symbolic meanings as well. For example, many landscapes in the western U.S. represent a sense of wildness, freedom, and exploration (Davenport & Anderson, 2005; Gunderson & Watson, 2007). Those symbolic landscape meanings represent connections based on emotional or cognitive processes, which are at their foundation developed and shared by socio-cultural groups (Greider & Garkovich, 1994; Tuan, 1977). Others value landscapes for aesthetic reasons or activities like recreation. Changes to the elements of the landscape that have significant meanings for people can lead to a renegotiation of their attachment to that place and behavioral changes (Burley, Jenkins, Laska, & Davis, 2007). For example, research has shown that wildfire impacts can affect recreation behavior, including types of activities, locations visited, and length of visit (Borrie, McCool, & Whitmore, 2006; Schroeder & Schneider, 2010).

A significant impact to WUI residents is a phenomenon referred to as loss of landscape attachment. Feeling a sense of loss because of the changes to the landscape from fires is increasingly explored in social science research conducted after wildfires (Brenkert-Smith, 2006; Kent et al., 2003). This feeling of loss can lead to negative effects to one’s psychological well-being (Eisenman, McCaffrey, Donatello, & Marshal, 2015; Paveglio et al., 2016). For many people, visual aspects of the burned landscape serve as reminders of their traumatic experiences and their losses (Ryan & Hamin, 2008; Toman et al., 2008). Thus, we expect that if people experience loss of landscape attachment after the fire, then they are likely to evaluate landscape recovery more negatively than someone not reporting this sense of loss. This evaluation depends on different elements of the landscape impacted by the fire, such as recreation opportunities or aesthetic conditions, as well as emotional responses to those changes.
2.2.3 Employment or income dependence on the landscape

Some landscape meanings or values reflect a dependence on a specific component of the landscape (e.g., a logger depends on being able to harvest the trees). Research has shown that the more people depend directly on a resource, the more they understand the dynamics that affect that resource (Lewis, 2008; Sieber, Medeiros, & Albuquerque, 2011). In the study area for this current research, fires are important to healthy range and forest conditions, and people who depend on those resource are likely to understand that relationship. Thus, people who depend on the forest or rangeland that was burned in a fire may have a different perspective on recovery than people whose livelihood is not directly dependent on the landscape. We hypothesize that people whose livelihood depends on the forest/rangeland will evaluate the landscape recovery process more positively. They are more likely to understand that those landscapes are fire-dependent and that in the long term their economic livelihood depends on a healthy forest, which includes periodic burning.

2.2.4 Expectations about fire characteristics and fire impacts

Previous experience with fires can affect people’s evaluations of landscape recovery. People with more experience might have more accurate expectations of recovery trajectories from seeing the process more throughout their lives. It is expected that people who have experienced fires will evaluate landscape recovery more positively because they understand the recovery process more than people without experience and have expectations based on previous experiences that it will recover. The areas affected by each of the 25 fires included in this research are part of fire-dependent landscapes where fires have historically occurred. Thus, post-fire changes are less surprising under the typical fire conditions, which characterize the fires selected in this study. We expect that longer-term residents would have more experience with these changes and would therefore evaluate recovery more positively than people with less previous experience.

More extreme fire behavior and characteristics (e.g., larger, longer lasting, faster spreading, or burning hotter) may occur in the future due to changing climates and dense fuels resulting from a century of fire suppression (Lannom et al., 2014; Westerling et al.,
These characteristics could lead to variable and longer lasting landscape impacts, such as hydrophobic soils or conditions favorable to invasive species (Sheehan et al., 2015). If the fire characteristics and post-fire impacts to the landscape exceed someone’s expectations, then their expectations about the recovery process could change. For example, they may expect the recovery process to take longer or to take a different trajectory that includes new compositional (e.g., different vegetation) or functional features (e.g., varied hydrological or nutrient cycling patterns). Therefore, perceptions of the typicality of the fire behavior could influence evaluations of landscape recovery.

One specific impact of wildfires, erosion, comes up consistently in research on wildfire impacts and related management tactics. The causes and treatments of post-fire erosion are complex (Moody, Shakesby, Robichaud, Cannon, & Martin, 2013; Spigel & Robichaud, 2007), but erosion is usually more of a problem after a fire than it was before a fire. Therefore, erosion is likely an important element when people think about a landscape recovering. If erosion is perceived to be a continued problem after the fire, we would expect people who perceive that problem to evaluate recovery more negatively than people who do not perceive or worry about erosion.

Perceptions of a fire’s characteristics and impacts may not always match the objective measurements (Brunson & Shindler, 2004; Zaksek & Arvai, 2004). Many social science studies do not account for objective measures of disturbance events, but this research provides an opportunity to include them as predictors of perceptions of landscape recovery. Limited research exists to offer empirical support for predicting how the size and duration of the wildfire event might affect perceptions of post-fire landscape recovery. However, experiencing a longer fire might give people the impression that the fire is more severe and has more long-lasting impacts than a fire that burned for less time. Similarly, people might believe that larger burned areas take longer to recover than smaller areas. This perception could be due in part to the reality that managers have less ability to mitigate negative post-fire impacts (e.g., erosion and invasive species) from larger fires due to limited resources. A larger burned area may be more visible, and
constantly being reminded of the burned landscape could negatively affect perceptions of recovery. Thus, including the size and duration of the fire in predictive models will provide insights into how actual characteristics of the wildfire event affect perceptions of post-fire landscape recovery.

2.2.5 Distance from fire perimeter

Proximity of a fire to one’s residence may also impact one’s perceptions of post-fire landscape recovery. People who live in or near changing forests may be more likely to perceive a sense of loss from those changes than people who live farther away. This could be due simply to more exposure to changes, or it could be due to disruptions of deeply held connections they have with that landscape (Irwin, 2001). The loss of landscape attachment may be exacerbated for people living closer to the burned area because they are reminded of the loss regularly and it becomes part of their lived experience. Using this logic, we might expect people who live closer to the fire perimeter to evaluate recovery more negatively, especially in the first few years after a fire when vegetation regrowth may be less visible and the charred landscape reminds them of the loss. However, people who live closer are also more likely to see new vegetation growth more quickly because they see the landscape more often than people who live farther away. In this sense, they might evaluate landscape recovery more positively. Further investigation will help explore the direction of the relationship between proximity to the burn perimeter and perceptions of landscape recovery.

2.3 Research questions

Based on the preceding review, the following set of questions guides the research presented here:

1. Which set of predictors best explain the variance in how people perceive post-wildfire landscape recovery? Specifically,

   How do impacts to landscape connections, beliefs about the ecological role and impacts of fire, previous experience with fire, expectations about wildfire characteristics, characteristics of the fire, dependence on the
2. Do influences on residents’ perceptions of post-fire landscape recovery differ across fires?

3. Methods

**Note, parts of the following methods section were adapted from an earlier publication (Paveglio et al., 2016) that used the same data to predict impact on individual well-being from experiencing a wildfire. I helped write that paper, but I did change some of the wording here to include my own voice.**

3.1 Selecting wildfires

The first step was to select the wildfires from within our study area of ID, MT, OR, and WA. We used a combination of geographic information system (GIS) tools and census data to select fires based on several criteria. This region covers a diverse range of forested terrain and human communities from rural to suburban areas. We wanted to choose fires that occurred at least one year previously, so that there had been time for some recovery. However, the event also had to be recent enough for participants to recall their experiences. Therefore, we narrowed our list to fires from 2011 and 2012.

Three main sets of data were used to select wildfires. Burn perimeters for all wildfires in 2011 and 2012 with a centroid in the study region were obtained from the Geospatial Multi-Agency Coordination Wildland Fire Support system through the US Geological Survey (see [www.geomac.gov](http://www.geomac.gov)). Census data were obtained from the US Census Bureau (see [www.census.gov/geo/maps-data/](http://www.census.gov/geo/maps-data/)) to identify broad classifications (i.e., census designated places and census urban clusters) and finer scale delineations (i.e., block level data) of household data for the study region. Information about the ecoregion in the study region was obtained from the Commission for Environmental Cooperation North American Atlas ([www.cec.org](http://www.cec.org)).

Selection of specific wildfires was based on the following six steps. First, only fires in the northwestern forested ecoregion were selected. This meant excluding any fires with the majority of the burn perimeter in grasslands or coastal forests because these
regions exhibit much different fire regimes, landscape impacts, and potentially landscape recovery trajectories. Second, we identified census places and census clusters that intersected the forested ecoregions from step one. Third, the selected census places and census clustered were buffered by 15 km, and only fires with a burn perimeter intersecting those buffers were selected. Fourth, any of these fires smaller than 1,000 acres were removed. Fifth, an internal and external buffer of 15 km was applied to the remaining fires so that overlap between those buffers and the ones from step three could be selected. Sixth, these overlapping areas from steps three and five were merged, and any spot fires not part of the main body of the fire were removed. This process resulted in 25 fires. The 15-km size buffer in step three and the 1000-acre minimum size in step four were selected to ensure that potential respondents were both aware of the fire’s occurrence and close enough to witness the fire impacts and recovery process. The 25 fires ranged from 1,031 acres to 95,090 acres, and their duration ranged from one day to 83 days. See Appendix E for a map showing their locations and a table with more information about the fires.

### 3.2 Selecting respondents and questionnaire administration

To select the sample frame for participants, census blocks with centroids inside the areas finalized from steps five and six of the wildfire selection process were identified. We purchased a random sample of 5,500 addresses within the selected census blocks from Survey Sampling International (SSI), which represented a stratified sample of 220 addresses for each of the 25 fires. After removing bad addresses, the final sample size was 4,989 respondents.

The questionnaire was administered using a modified mixed-mode Dillman tailored design method (Dillman, Smyth, & Christian, 2014). We first mailed a letter to each individual selected in the sampling process that explained the purpose of the study and invited them to participate (see Appendix F). They were asked to provide responses based on the fire mentioned in the letter and in the survey. A link was included to an online version of the questionnaire hosted by Qualtrics. Ten days after sending the letter, a reminder post card was sent to everyone with link to the online questionnaire (see
Appendix G). About a month after the reminder postcard was sent, a packet was mailed to all individuals who had not yet completed the online questionnaire. The packet included a paper version of the questionnaire, cover letter (see Appendix H), and a paid return envelope. Lastly, a final reminder postcard was mailed two weeks after the packet (see Appendix I). As an incentive to participate, respondents were entered into a drawing for one of ten $50 pre-paid Visa cash cards. After removing duplicates (a few people filled out the online version and the paper version) and surveys completed for a fire not included in our sample (some people wrote in the name of a different fire), the final number of usable questionnaires was 819 (of which 429 were completed online and 390 were returned by mail). This leads to a final response rate of 16%.

Nonresponse bias checks were conducted via telephone in November, 2013, to ensure the sample was representative of landowners who experienced one of the 25 fires in this study. Fifty people from the sample frame who did not complete the questionnaire were given a shortened version of the questionnaire over the phone. This number of participants was approximately 10% of the final sample, which is often recommended for nonresponse bias checks (Lindner, Murphy, & Briers, 2001). We compared answers from respondents and non-respondents for selected items most pertinent to the research objectives, as well as some of the socio-demographic characteristics (age, highest level of education obtained, gender, full-time/part-time resident status, and years lived in the area). Non-response results for pertinent variables are included in the results section when applicable. Nearly 38% of nonrespondents contacted said that they did not respond because they did not receive the survey materials. Along with the large number of bad addresses as indicated by materials returned by the US Postal Service, it appears that bad addresses were a significant reason for the low response rate.

3.3 Questionnaire measures

The entire questionnaire is in Appendix J. Responses were typically measured in the form of a 5-point Likert-type scale unless otherwise noted.
3.3.1 Dependent variable: Perceptions of recovery

The questionnaire included three statements aimed at capturing important dimensions of recovery perceptions. Agreement with each statement was recorded on a bipolar 5-point Likert-type scale (-2 = strongly disagree; 2 = strongly agree). Two statements in the questionnaire addressed temporal aspects of recovery: (1) “I am concerned that the landscape will not recover from the wildfire impacts for at least a generation,” and (2) “The landscape is recovering from the wildfire more quickly than anticipated.” A third statement also involved temporal considerations, but included references to ecological components and processes affected by wildfires. It stated, “I am concerned that the ecosystem components (for example, wildlife and plant species) and processes (for example, water and nutrient cycling) will never be the same after this wildfire.”

3.3.2 Predictor variables

The following questionnaire items were developed and included to measure the factors from Section 2 predicted to be most influential in affecting perceptions of post-fire landscape recovery.

Three statements addressed respondents’ beliefs about the ecological role of the fire in the landscape: “This wildfire improved the health of the landscape,” “The wildfire helped restore wildlife habitat,” and “The wildfire was a natural and healthy part of the landscape.”

Based on a review of literature related to measuring place attachment (see Williams & Vaske, 2003), as well as studies where people reported a sense of loss of landscape, a set of eight statements in the questionnaire asked how the fire and its impacts to the landscape affected people’s connection to the landscape. These encompassed visual qualities, emotional responses, and amenity-based activities like recreation. One questionnaire item asked respondents whether or not their employment or income was related to forests and/or rangelands (yes/no).
Several items in the questionnaire addressed previous experience with wildfires. One set of items asked the respondents to compare the fire to typical fires in the area in terms of size, proximity to homes, intensity, rate of spread, duration, wind and temperature conditions, and fire behavior. One item asked if people had seen wildfires in that area (their community) before (yes or no response). Another item asked how many years the respondent had lived in that area, which could provide an indication of their past experiences with fire and expectations for the recovery process. Additionally, one item measured people’s perception of the degree of erosion caused by the fire. Lastly, two predictors included in the model were the actual size (in acres) and duration (in days) of the respective fire for each respondent.

A self-reported item asking how close the fire perimeter was to the respondent’s property included seven response choices ranging from “it burned on my property” to “it burned more than 10 miles from my property.” This scale was later collapsed into three categories that each contained approximately 1/3\(^{rd}\) of the participants. Responses were initially left-skewed because approximately one third of the respondents indicated that the fire burned more than 10 miles from their property.

We measured several socio-demographic variables: age, education, income, race/ethnicity, and political orientation. These variables often have significant (though minor) relationships to perceptions of environmental issues. It may be important to control for their relationship to perceptions of landscape recovery, though we had no specific predictions about their relationships to recovery.

3.4 Analysis

The social science software, SPSS (version 22), was used for data analysis. After computing descriptive statistics like frequencies, means, and dispersion properties of each variable, principal components analysis with oblique rotation (direct oblimin) was conducted to identify latent constructs to reduce the number of variables when more than one item was used to measure a construct (Kline, 1994). Specifically, this analysis was applied to the measures related to four sets of variables: perceptions of landscape recovery (dependent variable); perceptions of the wildfire’s characteristics; loss of
landscape attachment after the fire; and evaluations related to the role of the fire in terms of forest health. Oblique rotation was used because we expected some degree of correlation between components since the individual measures were intended to represent broader concepts (like attachment to the landscape). Factor loadings less than 0.30 were deemed insignificant (Kline, 1994). Most items loaded well on to a single component for each set of variables; items with weak loadings were removed, as discussed in the results section where applicable. Cronbach’s α was used to assess the reliability of each construct (i.e., component), and indices were computed as the mean of the items.

Linear regression was used to address the first research question by exploring the relationships between the independent variables and perceptions of landscape recovery across all wildfires in the sample. Specifically, we used ordinary least squares (OLS) hierarchical linear regression to test our expectations regarding the influence of independent variables on perceptions of landscape recovery. To control for sociodemographic variables, we entered them first (step 1), followed by adding the predictor variables to the model (step 2).

Then, hierarchical linear modelling (HLM) was performed using the linear mixed models function in SPSS to address the second research question by testing whether the relationships among independent variables and perceptions of recovery differed across wildfires. Independent variables found to have significant relationships to the dependent variable in the linear regression analysis were included in the HLM process. HLM acknowledges the hierarchical structure of the data (i.e., level one variables represent the individual household level, while the second level is the wildfire) and tests whether relationships are similar at those different levels (Heck, Thomas, & Tabata, 2014; Woltman, Feldstain, MacKay, & Rocchi, 2012). OLS regression assumes fixed intercepts and slopes across the entire sample, while HLM allows the intercepts and slopes to vary, which could be likely in a multilevel situation. For instance, it is reasonable to expect that people from different communities affected by different wildfires experienced those fires in different ways. In other words, the effects of the independent variable(s) on perceptions of landscape recovery may be different across different wildfires. If so, the
intercepts could be different and the relationships between the independent variables and perceptions of landscape recovery could have different slopes across the different wildfires. As described below, the steps of the HLM analysis indicate whether or not allowing slopes and intercepts to vary across wildfires would improve the fit of the regression model.

Independent variables used in the HLM process were group centered to address multicollinearity among variables and because our primary interest was in understanding the association of variables at level one (e.g., the relationship between beliefs about the ecological impacts of the fire and perceptions of landscape recovery after the fire) (Bickel, 2007; Enders & Tofighi, 2007; Paccagnella, 2006). Centering predictor variables in HLM leads to a more interpretable intercept. In group centering, the intercept provides the best estimate of the dependent variable when the independent variable is set to its respective group (i.e., wildfire) mean. The intercept for each wildfire now represents the unadjusted mean on the outcome (perceptions of landscape recovery) for respondents who experienced that fire. It is advantageous to group-mean center predictor variables if the focus of analysis is on producing an unbiased estimate of the within-group (level 1 or household level) effect, since group-mean centering results in a level 2 mean that is unadjusted for the level 1 predictor (Heck et al., 2014). It produces an intercept equal to the expected value of Y (outcome, perceptions of landscape recovery) for an individual when X (predictor) is equal to the group’s (wildfire) mean (Heck et al., 2014). Group mean centering also diminishes correlations among random components and minimizes bias in estimating variances of random components (Bikel, 2007; Raudenbush & Bryk, 2002). There are two steps in the process to group-center the independent variables. First, each independent variable is aggregated by wildfire using the mean of all responses for an independent variable for each wildfire. Then, the raw values are subtracted from the aggregated value. This produces the group centered variable, which is the deviation of each observation from the group mean. Level two variables, which are unique to each fire, included the size (acres) and duration (days) of the fire; we explored their relationship to individuals’ perceptions of landscape recovery across fires.
The first step in the HLM process was to assess the intraclass correlation (ICC) for the landscape recovery perceptions construct. The ICC measure indicates common variance across all wildfires compared to the variation among individual respondents impacted by different wildfires (Field, 2013). A large ICC value (i.e., closer to 1 than 0) suggests a low degree of variation among respondents who experienced the same fire but high variation compared with respondents who experienced other fires (Heck et al., 2014; Woltman et al., 2012). It suggests further exploration of whether or not the relationships between dependent and independent variables differ between fires would be beneficial. Smaller ICC values (closer to 0) indicate that linear regression may provide a suitable model for the sample population because the variation in the relationship between independent and dependent variables across fires might be minimal. ICC values were determined with an HLM model that specified wildfires as the 2nd level in the model, and included the dependent variable but no independent variable. They were calculated with the following formula:

\[ \rho = \frac{\sigma_B^2}{\sigma_B^2 + \sigma_W^2} \]

where \( \sigma^2 \) is the variance and B and W stand for between groups and within groups, respectively. Using the output from the estimates of covariance parameters in the linear mixed models function in SPSS, the following is the specific equation:

\[ \text{ICC} = \frac{\text{Var} (u_{0j})}{\text{Var} (u_{0j}) + \text{Var} (\varepsilon_{ij})} \]

where \( \text{Var} (\varepsilon_{ij}) \) is the residual estimate and \( \text{Var} (u_{0j}) \) is the intercept variance estimate (Field, 2013; Heck et al., 2014). If the ICC value suggests significant variation exists across wildfires, then HLM analysis should be conducted to further analyze the relationships between the outcome and predictor variables across fires.

HLM analysis was conducted for each independent variable’s relationship to the dependent variable (if it was a significant predictor in the OLS linear regression model) as a bivariate analysis to assess if any of these lines had variable intercepts or variable relationships (slopes) across wildfires. This consisted of running successive HLM models.
to determine whether allowing variance in slopes and intercepts increased the statistical fit of the models. Specifically, four procedures were performed for each independent variable. First, the null regression model included only fixed effects (similar to OLS regression). The measure of the overall fit of the model, the log likelihood value (-2LL), was recorded and provided the baseline for comparison with subsequent steps. Second, we included random intercepts (Var \((u_0)\)) in the model under the assumption that intercepts could vary across wildfires. Third, we allowed both intercepts and slopes (Var\((u_1)\)) to vary to determine whether the relationship between the independent and dependent variables was different for different wildfires. Fourth, we allowed the covariance structure (Cov \((u_0,u_1)\)) to vary across wildfires. The covariance term reveals any relationship between the random slope and the random intercept (Field, 2013). The previous models assumed that these two parameters were uncorrelated. Using the unstructured covariance option in SPSS does not make this assumption. The key interest in the value of the covariance term is the direction, which indicates a positive or negative relationship between the random intercept and random slope. To determine whether fit improved, the log likelihood (-2LL) of each new model was subtracted from that of the preceding model \((\chi^2 = (-2LL(\text{previous})) - (-2LL(\text{new})))\). Smaller log likelihood values represent better fit, so a reduced -2LL value obtained after any step indicates a better fitting model. The significance of change in log likelihood was assessed using a chi-square statistic \((\chi^2)\) appropriate for the degrees of freedom in the new model \((\text{df change} = \text{df previous model} - \text{df new model})\). We are adding one additional parameter in each step, so \(\text{df change} = 1\). The critical values of the chi-square distribution were obtained from Field (2013). Specifically, for one degree of freedom, any \(\chi^2\) value above 3.84 is significant at the .05 level, and a value above 6.63 is significant at the .01 level. Implications of the results of these steps are included in the discussion section.

4. Results

The section first presents results from the descriptive analysis and factor analysis for the outcome and predictor variables. Then the results from the OLS multiple
regression are presented, followed by the HLM analysis using the statistically significant predictor variables identified in the previous OLS regression analysis.

4.1 Descriptive statistics and factor analysis

See Appendix K for a table displaying the range of responses for the outcome and predictor variables for each of the 25 fires. There is moderate variation in responses across fires, and the HLM analysis helped identify which relationships between the outcome and predictor variables might vary across fires. The following results are from the entire sample across all 25 fires.

4.1.1 Perceptions and evaluations of landscape recovery

Overall, respondents evaluated landscape recovery rather positively (Table 4.1). Two of the items were reverse coded to aid interpretation so that all items in the scale reflected a similar orientation (i.e., the first and third items were negatively worded, while the second item was positively worded). For example, the mean of the raw values for the first item in Table 4.1 was -0.32, which reflects overall disagreement with the statement. Reverse coding leads to a mean of 0.32 and an interpretation that the positive mean generally reflects a lack of concern that the landscape will not recover for at least a generation. The third item in the table has a similar interpretation after reverse coding. Considering that the items used to measure perceptions of landscape recovery had not been empirically tested before, and that only three items were included, the factor loadings and reliability measure (Cronbach’s $\alpha = 0.68$) indicate that the construct that emerged from factor analysis represents a fairly reliable measure of respondents’ perceptions of landscape recovery (see Table 4.1). While an $\alpha$ of $>.70$ is generally considered the threshold of reliability, it is not uncommon for newly developed scales with only three items to exhibit $\alpha < .70$ (Nunnally, 1978; Nunnally & Bernstein, 1994).
Table 4.1 Descriptive results and factor analysis for items measuring evaluations of landscape recovery

<table>
<thead>
<tr>
<th>Item*</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am concerned that the landscape will not recover from the wildfire impacts for at least a generation (reverse coded)</td>
<td>804</td>
<td>0.32</td>
<td>1.33</td>
<td>-.29</td>
<td>-1.11</td>
<td>.86</td>
</tr>
<tr>
<td>The landscape is recovering from the wildfire more quickly than anticipated</td>
<td>804</td>
<td>0.04</td>
<td>0.92</td>
<td>-.21</td>
<td>.27</td>
<td>.71</td>
</tr>
<tr>
<td>I am concerned that the ecosystem components (for example, wildlife and plant species) and processes (for example, water and nutrient cycling will never be the same after this wildfire (reverse coded)</td>
<td>803</td>
<td>0.68</td>
<td>1.19</td>
<td>-.54</td>
<td>-.65</td>
<td>.78</td>
</tr>
</tbody>
</table>

Factor Cronbach’s α = 0.68

| Eigenvalue (% of variance explained) | 1.84 (61.20%) |

*Scale of -2 (strongly disagree) to 2 (strongly agree), with higher value corresponding to less concern or more positive evaluation about recovery.

4.1.2. Beliefs about forest health and the ecological role of the fire

Responses were normally distributed and indicated fairly neutral or slightly positive evaluations of the natural role of the wildfire in terms of landscape health, though perceptions of benefits to wildlife habitat were generally negative (Table 4.2). The three items to measure this construct loaded well into one factor with an acceptable reliability measure (α = .76).

Table 4.2 Descriptive results and factor analysis results for evaluations of the fire’s ecological role and forest health impacts

<table>
<thead>
<tr>
<th>Item*</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>This wildfire improved the health of the landscape</td>
<td>802</td>
<td>0.13</td>
<td>1.14</td>
<td>-.27</td>
<td>-.62</td>
<td>.85</td>
</tr>
<tr>
<td>The wildfire helped restore wildlife habitat</td>
<td>793</td>
<td>-0.20</td>
<td>1.11</td>
<td>-.05</td>
<td>-.70</td>
<td>.85</td>
</tr>
<tr>
<td>The wildfire was a natural and healthy part of the landscape</td>
<td>801</td>
<td>0.19</td>
<td>1.33</td>
<td>-.28</td>
<td>-1.02</td>
<td>.78</td>
</tr>
</tbody>
</table>

Factor Cronbach’s α = .76

| Eigenvalue (% variance) | 2.05 (68.23) |

*Scale of -2 to 2, with higher value corresponding to more positive evaluations.
4.1.3 Loss of landscape attachment

Overall, people reported low to moderate impacts of the fire on their attachment to the landscape (Table 4.3). Impacts to the attractiveness of the area were rated the most negatively. Connections to the landscape and feeling happy about living there after the fire were rated most positively, indicating mild impacts to overall attachment to the landscape after the fire. The factor created with the six items was quite reliable (α = .89) and appears to be an appropriate measure of impacts of the fire on respondents’ attachment to the landscape.

Table 4.3 Descriptive results and factor analysis for items measuring post-fire landscape attachment

<table>
<thead>
<tr>
<th>Item*</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>The wildfire made this area less attractive</td>
<td>794</td>
<td>0.38</td>
<td>1.27</td>
<td>-.44</td>
<td>-.82</td>
<td>.72</td>
</tr>
<tr>
<td>The impact of the wildfire on forests and/or rangelands made me less happy about living here</td>
<td>795</td>
<td>-0.68</td>
<td>1.22</td>
<td>.47</td>
<td>-.82</td>
<td>.84</td>
</tr>
<tr>
<td>I feel less of a connection to the landscape after the wildfire</td>
<td>795</td>
<td>-0.81</td>
<td>1.17</td>
<td>.64</td>
<td>-.50</td>
<td>.83</td>
</tr>
<tr>
<td>My outdoor recreational habits were negatively impacted by the wildfire</td>
<td>796</td>
<td>-0.53</td>
<td>1.32</td>
<td>.37</td>
<td>-1.06</td>
<td>.79</td>
</tr>
<tr>
<td>Places in the landscape that I care a lot about were negatively impacted by this wildfire</td>
<td>796</td>
<td>0.01</td>
<td>1.32</td>
<td>-.12</td>
<td>-1.09</td>
<td>.79</td>
</tr>
<tr>
<td>I felt a sense of loss as a result of impacts to the landscape</td>
<td>794</td>
<td>-0.01</td>
<td>1.35</td>
<td>-.12</td>
<td>-1.18</td>
<td>.82</td>
</tr>
<tr>
<td>Factor Cronbach’s α = .89</td>
<td>800</td>
<td>-0.27</td>
<td>1.02</td>
<td>.13</td>
<td>-.65</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue (% variance)</td>
<td>3.84 (64.02%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Scale of -2 to 2, with higher value corresponding to more negative evaluation.

4.1.4 Employment or income dependence on the landscape.

A total of 19% of respondents indicated that their income or employment was related to forests and/or rangelands (n= 793).

4.1.5 Expectations about fire characteristics and perceptions of fire impacts.

The fires included in the study were generally perceived as being slightly larger, closer to homes, burning more intensely, spreading more rapidly, and burning longer than typical fires in the area (Table 4.4). However, fewer people agreed that the fire exhibited
unusual behavior. The seven items loaded well into a single factor ($\alpha = .87$) referred to as atypical fire characteristics.

Table 4.4 Descriptive results and factor analysis for items measuring perceptions of wildfire characteristics

<table>
<thead>
<tr>
<th>Item*</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>The size was bigger than a typical wildfire in the area.</td>
<td>722</td>
<td>0.56</td>
<td>1.18</td>
<td>-.35</td>
<td>-.92</td>
<td>.77</td>
</tr>
<tr>
<td>The wildfire was closer to homes than a typical wildfire in the area.</td>
<td>743</td>
<td>0.51</td>
<td>1.25</td>
<td>-.41</td>
<td>-.93</td>
<td>.57</td>
</tr>
<tr>
<td>The wildfire burned more intensely than a typical fire in the area.</td>
<td>681</td>
<td>0.45</td>
<td>1.21</td>
<td>-.20</td>
<td>1.02</td>
<td>.85</td>
</tr>
<tr>
<td>The wildfire spread more rapidly than a typical wildfire in the area.</td>
<td>702</td>
<td>0.58</td>
<td>1.20</td>
<td>-.40</td>
<td>-.85</td>
<td>.86</td>
</tr>
<tr>
<td>The wildfire burned longer than a typical fire for this area.</td>
<td>713</td>
<td>0.37</td>
<td>1.24</td>
<td>-.14</td>
<td>-1.08</td>
<td>.78</td>
</tr>
<tr>
<td>The wildfire conditions (e.g. wind, temperature) were unusual.</td>
<td>729</td>
<td>0.07</td>
<td>1.22</td>
<td>.07</td>
<td>-.96</td>
<td>.68</td>
</tr>
<tr>
<td>The wildfire exhibited unusual behavior.</td>
<td>678</td>
<td>-0.11</td>
<td>1.14</td>
<td>.22</td>
<td>-.62</td>
<td>.73</td>
</tr>
<tr>
<td>Factor Cronbach’s $\alpha = .87$</td>
<td>772</td>
<td>0.34</td>
<td>0.92</td>
<td>-.17</td>
<td>-.51</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue (% variance explained)</td>
<td>3.97 (56.77%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Scale of -2 to 2, higher values corresponding to perceptions of less typical (more extreme) fire characteristic.

Table 4.5 shows the results related to perceptions of erosion impacts, previous experience with fires, length of residency in the area affected by the fire, and distance of residence from the fire perimeter. Nearly half of the respondents indicated that the fire caused erosion problems (48%), slightly fewer respondents (42%) neither agreed nor disagreed, and only 9% of respondents disagreed. The overall mean ($\bar{x} = 0.59$) evaluation of erosion also suggests negative perceptions of erosion. However, means for this item varied across fires from $\bar{x} = -0.33$ to $\bar{x} = 1.30$, which suggests it was less of a problem for some fires than others. Slightly more than half (56%) of the respondents reported having seen fires in the area before experiencing the fire referred to in the questionnaire. Respondents had lived in the area for an average of 20 years before the fire. More than one third (36%) of respondents lived more than 10 miles away from the fire perimeter, while 32% lived 5-10 miles away and the other 32% lived less than 10 miles away.
Table 4.5 Descriptive results and factor analysis for items measuring constructs related to perceptions of wildfire impacts

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Item used to measure variable</th>
<th>Descriptive Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scale* or Range; Mean &amp; SD, or Median</td>
</tr>
<tr>
<td>Erosion</td>
<td>The wildfire caused erosion problems.*</td>
<td>794  ( \bar{x}=0.59, SD = 1.01 )</td>
</tr>
<tr>
<td>Seen fires before</td>
<td>I had seen wildfires in this area.</td>
<td>812 0 = No (44%) 1= Yes (56%)</td>
</tr>
<tr>
<td>Length of time in the area (years)</td>
<td>How many years have you lived at this residence?</td>
<td>784 Range 0-99 years ( \bar{x}=20, SD = 16.37 ) Median = 15</td>
</tr>
<tr>
<td>Distance of residence from fire perimeter (miles)</td>
<td>1= less than 5 miles away 2 = between 5 and 10 miles away 3 = greater than 10 miles away</td>
<td>795 1 = 32% 2 = 32% 3 = 36% Median = between 5 and 10 miles away</td>
</tr>
</tbody>
</table>

* Scale of -2 to 2, higher values corresponding to perceiving more erosion.

The average size of the fires included in the study was 16,383 acres (Table 4.6). The average duration was 22 days. See Appendix E for more information about the size, duration, and location of each of the 25 fires.

Table 4.6 Range, means, and standard deviation of fire size and duration

<table>
<thead>
<tr>
<th>Size (acres) of the fires (n=25)</th>
<th>Range: 1,031 – 95,090 acres</th>
<th>( \bar{x}=16,384, SD = 22,071 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (days) of the fires (n=25)</td>
<td>Range 1-83 days</td>
<td>( \bar{x}=22, SD = 22 )</td>
</tr>
</tbody>
</table>

4.1.6 Socio-demographic characteristics

Socio-demographic information of respondents is shown in Table 4.7. The majority (97%) were permanent residents, while approximately two-thirds were males and the mean age was 60 years old. Respondent’s political orientations were generally more conservative than liberal and 36% indicated a household income of less than $40,000 per year.
Table 4.7 Socio-demographic characteristics of respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measure</th>
<th>n</th>
<th>Scale</th>
<th>Frequency (%)</th>
<th>Median or mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Indicate the highest level of education you have completed.</td>
<td>802</td>
<td>1 = Less than HS degree</td>
<td>21 (3%)</td>
<td>median is two year technical degree or associates degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 = HS degree or GED</td>
<td>111 (14%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 = Some college or training</td>
<td>189 (23%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 = Two year technical or associates</td>
<td>119 (15%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 = Four year degree (BA/BS)</td>
<td>216 (27%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 = Advanced degree</td>
<td>146 (18%)</td>
<td></td>
</tr>
<tr>
<td>Resident status</td>
<td>Are you a permanent or part-time resident of the community affected by the fire?</td>
<td>779</td>
<td>0 = permanent</td>
<td>755 (97%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 = part time</td>
<td>24 (3%)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Are you male or female?</td>
<td>799</td>
<td>0 = male</td>
<td>522 (65%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 = female</td>
<td>277 (35%)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>What is your age (in years)?</td>
<td>785</td>
<td>Range 22-94</td>
<td></td>
<td>$\bar{x}$ = 60 median= 61 SD = 13</td>
</tr>
<tr>
<td>Income</td>
<td>Please indicate the level of your current household income before taxes.</td>
<td>722</td>
<td>1 = &lt; $20,000/yr</td>
<td>84 (12%)</td>
<td>median is in the $40,000 - $60,000 range</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 = $20,000 - $39,999/yr</td>
<td>171 (24%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 = $40,000 - $59,999/yr</td>
<td>163 (23%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 = $60,000 - $79,999/yr</td>
<td>120 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 = $80,000 - $99,999/yr</td>
<td>78 (11%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 = $100k - $149,999/yr</td>
<td>71 (10%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 = ≥ $150,000/yr</td>
<td>35 (5%)</td>
<td></td>
</tr>
<tr>
<td>Political Orientation</td>
<td>Please check the box that most accurately describes your political orientation on the following scale.</td>
<td>744</td>
<td>1 = Strongly Liberal</td>
<td>1 = 60 (8%)</td>
<td>median is 4 (middle)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 = Strongly Conservative</td>
<td>2 = 94 (13%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 = 60 (8%)</td>
<td>3 = 60 (8%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 = 204 (27%)</td>
<td>4 = 204 (27%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 = 95 (13 %)</td>
<td>5 = 95 (13 %)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 = 126 (17%)</td>
<td>6 = 126 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 = 105 (14%)</td>
<td>7 = 105 (14%)</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Non-response bias check

Respondents and non-respondents did not differ significantly ($p > .05$) on the socio-demographic variables of gender, resident status and years lived in the area. However, non-respondents, with an average age of 66 years, were significantly older than respondents ($p < .01$). Respondents also reported higher levels of education than non-respondents ($p < .05$). These variables were not significant predictors the final linear regression model, so we expect these differences between respondents and non-respondents have little influence on our findings. One of the three items for the dependent variable was included in the non-response bias check: “The landscape is recovering more
quickly than I had anticipated."

The mean ($\bar{x} = 0.40$) among non-respondents for this statement was statistically higher ($p = 0.02$) than that of respondents ($\bar{x} = 0.04$). This suggests that non-respondents had more positive evaluations of landscape recovery. The only other difference between respondents and non-respondents related to one of the measures for landscape attachment. Non-respondents reported a lesser degree ($p = .045$) of a sense of loss as a result of the impacts to the landscape ($\bar{x} = -0.46$) than did respondents ($\bar{x} = -0.01$), where larger values indicate more negative effects on landscape attachment from the fire. There were no significant differences between respondents and non-respondents in terms of their evaluations of the attractiveness of the landscape after the fire or their evaluations of the fire being a natural and healthy part of the landscape.

### 4.3 Linear regression

After controlling for demographic variables, results of the linear regression analysis indicated that a fairly large proportion of variance (45%) in evaluations of landscape recovery could be explained by several of the predictor variables (Table 4.8). The strongest predictor was the reported level of attachment to the landscape after the fire ($\beta = -0.44$, $p < .001$). People who reported a less negative impact to their connection to the landscape after the fire were more likely to report more positive evaluations of landscape recovery. The next strongest predictor was evaluations of the role of fire in the ecosystem in terms of forest health and habitat ($\beta = .31; p < .001$). People who perceived more positive impacts from the fire in terms of forest health and habitat were more likely to report more positive evaluations of landscape recovery. The third strongest predictor was evaluations of erosion problems after the fire ($\beta = -.10, p < .01$). Reporting more erosion after the fire was correlated with more negative perceptions of landscape recovery. These three independent variables contributed the most to the predictive power of the model.
Two other variables were also statistically significant predictors of perceptions of landscape recovery, residence proximity to the fire (β = -.07, p = .05) and duration of the fire (β = -.07, p < .05). People who lived closer to the burn perimeter evaluated landscape recovery more positively than people who lived farther from the fire. People who experienced longer lasting fires rated landscape recovery more negatively than people who experienced shorter duration fires. The objective measure of acres was removed from analysis because of its high bi-variate correlation (Pearson’s r = .84, p < .001) and
multi-collinearity with the objective measure of fire duration (tolerance statistics near 0.2, and VIF values above 3.0). We chose to keep duration because it was a stronger predictor than acres when either one or the other variable was included in the model.

No other independent variables were significant predictors of landscape recovery perceptions. Excluded variables were people’s perceptions of biophysical characteristics of the fire, previous experience with fires, length of time lived in the area, and employment connections to the forest. Age was negatively correlated with perceptions of landscape recovery, but that relationship was insignificant once the independent variables were added. No other demographic variables were significant predictors in either step.

4.4. HLM: Comparison across fires

The first part of the HLM process was to assess the ICC using a null model (no predictors) to determine how much of the variance in perceptions of recovery exists at the individual respondent or wildfire level. From the estimates of covariance parameters output and using the formula from above (ICC= .046/(.046+.775) = .056) the proportion of variance in perceptions of landscape recovery that lies across wildfires is 5.6%. Thus, only a small amount of variance in perceptions of landscape recovery lies across wildfires (Heck et al., 2014; Woltman et al., 2012). It is generally acknowledged that ICC values near or below 5% suggest that performing HLM will add minimal utility to the overall fit of the model because there is not much variance in the dependent variable across fires (suggesting more heterogeneity within fires) (Heck et al., 2014; Woltman et al., 2012). However, since the intercepts do vary significantly across wildfire (Wald-Z = 2.12, $p = .034$), and the ICC suggests that about 5.6% of the total variability in the dependent variable lies between wildfires, we continued with the next steps in the HLM process to explain this variability in intercepts within and between wildfires (Heck et al., 2014). Specifically, the next steps provide a better indication of which significant predictors have variable relationships with perceptions of landscape recovery at the wildfire level.

Results of the HLM analysis are summarized in Table 4.9. The intercepts for each independent variable included in the analysis exhibited significant variance across fires. This finding means that measures of attachment to the landscape after the fire,
perceptions of the ecological role of the fire in terms of forest health, perceptions of erosion impacts from the fire, respondents’ distance from the fire perimeter, and the duration of the fire all varied significantly across fires. The change in log likelihood ($\chi^2$) and subsequent tests using the chi-square statistic provide further insight into the distribution of the variance across fires in terms of each significant independent variable. Attachment to the landscape after the fire had the highest amount of variance across wildfires ($\chi^2 = 41.03, p < .001$), followed by beliefs about the ecological impacts to forest health from the fire ($\chi^2 = 29.29, p < .001$) and perceptions of erosion impacts after the fire ($\chi^2 = 21.22, p < .001$). Distance from the fire ($\chi^2 = 16.31, p < .001$) and fire duration ($\chi^2 = 8.92, p < .001$) exhibited significant variance in the intercepts across fires as well.

Table 4.9 HLM regression analysis of predictor variables across 25 wildfires

<table>
<thead>
<tr>
<th>Variable</th>
<th>Random intercept</th>
<th>Random Slope</th>
<th>Covariance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Var(u0j)</td>
<td>$\chi^2$(1)</td>
<td>Var(u1j)</td>
</tr>
<tr>
<td>Post-fire landscape attachment</td>
<td>.06</td>
<td>41.03**</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Ecological role and forest health</td>
<td>.05</td>
<td>29.29**</td>
<td>.02</td>
</tr>
<tr>
<td>Erosion after the fire</td>
<td>.05</td>
<td>21.22**</td>
<td>.02</td>
</tr>
<tr>
<td>Distance from fire perimeter (miles)</td>
<td>.05</td>
<td>16.31**</td>
<td>.01</td>
</tr>
<tr>
<td>Fire duration (# of days)</td>
<td>.03</td>
<td>8.92**</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note, the $\chi^2$(1) statistic is the change in that statistic compared to the previous model.
*p<.05 (chi sq diff is more than 3.84 for df1), **p<.01 (chi sq diff is more than 6.63 for df 1)

The next step, allowing slopes to vary when regressed against the dependent variable, revealed that two independent variables exhibited variance in slopes across fires. This means that the relationship between each of those two variables and the dependent variable differed across fires. Specifically, the relationships between the dependent variable and beliefs about the ecological role of fire ($\chi^2 = 4.45, p < .05$) and reporting erosion problems ($\chi^2 = 5.86, p < .05$), varied significantly across fires. For some wildfires, stronger beliefs about the positive ecological impacts from the fire (i.e., improving forest health), led to more positive evaluations of landscape recovery after the fire, but this relationship was not evident across all fires. Similarly, for some fires, reporting more erosion problems led to strongly negative evaluations of landscape recovery (the direction of the relationship is known from the OLS estimates), but the
relationship was not as strong for other fires. Examining covariance between the slope and intercept for these two variables can potentially provide more insight.

Covariance of random intercepts and random slopes was only tested for the two independent variables whose intercepts and slopes varied across fires (Field, 2013). This test, if significance is found, reveals if there is a predictable pattern in the relationships between the intercept and slopes across fires. The variable measuring evaluations of erosion problems did not exhibit significant covariance between intercepts and slopes across fires. Thus, we can conclude that the slopes and intercepts for the relationship between evaluations of erosion and perceptions of landscape recovery did vary across the different fires. However, the relationship or interaction between the random components (intercept and slope) did not significantly vary across the different fires.

However, beliefs about the positive ecological impacts from the fire had a significant covariance of random intercepts and random slopes across fires ($\chi^2 = 5.51, p < .05$). The value of the parameter estimate (-.024) is less important here than the sign (Field, 2013). In this case, the covariance is negative, suggesting a negative relationship between the intercept and slope. This means that, across the fires, as the intercept for the relationship between beliefs about the positive ecological impacts from the fire and perception of recovery increases, the slope of that relationship decreases (see Figure 1). Lines with low intercepts have steep, positive slopes. But as intercepts increase, the slopes become flatter.

The intercept for a group centered predictor variable is the expected value of perceptions of landscape recovery for an individual when the value for the predictor variables (in this case, evaluations of the ecological benefits from the fire) is equal to the group’s mean for that predictor variable (i.e., independent variables are centered around the group mean). Thus, interpreting these findings based on the group mean offers a bit more insight. For the fires with steeper slopes, as respondents’ rating of fire’s ecological role gets further from the mean of the ratings of that variable, their perceptions of recovery are increasingly different than people closer to the mean. For the fires with
flatter slopes, distance from the mean response for beliefs about the ecological role of the fire had a less striking impact on perceptions of recovery.

Importantly, the relationships between beliefs about the ecological role of fire and perceptions of landscape recovery were positive for each fire and across all fires as a whole. HLM analysis suggested that the nature of this relationship varies slightly across fires. The most appropriate conclusions we can reach with this information are that 1) the slopes and intercepts for the relationship between beliefs about the ecological role of fire and perceptions of landscape recovery vary significantly across the different fires, and 2) there appears to be a significant interaction between the random components (intercept and slope) as well. We discuss implications and limitations of these findings in the next section.

**Figure 4.1.** Fit lines by wildfire showing variable intercept/slope relationship between beliefs about ecological role of fire and perceptions of landscape recovery.*

*Note, the y-axis is the factor created from raw values, while the x-axis is the group centered mean for the factor representing the combined items to measure beliefs about the ecological role of the fire.
5. Discussion

The purpose of this research was to measure people’s perceptions of landscape recovery and explore how different characteristics of individuals and wildfire events affect people’s perceptions of post-fire landscape recovery. Perceptions of landscape recovery 1-2 years after the fire were overall positive, though there was some variation across fires in mean levels of evaluations. This finding adds insight to knowledge about the importance of temporal aspects of landscape recovery. It may not take generations or decades for people to consider a landscape as recovering from a wildfire. It appears to happen relatively soon after the fire, though it is difficult with our data to further specify how early those perceptions develop. These results are encouraging because people support forest management actions like the use of fire if they think the landscape will recover quickly (Kneeshaw et al., 2004). Helping communities to live with wildfire and mitigate negative social and psychological impacts through various management activities is an important aspect of fostering resilient and adaptive WUI communities.

While we did not measure attitudes about future fire and forest management, our findings suggest that perceptions of landscape recovery may not be a major barrier to increasing the resiliency and adaptive capacity of WUI communities.

Linear regression tested the effects of predictor variables. These variables included people’s perceptions of impacts from the fire (e.g., beliefs about the ecological benefits of fire in terms of forest or landscape health, impacts to one’s connection to the landscape from the fire impacts, and noticing erosion problems from the fire), their individual experiences with the fire (e.g., proximity of residence to the fire perimeter), having seen wildfires before, the length of time living in the area, the degree of dependence of their income on the forest, and characteristics of the wildfire event (including the duration of the event and how fire characteristics compared to people’s expectations of a typical fire event).

Then, HLM was used to further explore the relationships between perceptions of landscape recovery and significant predictors from the regression model by taking into consideration the nested design of the study. This approach allows us to account for the
specific context (i.e., the wildfire event) in which people experience fires. Including the context in these investigations assists in efforts to create universal measures of how people evaluate the fire impacts after the event by indicating which factors consistently influence perceptions of recovery across fires. Many social science wildfire studies lack the ability to generalize effectively to other wildfire events and communities. In contrast, this study accounted for differences across fires and revealed several key findings about the ability to generalize how people perceive landscape recovery across different wildfire events. Our analysis indicates that perceptions of landscape recovery can be explained fairly well and consistently across wildfires using several predictors.

The strongest predictor of people’s evaluations of post-fire landscape recovery was the degree to which their attachment to the landscape was negatively affected by the fire. Increasingly negative impacts to one’s attachment to the landscape after a fire lead to more negative evaluations of post-fire landscape recovery. The results shown in Table 4.3 suggest that, overall, many people’s attachment to the landscape was not significantly altered by the fire, but it did have some impact. This finding reinforces the importance of considering a loss of landscape, a point that has emerged in other recent research (Eisenman et al., 2015; Kent et al., 2003; Paveglio et al., 2016). Negative impacts to people’s connections to the landscape appear to be most influenced by negative evaluations of the changed aesthetic conditions of the post-fire landscape. This is not surprising given the well documented importance of aesthetic features of the landscape among WUI residents. However, our research provides insights into the relationship between people’s connections to the landscape and the landscape changes after fires. People with more negative evaluations of the landscape recovery process are less likely to support future management activities that incorporate the use of fire as a management tool (Kneeshaw et al., 2004). Thus, our data add another insight in that perceptions of landscape recovery may affect the relationship between impacts to landscape attachment from a fire and people’s support for certain forest and fire management activities. While we did not measure attitudes towards forest/fire management, or test for this type of effect, other research has shown that stronger connections to the local landscape and community are associated with more engagement in fire mitigation measures (e.g.,
defensible space implementation, attending community planning meetings about wildfire preparedness, and helping other community members with mitigation implementation) (Kyle, Theodori, Absher, & Jun, 2010). Reinforcing or protecting people’s connections to the landscape after a fire should be a consideration in post-fire management decisions, and managers can use the concept of landscape recovery to facilitate support for mitigation and behaviors on private land based on people’s connections to the landscape. Further research should explore the relationship between perceptions of recovery, loss of landscape attachment, and support for forest and fire management in more detail, including whether perceptions of landscape recovery have a reciprocal effect on feeling a loss of landscape attachment.

Recent research shows a direct link between a loss of landscape attachment after wildfires and negative impacts to psychological well-being (Eisenman et al., 2015; Paveglio et al., 2016). Residents have specifically mentioned experiencing grief over the loss of the landscape and feeling a loss of connection to it in research about specific fire events (Eisenman et al., 2015; Kent, 2003; Ryan & Hamin, 2008). People tend to support post-fire management actions intended to mitigate further negative social and ecological impacts from fires, to bring back the features of the landscape important to them, and to remove signs of the wildfire which bring back bad memories of the experience (Olsen & Shindler, 2010; Ryan & Hamin, 2008). One way to help people reconnect to the surrounding forest is encouraging local participation in the post-fire restoration management process and getting people out to see the changing landscape conditions after the fire (Burns, Taylor, & Hogan, 2008; Ryan & Hamin, 2008; Toman et al., 2008). For example, taking tours of the burn site with land managers and using volunteers from the community in post-fire restoration efforts can help the community heal and reestablish its relationships with the landscape after experiencing the trauma of the fire, especially by focusing on special areas or areas that are of particular importance to the community (Ryan & Hamin, 2006, 2008; Toman et al., 2008). If people believe that the landscape changes are irreversible, they may never want to return to burned places (Ryan & Hamin, 2008). However, the impacts often occur as a mosaic, and showing people these patterns could positively influence their perceptions of recovery (Lentile et al.,
These types of firsthand experiences could positively influence their perceptions of the recovery process by illustrating that important landscape features (i.e., vegetation) are in the recovery process. Land managers should make efforts to work with residents to understand specifically which landscape elements and specific places are most important to people’s connections to the landscape. Then they can work towards restoring those features and places while implementing other measures like erosion control. Having these plans set up before a fire can help facilitate implementation after the fire.

People who see or visit an area over time after a fire are likely to notice new vegetation growing and feel more positively about recovery than those who only saw the fire and its immediate aftermath. Indeed, our findings support these inferences in that people living farther from the burn perimeter had more negative perceptions of the recovery trajectory. Managers and community leaders should be sure to not only focus on engaging residents adjacent or nearest to the burn perimeter, but should also make special efforts to work with people farther way from the perimeter since they may make more generalizations or assumptions about the recovery process without seeing it. These generalizations could lead to misperceptions about the recovery process (e.g., thinking the landscape is void or vegetation or that all trees die in wildfires) that affect their attitudes towards future management issues.

These insights are particularly relevant based on our findings of the variable influence of people’s beliefs about the wildfire impacts to forest health on their perceptions of landscape recovery. Overall, people who believe that the fire had positive impacts on forest health were more likely to evaluate landscape recovery positively. Unlike most of the other variables tested, the HLM analysis showed some variability in this relationship across the 25 fires included in our study. The intercepts and slopes for this relationship varied across the fires, as did the relationship between the intercept and the slope (i.e., the covariance was statistically significant). Looking at Figure 1, five fires exhibit a flatter slope in the relationship between beliefs about the ecological role of the fire and perception of landscape recovery. For these five fires, an increase in positive
beliefs about the ecological role of the fire has a weaker, though still positive, effect on perceptions of recovery than among respondents for the other 20 fires with steeper slopes. Interpreting covariance is particularly challenging and usually requires more information about contextual variables and the interaction of variables at the different levels of the study (i.e., the individual household and the wildfire level) (Bickel, 2007; Field, 2013). Based on the information about the year, state, size, duration, and average rating of landscape recovery for the different fires, no immediate pattern emerges for these fires (the fires were Manila Creek, Highway 141, St. Mary’s Mission Road, West Garceau, and High Cascade Complex). Thus, more information about those five fires would be needed to interpret the variable relationship between ecological beliefs and perceptions of recovery. It is possible that the recovery trajectories for the five fires with flatter slopes were different in some way than the other 20 fires.

It is not uncommon for fires of any size or severity to exhibit mosaic impacts and/or variables recovery trajectories across the burned landscape (Lentile et al., 2007). Visual cues, such as charred trees or vegetation regrowth, are important factors that could affect one’s evaluation of the ecological role of fire in terms of forest health or wildlife habitat (Hull et al., 2001; Islas & Vergara, 2012; Taylor & Daniel, 1984). If the visible recovery trajectories at the time the questionnaire was administered were similar to pre-fire conditions, then it is reasonable to speculate that beliefs about the ecological role of that fire would have less influence on perceptions of recovery than for fires whose recovery trajectories were less similar to pre-fire conditions. For example, hypothetically consider someone who experienced one of the fires with a flatter slope who believed that the fire had negative ecological impacts. If the landscape looked like it was recovering, they may have still rated recovery similarly to someone with more positive beliefs about the ecological role of that fire.

The take home point is that, overall, the more strongly someone believes a fire had a positive ecological impact, the more positively they will evaluate landscape recovery. The strength of this relationships could vary across fires, likely due to contextual variables not accounted for in this study. Therefore, community leaders and
managers should seek to understand the different beliefs among WUI residents regarding the relationship between wildfire, forest health, and landscape recovery. If beliefs are predominantly that the fire had a negative impact on forest health, then managers can focus communication, education, and engagement efforts on discussing and illustrating forest health from multiple perspectives to explain the role and dynamic nature of fire in an ecosystem. These efforts could lead to more positive perceptions of landscape recovery (especially in communities where this relationship has a steeper slope), which could ease their concerns about the landscape and increase support for future management actions (Burns & Cheng, 2007; Carpenter et al., 1986; Cortner, Gardner, & Taylor, 1990; Kneeshaw et al., 2004; Manfredo, Fishbein, Haas, & Watson, 1990; McCaffrey, 2006; Winter, Vogt, & McCaffrey, 2005). However, in some communities (i.e., where the relationship between beliefs and perceptions of recovery has a flatter slope) efforts to increase positive beliefs about the ecological role of fire may have less positive impact on perceptions of recovery. In that case, assuming a goal is to strengthen positive perceptions of recovery, efforts might need to focus on other aspects of the fire or landscape, such as those related to people’s values for the landscape.

As described earlier, the concept of forest health is somewhat subjective based on one’s objectives for the forest. Land managers use a variety of indicators to help measure and monitor the overall health of the forest. Our findings that the nature of the relationship between beliefs and perceptions of landscape recovery vary across different fires illustrate the importance of understanding the different indicators used among the public to evaluate the ecological role of fire in the landscape. For instance, Brunson and Shindler (2004) found that, although residents in some geographic areas displayed relatively high levels of knowledge about fire, some still had misperceptions, for example, that fires kill most large trees. Considering that people may consider signs of fire, like dead trees, as a sign of an unhealthy or unnatural forest (Hull et al., 2001; Taylor & Daniel, 1984), misperceptions about the fire impacts could lead to misperceptions about the recovery process and negative attitudes towards future fire and fuels mitigation techniques. Discussing the larger role of fire for forest health could lead to more positive evaluations of forest health and the recovery process. If people understand specific
aspects of the recovery process, for instance that not all burned trees die or that vegetation regrowth can happen quite quickly, then they may be more likely to support future management efforts to reintroduce wildfire to a landscape.

These findings about the importance of beliefs related to forest health and the role of wildfire in terms of landscape recovery further illustrate the importance of directly engaging the public in management decisions. Learning and information processing theories like the Elaboration Likelihood Model highlight the importance of personal relevance and involvement in an issue in terms of processing information (Petty & Cacioppo, 1984). When people are more involved with an issue, they are more likely to increase their cognitive attention towards information about that issue. The benefits of public involvement in natural resource decision making are well documented and theorized (Brummel, Nelson, Souter, Jakes, & Williams, 2010; Jakes & Sturtevant, 2013; McCool & Guthrie, 2001). Involving people more in the post-fire management process, including site visits to see the changes over time, can increase their cognitive attention towards the role of fire in the landscape and may lead to more positive evaluations of the recovery process if they understand it more as a natural process that it is part of a healthy landscape.

Another finding concerns the impact of perceiving negative impacts related to erosion on perceptions of recovery. Social aspects of post-fire management efforts receive considerably less research attention than the ecological aspects. People seem overwhelmingly supportive of post-fire erosion control management efforts for ecological purposes (Olsen & Shindler, 2010; Ryan & Hamin, 2008; Toman et al., 2008; Toman et al., 2013). Our research reinforces the importance of post-fire erosion from a social perspective. The relationship between erosion evaluations and perceptions of landscape recovery varied across fires, which could reflect different objective levels of erosion impacts after each fire. Erosion impacts can vary widely within and across landscapes. Working to reduce erosion can help shape more positive perceptions of landscape recovery and reduce the perceived level of impact from the fire. Perceiving more impacts from a fire is likely to increase the negative impacts on one’s psychological
well-being after a fire (Paveglio et al., 2016). Thus, reducing erosion and subsequent impacts (e.g., poor water quality, degraded wildlife habitat, or loss of topsoil for agriculture or other purposes) could lead to more positive perceptions of the post-fire recovery process and improve negative perceptions of landscape impacts, which may lead to less negative psychological impacts from the fire.

Duration of fire events is often used as a proxy for gauging biophysical and community impacts from a fire (Lannom et al., 2104). Our research suggests that as duration increases, people are more likely to negatively evaluate the post-fire landscape recovery trajectory. Future research could further investigate this relationship by examining biophysical characteristics of recovery (e.g., vegetation growth) over time for fires of varying duration. We did not have this type of information for the 25 fires in this study, but it could be interesting to explore whether or not experiencing the longer event itself leads to more negative evaluations of recovery, or if it is more of an issue of correlation between longer events and longer recovery time (e.g., longer events could lead to higher severity impacts, which would take longer to recover). Our analysis shows that perceptions of unusual wildfire behavior did not have a significant relationship with perceptions of landscape recovery, which may suggest that other aspects of longer lasting fires, including burn severity and vegetation impacts, could affect perceptions of landscape recovery. At the least, managers should be aware that, as fire duration increases, it may be increasingly important to address negative public perceptions of post-fire landscape recovery. Thus, characteristics of a fire, such as the duration, can be used to help predict perceptions of landscape recovery. Future research should investigate the utility of other measures of biophysical characteristics related to the fire, including burn intensity, burn severity, and actual vegetation changes over time.

Limitations

Overall, the research presented here is conceptually and empirically strong. We explained more of the variance in perceptions of landscape recovery across a relatively large geographic context than many human dimensions of wildfire studies (McCaffrey,
Toman, Stidham, & Shindler, 2013; McFarlane, McGee, & Faulkner, 2012). However, there are several limitations to keep in mind.

In terms of data collected, one limitation relates to the questionnaire response rate (16%). It is not uncommon for social science research to experience a low response rate (Baruch, 1999; Sivo, Saunders, Chang, & Jiang, 2006). As mentioned earlier, we expect this was in part due to a large number of incorrect addresses in the purchased sample. Another explanation could be that some people may not have felt that completing the questionnaire was important because they viewed the fire as insignificant. This was indicated by messages received from a few participants. Fires of shorter duration and smaller size may have less of an impact on people’s experience, especially among residents living farther from the fire. We had anticipated this type of challenge during the design phase, which is why we restricted our sample to communities near fire perimeters. Nevertheless, we likely included many people who did not think the questionnaire was relevant to them. More advanced sampling methods could be possible with geocoded census information that was not available for our study region. This could lead to more targeted selection of participants for whom the topic was most salient based on their likelihood of experiencing the fire and the landscape changes. Despite the low response rate, the non-response bias check, as described earlier, suggested minimal differences between respondents and non-respondents that would affect the interpretations of the results. The main finding from the non-response analysis was that perceptions of recovery may be even more positive for the population (though the relationships between the predictor and outcome variables are likely similar to what we found).

Another limitation relates to the characteristics of the ecoregion for our study site. We focused on northwestern forested ecoregions, and we believe our study is representative of them. However, there could be key differences in contextual details like the fire regimes, climatic conditions, landscape impacts, and recovery trajectories in other regions, such as grasslands or coastal forests.

Lastly, we used only three items to measure perceptions of recovery. Although they were shown to be a fairly reliable set of measures, future efforts might include other
questionnaire items that capture more aspects of recovery. For example, respondents could rate the level of recovery on a Likert-type scale for different time periods after the fire (e.g., monthly or yearly post-fire evaluations). Researchers could also present an extensive list of specific landscape attributes (e.g., scenic quality, vegetation diversity and growth, forage quality, invasive species, water quality, or presence of charred vegetation) and ask respondents to rate the perceived level of recovery for each attribute. Respondents could also indicate to what extent certain attributes need to resemble pre-fire conditions before the landscape is considered recovered. These additional measures would add further insight into the dimensions of people’s perceptions of landscape recovery.

6. Conclusion

There is a fundamental relationship between people and dynamic landscapes characterized by natural disturbances. Perceptions of landscape recovery no more than two years after the fire were overall positive. This suggests that people are aware of the landscape changes in a fairly short period of time following the fire, which is encouraging considering the likelihood of future disturbances and resulting landscape changes (Sheehan et al., 2015). Future research should explore this important window of time after a fire in more detail to better understand how quickly perceptions of recovery become positive, or even if they are relatively positive immediately after the fire.

Perceptions of recovery can be explained fairly well, especially for social science, with several key variables. Specifically, more negative evaluations of recovery were related to negative impacts to people’s attachment to the landscape, negative perceptions of erosion problems, and longer fires. More positive evaluations of recovery were related to more positive beliefs about the beneficial role of fire in terms of landscape health. HLM analysis showed that these relationships are mostly consistent across fires, though there was some small variability in the relationships between perceptions of landscape recovery and the variables that measured perceptions of erosion and beliefs about the ecological role of fire. An additional, limited amount, of variance may be explained by contextual factors related to the wildfire and the community. More robust measures of
people’s experiences with fires and evaluations of more specific aspects of landscape in terms of recovery may further improve the model’s predictability.

Based on the relationships revealed in our study between different social and ecological aspects of wildfires, managers should discuss the important role of fire in the landscape with the public if their goals include positively affecting people’s perceptions of landscape recovery. It may be most efficient to first gauge the present degree of these beliefs about the ecological role of fire in any population. Successful efforts to increase positive evaluations of recovery by shaping beliefs about the ecological role of fire could have more of an impact on perceptions of recovery in some areas (e.g., where aesthetic values are not the only motivation for living there). Furthermore, our research highlights not only the importance of people’s evaluations of landscape features (e.g., attractiveness) in affecting people’s relationships with the landscape, but also how changes to those connections from post-fire landscape changes can affect evaluations of the recovery process. This reinforces the importance of considering why landscapes are important to people when making land management decisions. There can be many fears about the unknown consequences of wildfires, impacts to the landscape being one of them. Helping people understand the recovery trajectory, and the larger role of fire in a healthy forest, could lead to greater appreciation for the need to adapt to the environmental conditions to mitigate future negative impacts. Engaging with the public could help foster and promote this adaptive capacity by using the concept of landscape recovery to help people further understand the important and dynamic role of fire in the landscape. Landscape changes from fires may be increasingly novel in the future, so it will be important to continue monitoring perceptions of these changes and the factors that influence those perceptions.
7. References


Chapter 5. General Conclusion
1. Summary of key findings and implications

Land managers and community leaders are faced with the difficult task of balancing social needs and values with the dynamic nature of the environment. It is increasingly recognized that ecological disturbances occur within a complex system characterized by interactions between social and environmental factors (Moritz et al., 2014; Smith et al., 2016; Spies et al., 2014; Spies, Lindenmayer, Gill, Stephens, & Agee, 2012). The landscape changes from disturbances are ecologically significant in terms of maintaining resilient systems. Disturbances typically promote resiliency by maintaining heterogeneous landscape features that can absorb and respond to future disturbances without changing their fundamental character or properties. However, people’s perceptions of post-disturbance landscape changes can be negative, making it difficult for land managers to achieve their goals. Thus, the broader context for my research was the need to balance social and ecological considerations in a highly complex and interdependent system. My specific goal was to better understand people’s perceptions of landscape changes after natural disturbances. I began by thoroughly reviewing and integrating key insights and findings from a wide range of disciplines about how people experience their environment and changes to it. These efforts led to the development of a conceptual framework for understanding how people perceive post-disturbance landscape recovery. Then, I conducted in-depth, qualitative research to apply that framework towards a deeper understanding of what landscape recovery means to different people who recently experienced a wildfire in or near their community. I also quantitatively examined perceptions of post-fire landscape recovery across 25 different wildfires to produce insights about the factors that influence these perceptions across different contexts. Several key insights can be gained by looking at results from these studies together.

1.1 Beliefs about the ecological role of fire affect perceptions of recovery

My research confirmed the importance of understanding people’s beliefs about the ecological role of disturbances in shaping perceptions of recovery, and it revealed how those beliefs can vary across and within communities. Respondents from both social
groups interviewed in Roundup, MT, believed that fire had historically played an important role in shaping the surrounding landscape. Their representations of landscape recovery were centered on beliefs about natural processes. They learned about these processes through varying degrees of personal experience with disturbances and the recovery process, through conversations with other people around them, and the media. However, my discussions with them about landscape recovery revealed that the views about the current and future role of disturbances can vary widely within a community. These differences stem broadly from different degrees of accepting natural disturbances and the recovery process as inevitable. For some people (rural lifestyle residents), wildfires threatened the aspects of the landscape they valued the most. These were typically associated with aesthetic evaluations and related impacts like decreased privacy and a loss of important landscape features. Thus, landscape recovery meant restoring those conditions to some degree, and they recognized that it could take several decades at least for them to return, given the slow nature of vegetation growth in a relatively dry climate. They valued certain natural elements of the landscape; a key influence on those elements, wildfire, was seen as a threat that needed to be suppressed.

However, residents with more experience with wildfires and landscape recovery had more complex representations of recovery. These were typically people who depended directly on the resource, such as ranchers and people in the timber industry (i.e., working landscape residents). They expressed more awareness of the ecological role of fire in the local landscape, for example, in relation to processes like nutrient cycling and benefits such as better forage. They believed that the landscape was healthier when disturbances occurred because disturbance is a natural process. They favored the use of fire as a natural process and characterized a recovered landscape in part as when natural processes are allowed to occur.

The quantitative results from Chapter 4 further reinforced the importance of people’s beliefs about the ecological role of disturbances in affecting perceptions of recovery. The construct measuring those beliefs was one of the statistically strongest predictors of people’s perceptions of landscape recovery across all 25 fires in the study.
People who believed that the fire improved the ecological conditions of the landscape, like wildlife habitat and landscape health, were more likely to positively evaluate the landscape recovery trajectory. The HLM analysis provided further insights into this relationship. Although most of the variation in perceptions of recovery could be accounted for at the individual household level, approximately 5% of the variance was observed at the wildfire level. HLM analysis revealed that the intercepts and slopes for the relationship between beliefs about the ecological role of the fire and perception of landscape recovery varied significantly across the different wildfires. Among fires where the slope of this relationship was steeper, people with more negative beliefs about the ecological role of fire, compared to the average measure of those beliefs for that fire (i.e., the group mean), had much more negative perceptions of landscape recovery than people who had more positive beliefs (than the group mean for that fire) about the ecological role of that fire. Among the few fires where the slope of this relationship was relatively flat, the difference in perceptions of recovery between people with negative compared to positive beliefs about the ecological role of the fire was negligible. It is difficult to know exactly why the slopes for this relationship between ecological beliefs and perceptions of landscape recovery varied across fires without more contextual information related to characteristics of each wildfire and community. Nonetheless, beliefs about the ecological role of fire had a positive effect on perceptions of landscape recovery across all fires. Thus, taken together, these studies show that beliefs about ecological processes consistently have a positive relationship with perceptions of recovery, but the precise degree of impact may slightly vary. Importantly, these educational efforts may have limited positive impacts on perceptions of recovery for people who simply prefer a dense stand of mature trees. Efforts may be more fruitful with people who are more open to a landscape characterized by dynamic or varied features.

Managers can use this information to inform their communication and outreach strategies. It is well recognized that beliefs about ecological health are an important factor influencing support for different management strategies (Shindler, Brunson, & Stankey, 2002). People are more likely to support management activities if they believe those activities lead to a healthier forest and if the activities (e.g., fuels thinning) will help the
landscape recover more quickly from future disturbances like wildfire (Kneeshaw, Vaske, Bright, & Absher, 2004; McCaffrey & Olsen, 2012). Thus, the concept of landscape recovery can be useful for connecting people’s beliefs to increased support for management. Managers should communicate about the recovery process by highlighting the ecological benefits from disturbances. Strengthening one’s beliefs about the positive ecological role of a fire could lead to more positive perceptions of landscape recovery, even where visual characteristics are quite different from pre-fire conditions. The strength of these effects could vary across different wildfires, highlighting the importance of understanding the beliefs among different WUI residents and communities when designing communication and outreach efforts.

1.2 Values for the landscape affect perceptions of landscape recovery

Both empirical studies in my dissertation also highlighted the importance of understanding how people’s values for the landscape affect their perceptions of post-fire landscape recovery. The qualitative research revealed how the aspects of the landscape that people value the most served as targets in the objectification process when explaining the tangible aspects of landscape recovery. Rural lifestyle residents strongly valued the aesthetic qualities of the landscape. They lived in the Bull Mountains because they liked the scenery and the amenities they provided, like privacy and being able to watch wildlife. They felt those aspects were negatively affected by the fire, and restoring them to some degree would be important to a recovered landscape. People in the other main social group, the working landscape residents, placed more value on the functional aspects of the landscape. Their livelihoods depend on healthy range and timber conditions, so restoring those conditions was a major focus of their representations of recovery. They were more likely than rural lifestyle residents to describe recovery in a way that included benefits to ecological processes from the fire, such as nutrient cycling that leads to better quality forage. They tended to benefit from the fire in this way, which led to generally more support using fire as a management tool. They recognized the natural role of disturbance, and the effects of it largely aligned with their key values for the landscape.
Vegetation regrowth was an important part of recovery for all respondents. Across both social groups, removing signs of the fire, notably the dead trees, would help speed recovery by creating openings to encourage vegetation regeneration. Others supported additional planting and seeding efforts to further speed the process. These efforts were supported because they helped the landscape recover in the sense that they would restore important landscape values (e.g., forage abundance and scenic quality).

The results from the questionnaire across 25 different wildfires confirmed that people’s relationships with the landscape are an important and consistent predictor of perceptions of landscape recovery. Less negative impacts to one’s attachment to the landscape after the fire were associated with more positive evaluations of landscape recovery. I expect that this relationship may work the other way as well; perceiving the landscape as recovering might be an important aspect of restoring people’s connections to a landscape. The findings from the qualitative research support this reciprocal relationship. Some people, especially in the rural lifestyle group, expressed that areas burned by a fire in 1984 were still far from recovered because the trees had not regrown and many of the dead trees were still there. They said they would not want to live in areas like that shown in a recent picture of the landscape from the 1984 fire. When they looked at a picture of the same fire, but in a different area where many trees had regrown since 1984, they had much more positive evaluations of recovery and said they would enjoy living in that type of landscape. So, when people discuss wanting to live in an area because it is recovering, I can infer that perceiving the landscape as recovering would likely have a positive impact on one’s attachment to the landscape. Further research should explore this relationship in more detail. This discussion highlights the importance of helping residents restore their connections with the landscape after a disturbance to improve perceptions of recovery, which could then lead to more support for future fire and forest management goals related to allowing natural disturbances like wildfires to occur.
1.3 General insights about recovery perceptions and management implications

Another key finding from both studies was that, overall, people’s perceptions of landscape recovery were fairly positive even in the short period of 1-2 years following the fire. Some people in the interviews certainly had more negative evaluations, especially if they felt that preferred landscape conditions would not return in their lifetimes. However, even many of those residents described finding other parts of landscape to appreciate, like the presence of more birds and wildflowers than before the fire. We have anecdotal evidence of how perceptions can change from earlier work we did in Roundup. Specifically, our research team had conducted interviews in Roundup in 2013, the year after the Dahl Fire. Those efforts were focused more broadly on understanding the factors that affected people’s perceptions of the extremity of wildfire events. While perceptions of landscape recovery were not a focus of that study, at least one quarter of the respondents used terms like “moonscape” or a “bomb site” to describe the impacts, implying that they perceived the landscape to have been drastically affected by the fire. However, such terms did not come up in the interviews in 2014 about the current or future landscape condition. Similarly, in the quantitative study, even though the average rating for evaluations of recovery was negative for a few fires, it was positive for the majority of fires. The non-response analysis suggested that perceptions of recovery may be even more positive for the population. These findings suggest that people are aware of the post-fire landscape recovery process and generally evaluate the outcomes positively, even after a relatively short period of time following the event. These are positive indications regarding the adaptive capacity of WUI communities.

The ability to adapt to changes without any major long term disruptions in social or ecological functions is an important aspect of resiliency and adaptive capacity. Budgets for land management agencies are increasingly consumed by wildfire related expenditures. More than half of the U.S. Forest Service budget in 2015 was allocated to wildfire suppression and mitigation, up from 16% in 1995 (USDA, 2015). The agency projects that the number could be as high as 67% of the budget, or up to $1.8 billion annually, by 2025. These trends have serious implications for managers’ ability to
accomplish the wide range of their other goals and objectives beyond fire. In this sense, researchers, managers, and the public must work together to find ways to allow natural processes, including disturbances, to occur while also minimizing negative social impacts (Moritz et al., 2014; Smith et al., 2016). It is not sustainable to continue investing vast resources into wildfire suppression. A century of fire suppression has created dangerous situations in some areas where overgrown fuels lead to more abnormal fire behavior and where growing communities lead to more social risks. My research suggests that the concept of landscape recovery may provide an important opportunity for managers and community leaders to engage with the public towards goals of increasing support for management actions to restore and maintain healthy ecosystems.

The time immediately after a disturbance event can present a window of opportunity to engage with people to help them learn from that event in a way that mitigates negative impacts from future disturbances (Hystad & Keller, 2008; McGee, McFarlane, & Varghese, 2009). The landscape is something residents share. It is important to them for a range of reasons. Changes to the landscape are something they notice, and they are interested in the recovery trajectory as it relates to their values for the landscape. Thus, in the first year or two after a wildfire, the landscape impacts and recovery trajectory are likely salient issues among community members. The personal relevance and urgency of landscape recovery means that residents could be more attentive to messages from land managers about the ecological role of fire in the landscape, which would increase the likelihood of influencing their beliefs (Petty & Cacioppo, 1984). My research suggests that if managers can strengthen the beliefs that fires play an important ecological role in the landscape, especially in terms of values important to residents, then people may have more positive evaluations of landscape recovery. More positive evaluations of landscape recovery among the public could increase their support for future forest management efforts (e.g., prescribed burns) intended to mitigate negative social impacts from future disturbances while also harnessing the ecological benefits of those disturbances (Kneeshaw et al., 2004).
One of the most effective ways to strengthen people’s beliefs about the positive ecological role of wildfires in a landscape is to show them firsthand (Toman, Shindler, Absher, & McCaffrey, 2008). There may be misperceptions about the trajectory, especially in that first year, and engaging with the public can help align people’s expectations with the most likely trajectory based on climatic, ecological, and managerial influences. In many fire-dependent landscapes, vegetation tends to return fairly quickly after a fire (Lentile et al., 2007). Seeing that vegetation growth could ease concerns that the landscape might look like a “moonscape” or be destroyed forever. Site visits give managers the opportunity to use visual cues like post-fire vegetation growth to talk about important, underlying processes (e.g., nutrient cycling) that lead to the preferred or valued landscape features. Many of these features may depend on periodic wildfires. Using visual cues to talk about the ecological role of fire and how it relates to important landscape values may lead to more positive perceptions of landscape recovery and perhaps more support for future management goals that include permitting natural disturbances to occur.

These public engagement efforts could be especially important for fires of longer duration and for people in communities farther from the burn area. My findings suggest that, at least in the first two years after the fire, experiencing longer duration fires leads to more negative evaluations of the recovery process among the public. This could be due to a misperception that longer lasting fires lead to longer and/or less desirable recovery trajectories. Longer lasting fires may not, in fact, create more severe impacts or longer recovery trajectories (Keeley, 2009). Seeing and learning about the ecological role of fire and the actual recovery trajectory could help correct these misperceptions. Furthermore, results from the questionnaire across fires showed that living farther away was associated with more negative perceptions of recovery. People may not see the recovery process unfolding if they live farther away from the burned landscape. Thus, helping them see the changes firsthand and understand the ecological role of the fire could lead to more positive perceptions of landscape recovery.
People care about fire impacts to the landscape and the management actions taken to address those impacts (Ryan & Hamin, 2008, 2009). On some fires, especially ones of greater severity, extensive management efforts are taken to reduce social and negative impacts from the fire. Erosion control, seeding, and tree planting are conducted to prevent topsoil runoff and invasive species dominance. The public tends to be highly supportive of these management efforts for social and ecological reasons (Olsen & Shindler, 2010; Ryan & Hamin, 2008, 2009). Many people also want to be involved in the restoration and future management process, and including them in the process of managing public lands could help improve their relationships with land managers and other community members, restore connections to the landscape damaged by the fire impacts, increase their support for future management activities, and strengthen their understanding of the fire impacts and landscape recovery process (Burns, Taylor, & Hogan, 2008; Ryan & Hamin, 2006; Toman et al., 2008; Toman, Stidham, McCaffrey, & Shindler, 2013).

My findings validate the importance of tailoring land management efforts to meet diverse social and ecological goals. Some issues are salient for all people and therefore might be addressed with uniform communication. For instance, noticing more erosion problems was associated with less positive evaluations of recovery in both studies. Thus, reducing post-fire erosion problems is likely to improve people’s evaluations of landscape recovery. On the other hand, management approaches that emphasize aesthetics will only be relevant to people with particular aesthetic preferences. Likewise, focusing on forage quality will not be relevant to everyone. Therefore, managers must balance the different values among their constituencies. To do this, they can take advantage of temporal and spatial scale variation in fire impacts and recovery. For example, if one specific area burned in a fire is especially important for aesthetic reasons, then managers can use seeding and planting to influence the aesthetic aspects of short-term (e.g., faster growing grasses or plants) and long-term (e.g., trees) landscape recovery. Other areas may be valued more for their rich soils that lead to excellent forage quality. Management efforts in these areas could focus on establishing high quality forage through intensive seeding combined with aggressive control of invasive species. Thus, land managers, community leaders, residents, and other stakeholders can work
together to identify acceptable short- and long-term recovery trajectories and encourage management actions that meet those goals across the landscape.

2. Limitations and other challenges

Any research effort has limitations. One limitation relates to the unexplained variance in the regression analysis from Chapter 4. That analysis illustrated that nearly 50% of the variance in perceptions of recovery could be explained by several key predictor variables. This means that slightly more than 50% of the variance is still unexplained. While this remaining unexplained variance is a limitation, my findings are particularly encouraging because this level of variance explained is towards the higher end of explained variance typically found in other wildfire social science research (Absher, Vaske, & Shelby, 2009). Furthermore, this study is, to my knowledge, the first study to explain perceptions of post-fire landscape recovery with factors beyond focusing on aesthetic judgements and preferences (Islas & Vergera, 2012). Thus, these initial findings are encouraging and support the continued exploration of variance sources towards further explaining people’s perceptions of landscape recovery. An additional, though limited amount, of variance may be explained by contextual factors related to the wildfire and the community. More robust measures of individual’s experiences with fires and evaluations of more specific aspects of landscape in terms of recovery may further improve the model’s predictability.

While a strength of HLM is the ability to detect the amount of explained variance in an outcome variable that exists at different levels (e.g., the individual household or wildfire level), it may not explain the source of variation at those levels. It is likely that variance at higher levels (e.g., the wildfire) is due to complex interactions between contextual factors and various predictor variables (Bikel, 2007; Field, 2013). However, in my data, the HLM analysis confirmed that most of the relationships identified in the linear regression were consistent across the 25 fires. Even the variation that existed in key relationships across fires (i.e., the relationship between perceptions of recovery and two predictors, evaluations of erosion and beliefs about the ecological role of the fire) appears to be relatively minimal (approximately 5%) compared to the variation that exists across
individuals who experienced any of the 25 wildfires. Thus, although there was some variation in relationships between key variables of interest across fires, results reveal general consistency in the observed relationships.

Some people may consider a single case study approach, as used in the qualitative research for Chapter 3, to be a limitation. This stems from the difficulties related to generalizing the findings to other contexts, or even to other individuals in the same context. These concerns were largely addressed by the study for the fourth chapter across 25 different fires. Because the research questions and study design were both heavily influenced from an extensive review of theoretical and empirical literature, and given the overlap in findings from both of my empirical chapters, I expect that the factors revealed as important influences on perceptions of recovery would be important in other case study locations. Thus, while the degree of importance of each factor may vary, I expect the general relationships among variables to be similar.

One particular challenge relates to the larger context of this research. Specifically, it is important to recognize challenges associated with the scale of land management in the U.S. I have contended that efforts to positively influence public perceptions of post-fire landscape recovery can lead to more support for management actions intended to maintain the ecological role of disturbances. Empirical research has revealed this link (Kneeshaw et al., 2004). However, it is also important to recognize that many other factors affect support for management activities, and the importance of different factors can vary across contexts (Brunson & Shindler, 2004; Shindler et al., 2002). These factors include concerns about impacts to people’s safety, well-being, and property; lack of trust in land managers to make the right decisions or to be able to control a fire if weather conditions change unexpectedly; and varying beliefs about the effectiveness of different management actions. Furthermore, land management agencies are also constrained by limited resources and bureaucratic and procedural barriers that limit flexible approaches and major shifts in current approaches to disturbance management (North et al., 2015; Quinn-Davidson & Varner, 2012; Steelman & McCaffrey, 2011). Thus, increasing public
support to allow natural disturbances like fires to occur more frequently will require a multi-faceted approach, and public support is only one of numerous barriers.

3. Validity and reliability

Considering the validity and reliability of the research in my dissertation was an important part of the research process. These concepts have important implications for making inferences from the data, replicating the studies, and generalizing conclusions appropriately. The terms have similar implications across quantitative and qualitative research, though slightly different applications given the nature of each approach.

Validity refers broadly to the methodological soundness or appropriateness of the research design and the measures used to assess different constructs (Graziano & Raulin, 2010). This concept is generally discussed around two dimensions, internal and external validity. Internal validity typically refers to the accuracy of the findings (e.g., the extent of confidence in making causal inferences in experimental studies). In my quantitative research, it refers to the ability to infer that changes in the value of the outcome variable are solely related to changes in the value of the predictor variables. One important and relevant part of internal validity in my research which helps evaluate this inference is construct validity, which evaluates how well I measured what I intended to measure. Extensive reviews of theoretical and empirical literature helped ensure that the different constructs (e.g., place attachment or landscape connections) in the questionnaire were conceptually logical and, when possible, derived from empirically-developed scales previously shown to accurately and consistently measure the concepts of interest. Measures of reliability (i.e., Cronbach’s alpha) were used to validate the consistency of items in the questionnaire. This ensured that the different items used to measure a construct were related and indeed consistently measured that concept across participants. Most constructs in the questionnaire showed strong reliability and suggested the items’ responses were consistent across respondents. Some concepts have received minimal empirical attention, such as the items used to measure evaluations of landscape recovery, and these had smaller yet still acceptable levels of reliability. As discussed in Chapter 4, future research could improve the robustness and reliability of the recovery construct for
questionnaires. However, overall, these aspects of validity and reliability indicated a methodologically sound instrument.

External validity refers to the ability to generalize findings from a study to other people and contexts (Creswell, 2013). The methodological design for the research in my fourth chapter was especially unique and valuable in this aspect. It is one of few studies related to human dimensions of wildfire, or perceptions of landscape change, to collect data at a scale larger than an individual community or wildfire event. Given the range of fires and communities studied and the largely consistent findings across them, inferences can be made about the relationships between different constructs that likely apply to broader geographic and social contexts. While some of the specific outcomes of different variables may vary depending on characteristics of the fire, the fire impacts, and different community characteristics (e.g., differences between WUI archetypes described by Paveglio et al., 2015), the design enabled us to draw more confident conclusions about the relationships between the different variables than if the questionnaire had only been administered in one community or for one fire.

Furthermore, although nonresponse bias checks revealed some minor differences between respondents and non-respondents, overall they suggested that our respondents adequately represented the populations from which they were drawn. Given the wide geographic context of that study, strong measures of validity and reliability suggest that the study findings are likely to hold across other contexts.

Producing strong internal validity, particularly very accurate findings, can be a strength of qualitative research (Creswell, 2013). Multiple approaches were taken to ensure internal validity in my qualitative research for Chapter 3. One approach during data collection was to use member checking (Creswell & Miller, 2000) during the interviews to confirm that we were interpreting responses accurately. This involved follow-up questions to further explore the meaning behind a statement, and repeating and confirming statements made by the respondents before moving on to a different topic. Then, after each day of interviews, I, Dr. Paveglio, and a research assistant engaged in peer debriefing where we discussed our interpretations of key findings. This process was
important in ensuring that we were interpreting responses accurately in the context of the research. Accuracy of the transcripts was also checked by randomly selecting different interviews to listen to the audio while simultaneously reading the transcripts to ensure accurate transcription. Debriefing sessions, and listening to recorded interviews in the evening, were also valuable in terms of reliability because they ensured that we were asking the questions consistently across participants. Another aspect of reliability addressed during the analysis portion was using different coders to discuss and interpret the meanings of the responses. Three people helped develop and refine a codebook that included detailed descriptions of the different codes assigned to every line of text in the transcripts, as well as examples of each code. A statistical measure of reliability, Cohen’s Kappa, was then used during the coding sessions to ensure that we were consistently apply the different codes across the interview transcripts.

Though qualitative research enhances internal validity, it is relatively limited in terms of applying the specific findings from one study to another study or context (generalizability). Thus, it may not be appropriate to make specific claims about other potential case studies related to understanding perceptions of landscape recovery based solely on the findings from the interview in Montana. However, the factors that affected perceptions of recovery in the case study were also important predictors of recovery perceptions in the quantitative study that explored these relationships across a larger context. This suggests that exploring these relationships in future case studies would have some merit. Furthermore, I’ve provided detailed descriptions of how the interviews were designed, conducted, and evaluated. This accountability will significantly inform any future efforts to repeat the study at a different time and/or in different locations.

Thus, between the two studies in my dissertation, I have presented valid and reliable research. I used a mixed methods approach to understand and explain people’s perceptions of landscape recovery at a finer, in-depth, and more local scale, as well as at broader scales. I strongly believe that mixed methods social science provides the most accurate and thorough perspectives on any phenomenon of interest. The qualitative data provided in-depth, thick, and rich descriptions of the constructs and relationships between
them. This is evident in the lengthy results section in my third chapter where I included more examples and explanations than may be found in most manuscripts. Then, the quantitative research provided more insights into these constructs and relationships at a larger context. It also provided an opportunity to measure the strength of the relationships documented in the qualitative research using statistical techniques. For example, people’s beliefs about the ecological role of fire, as well as how they discussed different impacts (e.g., erosion) from the fire, were clearly important in the qualitative research. The quantitative research confirmed these relationships given the strength of predictors in the regression and HLM analysis.

4. Future research

I presented a research agenda in Chapter 2 associated with the conceptual framework of people’s perceptions of post-disturbance landscape recovery. Here, I elaborate on some of those suggestions and discuss others in the context of my empirical research in the third and fourth chapters.

The utility of my findings could potentially be strengthened through a rigorous interdisciplinary approach. Data from social science, remote sensing, and on-the-ground measures would help understand the actual recovery trajectory at finer and coarser spatial and temporal scales, which could assist interpretation of people’s perceptions of those changes. For example, the post-fire vegetation may be different than before the fire, but it is unclear how those differences would affect perceptions of recovery. Some people in the interviews described new vegetation as weeds, although this often implied that it was simply less desirable vegetation than the large trees that were present before the fire. Others did not make such a distinction. Ranchers talked about weeds more in terms of invasive species, which directly and negatively affect their livelihoods. Scientific observations of the vegetation would provide further insight into how people conceptualize different characteristics of recovery by knowing whether perceptions are influenced by knowledge of actual changes like increases in invasive species cover or mischaracterizations of these vegetation changes based on some other factor (e.g., a value or belief).
Characteristics of the vegetation could be included as predictor variables in the regression models. For example, analysis could include values from spectral indices, such as the differenced Normalized Burn Ratio (dNBR) or the Normalized Difference Vegetation Index (NDVI), derived from remotely sensed images that quantify changes in vegetation cover, net productivity, and overall greennis. Additionally, on-the-ground field data like plant height, species types, and vegetation density (especially compared to pre-fire conditions) could also be included. These efforts would further help managers identify any misperceptions about the actual recovery trajectory and help inform management efforts if people did prefer a specific pattern or type of vegetation.

Perceptions of landscape recovery should be investigated in different parts of the country or world. Although the combined methodological approaches in this study provide a fairly rigorous assessment of people’s perceptions of landscape recovery in the Pacific Northwest, there may be some differences across geographic contexts. One reason is the different ecological and climatic factors that affect fire regimes and the recovery process. These factors could lead to different recovery trajectories, like faster or slower post-fire vegetation growth than occurs in my study region. An interdisciplinary approach across different ecoregions would provide more insights into these possible relationships.

The research in my second chapter also focused on only two of the archetypes described by Paveglio et al. (2015). Based on their discussion and presentation of the typology, there could be reasons to believe that some findings would be different in formalized suburban and amenity based communities. This could stem from different past experiences with fire, different values to protect, more specific preferences regarding vegetation, and different beliefs about the ecological role of fires. Future research should continue to explore similarities and differences between the different archetypes, and including perceptions of recovery in those efforts would be interesting. This could confirm whether my findings about the impact of values, beliefs, and visual and aesthetic cues on perceptions of landscape recovery hold in different contexts. I would expect these main factors to remain important across archetypes, especially given their significance in the quantitative research across 25 different fires. However, the degree of their influence
could vary. For example, aesthetic and scenic evaluations of the landscape could be even more important to amenity-based communities where many people earn their livelihoods by means directly related to those elements (e.g., tourism, sightseeing, and real estate).

Future research efforts should include longitudinal data collection and analysis. This type of data is often lacking in research about human dimensions of natural resource issues, but is highly important given the dynamic nature of both social and natural systems (Stidham et al., 2014). Social and ecological characteristics change over time. For example, people’s connections to a landscape can change based on biophysical impacts from disturbances, as well as an influx of new residents who have different values for the landscape than older residents (Gordon, Gruver, Flint, & Luloff, 2013). Some impacts, such as erosion, are likely to last only a short period of time after the fire, but others could persist indefinitely, such as invasive species. Two years after the fire may be too early to notice any major changes in long term recovery trajectory.

At the time of my studies, the fires I included did not seem to have abnormal recovery trajectories. Although I cannot confirm these claims with data, the fire severity data for the Dahl Fire (Chapter 3), as well as available data for the 25 fires included in the quantitative investigation, indicate heterogeneous fire behavior typical of most fires. This means fires burned hotter and probably had different ecological impacts in different locations. Such differences often exist at a fine scale, meaning that some areas experiencing low burn severity can serve as biological legacies or seed sources for areas that experienced higher burn severity, so pre-fire species may return. However, under the right circumstances, disturbances (or suppression of them) can lead to major changes in the composition and functions of the ecosystem (Romme et al., 2009). These types of transitions are often referred to as phase shifts or state changes. For example, long-term fire suppression in sagebrush ecosystems permits the dominance of juniper trees. Grasslands could shift to shrub lands if fires are suppressed. Alternatively, different types of forest ecosystems could become dominated by grasses or shrubs depending on seed conditions and availability, as well as other climatic, ecological, and managerial factors like precipitation, temperature, species composition, and planting/seeding efforts. A state
change after a disturbance suggests that ecological resiliency was compromised. Future interdisciplinary research should examine recovery trajectories and perceptions of landscape recovery across landscapes exhibiting different degrees of post-disturbance recovery, including where state changes occur. These efforts would lead to a better understanding of which social and ecological dimensions of landscape change over time most affect perceptions of landscape recovery.
5. References


Bibliography


reduction activities in Oregon’s (USA) ponderosa pine ecoregion. *International Journal of Wildland Fire, 23*(1), 143-153.


Appendices
Appendix A. University IRB approval notifications for empirical research

July 25, 2012

To: Hall, Troy
Cc: Kooistra, Chad

From: Traci Craig, PhD
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Title: 'Case Study Research to Identify and Explain Social Characteristics and Impacts of Extreme Wildfire Events'

Project: 12-235
Approved: 07/24/12
Expires: 07/23/13

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

This approval is valid for one year from the date of this memo. Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.

Traci Craig

University of Idaho Institutional Review Board: IRB00000843, FWA00005639
June 19, 2013

University of Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010

Phone: 208-885-6162
Fax: 208-885-5752
itb@uidaho.edu

To: Troy Hall
Cc: Chad Koolstra

From: Traci Craig, PhD
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Title: 'Evaluating the effect of social and biophysical wildfire characteristics on perceptions of wildfire extremity and psychological well-being'

Project: 13-147
Approved: 06/18/13
Expires: 06/17/14

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

This approval is valid for one year from the date of this memo. Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.

Traci Craig

University of Idaho Institutional Review Board: IRB00000843, FWA00005639
**Date of Notification:** 09/19/2014  
**Study ID:** 6463  
**Study Title:** Understanding Social Aspects of Extreme Wildfires  
**Principal Investigator:** Troy Hall  
**Study Team Members:** Hannah Brenkert-Smith, Matthew Carroll, Melissa Clark, Sara Gress, Chad Kooistra, Travis Paveglio  
**Submission Type:** Initial Application  
**Date Acknowledged:** 09/19/2014  
**Level:** Exempt  
**Category(ies):** 2  
**Funding Source:** NASA  
**Proposal #:** 10051-R  
**PI on Grant or Contract:** UI PI: Allistair Smith  
**Cayuse #:** N/A

The above referenced study was reviewed by the OSU Institutional Review Board (IRB) and determined to be exempt from full board review.

**EXPIRATION DATE:** 09/18/2019

*The exemption is valid for 5 years from the date of approval.*

Annual renewals are not required. If the research extends beyond the expiration date, the investigator must request a new exemption. Investigators should submit a final report to the IRB if the project is completed prior to the 5 year term.

Documents included in this review:
- Protocol
- Consent forms
- Assent forms
- Alternative consent
- Letters of support
- Recruiting tools
- Test instruments
- Attachment A: Radiation
- Alternative assent
- Project revision(s)
- External IRB approvals
- Translated documents
- Attachment B: Human materials
- Grant/contract
- Other: OSU Specific Supplement

**Comments:** Data analysis only.

**Principal Investigator responsibilities:**
- Certain amendments to this study must be submitted to the IRB for review prior to initiating the change. These amendments may include, but are not limited to, changes in funding, study population, study instruments, consent documents, recruitment material, sites of research, etc. For more information about the types of changes that require submission of a project revision to the IRB, please see: [http://oregonstate.edu/research/irb/sites/default/files/website_guidancedocuments.pdf](http://oregonstate.edu/research/irb/sites/default/files/website_guidancedocuments.pdf)
- All study team members should be kept informed of the status of the research. The Principal Investigator is responsible for ensuring that all study team members have completed the online ethics training requirement, even if they do not need to be added to the study team via project revision.
- Reports of unanticipated problems involving risks to participants or others must be submitted to the IRB within three calendar days.
- The Principal Investigator is required to securely store all study related documents on the OSU campus for a minimum of seven years post study termination.
Appendix B. Map of 5 major fires in the Bull Mountains since 1984
Appendix C. Photos used during the interviews for Chapter 3

Photo A (2012 Dahl Fire, taken in 2013)

Photo B (2012 Dahl Fire, taken in 2013)
Photo C (2012 Dahl Fire, taken in 2014)

Photo D (2012 Dahl Fire, taken in 2014)
Photo E (1984 Hawk Creek Fire, taken in 2014)

Photo F (1984 Hawk Creek Fire, taken in 2014)
Appendix D. Codebook for interview transcript analysis (Chapter 3)

<table>
<thead>
<tr>
<th>Code name/theme</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Place values and connections | - any mention of any aspect of the Bull Mountains/Roundup area they value (e.g., why they live there)  
- includes when and why they moved there  
- could include things like privacy, aesthetics, trees, get away from the city…as long as it is in the context of being a reason they like (or don’t) like living there  
- also includes perceptions of why other people moved there or like living there  
- includes impacts on place (attachment) from the Dahl Fire if mentioned directly (e.g., I used to like this aspect of the area but the fire took that away)                                                                                                                                                                                                 | - “I just liked the mountains better, less traffic, liked the mountains, not as busy.”  
- “Just for a nice place to live. Just the seclusion, nice place live, close to Billings.”  
- “Well, these people that moved out here liked the timber, they thought this timber was pretty, which it is  pretty, they liked the pine trees, and they had them right up against the houses, they didn’t cut anything down, and after the fire I think they realized hey we need to keep these trees away from here.”  
- “I think if they are here for the right reasons they’ll find things to love about it, if they’re not then they should move on.”  
- “Well it is for the grasses, if you have cattle or something like that you’d be ok with it. If you’re going to move out into the country to have trees around I don’t think you would want to build there, it’s good grazing.”  
- “Trees are the main reason I moved out there. I wouldn’t move out to a place like with the one picture. I wouldn’t build a house out there.”  
- “It’s, from a ranching standpoint, there’s grass up in here, yes. There is a few trees coming, it’s gonna be another 10 or 15 years before you’re going to see many trees. From a ranching standpoint, yeah it’s recovered, from a scenic standpoint no it hasn’t recovered and it’s gonna take a lot of years. From ranching yeah, I like this standpoint, but from an owner of the land that wants multiple use out of it, I don’t, this isn’t recovered. This one (H) from a ranching standpoint is gonna be problematic because you won’t have any grazing and you will have some fire danger coming and you don’t have any logging coming.”  
- “Because of the loss of the trees, because this was a pretty nice little hiding hole when we bought it, you didn’t hear traffic off the highway, you didn’t hear nothing, now you can read the god damn advertisements on the side of the trucks. I’m not real happy with that at all.”                                                                                                                                                                                                 |
| Experience                  | - discussion about seeing the Dahl fire, or hearing about the Dahl fire on the radio, TV, or from someone else                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | - “I hear it on the radio, and the fire was way over on Goulding creek. I got a brother who lives on Harper creek about 5 miles west of here. I called him when I got to cedar ridge by billings. They were leaving. I could see the smoke...”                                                                                                                                                                                                                                                                                      |
• includes evacuation stories or stories about access and roadblocks
• conflict with law enforcement and fire officials during the fire
• includes rebuilding or not, moving to a different part of Roundup or completely away from the area because of the Dahl Fire
• includes perceptions of other people’s experiences (and all the above for other people)

just boiling up there. It was going more like NW. So I get home, run down the house, left my truck at the highway and told Toni that we need to start getting everything important.”
• “I don’t know. The fire scared them enough, they lost everything, or didn’t have the money to rebuild. A lot of people I know didn’t have insurance. Nobody carries enough insurance to replace everything. Cause they never think that is going to happen. “
• “It (dead trees) invokes a memory that was not fun to go through, when we left here I couldn’t get the pickup in gear, and all I saw was these little balls he says they were the pine cones exploding and coming in to, hitting the truck I wasn’t sure we were gonna make it out of there.”
• “Oh I think most definitely. Certainly made us more acutely aware, it made us realize we need to be better prepared as far as, you certainly think you know what you want to grab when the sheriffs are knocking on your doors saying get out. And you’re thinking all this stupid stuff and really the things I grab are memorabilia, things that can’t be replaced. We basically left here with the shirts on our backs because we were busy getting our horses and dogs out of here, that by the time we came back to get our own stuff, the sheriff was saying you can’t go back. And we are like, I don’t even have a change of underwear, too bad. But I was pretty happy because my concern was getting the animals out of here. And they were all safe and that’s all I cared about. I always say, anything can be replaced but we were lucky in the fact that it didn’t burn up.”
• “…they warned us to get out. I was at Laurie’s’ and that’s like 30 miles away. So we hopped in the station wagon and talked about what we would do when we got here cause we didn’t know what to grab. So I grabbed my files with all the bills and stuff and then ran through the house and grabbed all we could, like the dog, and I had a bird and I had a cat but we never found her, well we did later but we didn’t find her that day. When we left the ashes were already coming down, the stuff we grabbed up, she called over here and it was gone by then, so that’s the way it’s gone.”

Fire behavior
• usually refers to the Dahl fire or other fire in the area (like Hawk Creek or Majerus)
• fire spread, speed, intensity, heat, or other discussion about the behavior of the fire
• includes discussion about a typical fire (i.e. expectations)

• “It burned hot enough to kill the seeds, so I just wish there would be some remnants of it trying to come back. If we want them we will have to plant them”
• “Talk about his fire being crazy and missing one thing and leaving another. The only building standing was that one out there and I had a trailer next to it and it burned a tire off of this side and blackened it and the other tire was
perfectly fine. Can’t remember it it melted the light off or not. Melted half his tractor and not the other half. There was a house down here across from the bar a couple years ago. The trees were thick just like that, and it didn’t touch some of them and it should have. It didn’t take the house, it melted the siding and probably did terrible things to the inside from the heat. So this fire was not typical.”
- “Well that thing come over in a big ball, come right up to it, hit that roof, rolled off but it just kept going. (Inaudible)…unpredictable fire behavior, bit red ball. Another neighbor had trees right up the house, it burned that side and the bedroom and her kitchen a little bit, the rest of it didn’t scorch it. It was crazy.”

### Expectations/Typicality
- any discussions about what they expected to experience or see
- could be in terms of fire behavior, landscape impacts, and/or recovery trajectory
- “It was, it started over that way, small at first, in this territory they have a lot of trouble pin pointing it, and we had a wind come in and that was the difference right there, a lot of these other fires if you don’t have that wind they can get a handle on it. This one, when it took off, I guess when it hit my place, it was between 2 and 3000 degrees, they build their own heat. Seeing what happened you can understand that too.”
- “There isn’t a normal; T: what kind of fires do you expect to see?; M: “well, it depends on what the fuel and whether conditions are like. Since the environmental movement, since we quit harvesting the national forest, we got all these dead and dying forests cause they aren’t getting properly managed and there’s gonna be severe fires when you have that situation.”
- “Yeah, I would expect to see that because I went through Yellowstone one time right after a fire down there and it was just like black, black like Mt Saint Helens, trees weren’t tipped over.”

### Firefighting response
- attitudes (positive or negative) towards how a fire was fought (any fire)
- complaints about lack of fire fighter activity (not putting out the fire)
- complaints about officials and response
- includes evacuation procedures and road blocks
- being able to control the fire, including controlled burns (past and future or hypothetical)
- “I stayed and my son in law stayed. My wife left and they, my daughter left with all the animals and then they wouldn’t let them back in to help. We had 2000 gallons of water and a fire truck and they wouldn’t let that in to help us. So we had to fight it with garden hoses and tractor. Saved all our buildings, except for one old building. It caught on fire cause we were fighting a fire at the end of the arena. All these buildings were on fire, managed to get them out. Just lost one of the old old old barns.”
- “I don’t know. That fire was weird fire, the one in 2012. The Dahl fire was a strange fire. It would just, some of the shit it did was just unreal. Places that should have burned didn’t and places that shouldn’t have burned did. They wouldn’t let people back in. A lot of people would have went back to their
<table>
<thead>
<tr>
<th><strong>Property loss from fire</strong></th>
<th><strong>Landscape impacts from fire</strong></th>
<th><strong>Landscape recovery</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>includes their own firefighting efforts on their own property</td>
<td>any mention of property lost from ANY fire: buildings, vehicles, etc.</td>
<td>includes aesthetics and vegetation growth and changes in erosion conditions over time since the fire</td>
</tr>
<tr>
<td>places, they could have saved a lot of buildings, a lot of cars, a lot of stuff. I hold that against the county and highway patrol.”</td>
<td>“We had 2 mobile homes, ours and our sons, we lost a barn and 7 outbuildings, well/well house everything, and vehicles. Had a farm truck down there burned it, a pickup, a trailer. It was so hot. When we got back down here, all this stuff appliances, you couldn’t tell what it was. The only thing we found that don’t burn in the fire is corningware and stainless steel.”</td>
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</tbody>
</table>
may relate specifically to grass for forage or range, could include reference to weeds
includes expectations (what they expected)

Devastation is what it is. Obviously it’s going to come back, but all of this right here this is all going to pixie itself and turn into a pile of pixie sticks and rot.”

“And we were kind of hoping, of course we didn’t lose hardly anything, but we kind of thought that area that burned might grow better grass and it’s just wildflowers and weeds, we got no grass coming back.

“Then the grass it heads out, those seeds are going to fall back in there, birds are going to spread them around. Grass seed is phenomenal in what it lasts through. You just ain’t gonna have the goddang green. How long will it take trees to come back? Like in the Bitterroot where we lived in that, Ponderosa Pine they reseed that, Lodge pole they reseed and need a fire to open up the pod to seed, where ponderosa pine don’t. I think the deal with the ponderosa pine its moisture, and cones. There should be a lot of ones on these trees this year after the spring we had because they had a lot of new growth on them and everything.

“Oh jeez, the birds, first the cowbirds came in, no the woodpecker, so we’re feeding them off the front porch, and then the pond down below filled up with geese and ducks…but ecologically it’s really amazing because we’ve seen things that we’ve never seen before, and all of a sudden I mean 9 years living here and all this golden rod up here and then a neighbor said oh I think they must have flown over and planted the seed and they planted too much golden rod, you know, no, that didn’t happen I would notice.”

“He had a natural fire guard. I think in those places you’re going to get a lot more weeds and stuff come back but I guess you know like I said, we need the trees I think in this country to act as a natural control for the erosion and for the water and stuff. it makes it soak into the soil better and that’s something I’ve said all along. You can definitely have too many trees too.”

“I think it will eventually fall on its own and the bugs will get in there.”

“We definitely got more bugs, it didn’t kill the pine beetles like we hoped. Them things are invincible.”

“And the grass any place there was a fire and the grass is coming back, the grass has come back twice as good as normally it would be. A lot of it due to the fact that now you don’t have any cover from those trees any more. This place is out there where you could hardly walk through the trees because they were so thick. They were all that big around and 6 inches away from each other and fighting for sunlight. But now that you don’t have all that cover the
| Other fires | • includes everything above, but for fire other than Dahl  
• also use this anytime they mention other fires in any context or topic  
• includes fires in the Roundup area (e.g., Hawk Creek, Delphia, Wilson, Majerus Rd) and other places like **Yellowstone** or anywhere else referred to by the participant  
• includes when talking about other fires when the respondent is shown pictures from hawk creek fire |
| --- | --- |
|  | • “You drive through Yellowstone park and you see the fires they had and it’s really growing back fast in a lot of it, but they get a lot of snow, a lot more water than we do, so, everything is relative, if you’re living there you don’t want it to burn down, if you don’t live there well, even that’s kind of controversial, I don’t see any reason just to arbitrarily get out of hand and destroy and bunch of natural resources, but at the same time if it’s remote and overgrown and there’s nothing you can do about it, then that’s it, so be it, you know.”  
• “Well like I say I outfitted for all those years, and they had it closed down so tight, no grazing or nothing, and all you were waiting for was a match or lightning to strike and it needs to be cleared every so often. I hate to see them get too big. And you know what the Yellowstone fire was, I remember having at 5:00 in the afternoon and you couldn’t see across the… street lights come on, pine cones on cars.”  
• “No that was east of us, we had one in 69 that burned about half of the place, we’ve had little fires, there’s always lightning fires, for some reason these bull hills attract a lot of lightning.”  
• “Well, it’s interesting how those fires go. We had a fire that burned on the homeplace in 69, and by the time 30 years came by, there was a lot of dog hair coming back. when 30 years had gone by on this Hawk creek fire there wasn’t hardly any trees, quite few trees coming in that now, but it was 84 so…that’s 30 years and there’s just trees here and there.”  
• “We had grass and we always brought water up there, since then it’s been a well-watered ranch. The only bad part of that fire in 84, the first year after the fire it took all the vegetation so we had some flooding. Now this Dahl fire, this end and some of the people had some flooding issues. The Dahl fire was a month earlier than the Hawk Creek fire, it burned some trees and had some hot spots but didn’t have the devastation on the trees as the hawk creek did. There was some flooding towards this end, on the ranch itself we had very little flooding. We did get the loggers to come in this winter and they cleaned up the old dead trees, which the one in 84, those trees fell down it took them a decade to fall down and then we tripped over them and we still trip over them. Where this fire, we got loggers in there so we won’t have that problem.”  
• “Yeah, well you got some trees that are still alive there, you’ve got the benefit of at least something growing and they’re gonna cast off some things too, I
think that’s in pretty good shape. Naturally, I don’t know if that would happen, you’re talking about the fire out on the divide, that’s 30 some years ago and it doesn’t look like that.”

| Other disturbances | • usually in reference to risks, or that there is always some type of disturbance you have to worry about and in Roundup it is fire  
• the point is when they are comparing fires to other disturbances (like an anchor)  
• floods, tornados, windstorms, hurricanes, etc. (just not fires) | • “I guess it’s just something you got to live with. Like snow. Snow or rain, got to deal with it. Keep everything trimmed down. Don’t do stupid shit. Hope your neighbor don’t.”  
• “You look at down south, you’ve got something there, you’ve got your tornados, you’ve got your floods. I don’t care where you go, there’s gonna be something, I mean live with it, and look at those people who are totaling wiped out. Oh of course, and they’re rebuilding right there until the next tornado comes around.”  
• “If everywhere you live, whether it’s tornado alley or along the hurricane coast or the mudslides in CA you all pick a spot where you have to be responsible and this could happen. If you’re not willing to say this could happen to me, then dig a hole and climb in it. Pull the dirt in after you. Unfortunately, you know, I feel bad for people who lost their homes, but the thing is there’s a certain amount of responsibility that every human has to take living on the planet.” |

| Wildfire’s ecological role in the landscape (beliefs about it) | • discussion about fire’s role in the landscape/ecosystem (in general, in Roundup/Bull Mountains, and/or in another location)  
• good or bad thing including specific attributes like regeneration, invasives, birds, flowers—as related to fire  
• knowledge related to fire’s role in the ecosystem  
• mental models of fire including ignition and fuels buildup and regeneration process  
• may include attitudes about prescribed fire if in terms of reintroducing fire for ecological benefits  
• anytime they talk about a healthy forest or landscape | • I’m gonna age myself, 20 to 30 years ago I said fire is fantastic because it cleaned out a lot of the areas and it got the vegetation back. These guys were really happy because it’s a natural progression for plants for what we’re used to.”  
• “Well I have heard that fires are good for the land and they were always a natural thing until we started building in the mountains and stuff. So you hear than and I know it’s good for the trees and the soil and the land, it cleans up all the, you know, that’s great. But for those of us that choose to live here it’s not so great. So, it’s a real catch 22 I think. You’d love to let it burn and do what it’s supposed to do. But yet if there’s homes in the way you can’t let it happen.”  
• “I think it’s a great thing. Other people will argue this point. But it’s mother nature’s way of cleaning it out. The areas that have not had fires or have not been logged, the forest there is in poor condition. To keep a healthy forest, you either need to log it or have a fire.”  
• “Oh yeah, the grass is there. This Delphia fire actually cleaned up where it burnt out here, it burned a bunch of this stuff from the 84 fire, so it was
- references related to cleaning up the forest
- make conditions better for wildlife
- helpful, cleaned it up, all that stuff that was dead and tipped over laying on the ground, it all burnt.”
- “I think it’s better for the regrowth because when they fall they got to rot into the ground and if it’s clear the grass comes in a little better but I mean the grass will fill in around them when they fall.”
- “Well the park is good evidence of that, I haven’t been up there personally, read some things, I don’t know if the timber is coming back like it should and that’s probably the only downfall. I guess as far as the animals and that, it’s been pretty beneficial for wildlife.”

Mother Nature
- any time mother nature is mentioned
- or anything like “it’s nature’s way” or “that’s just nature”
- could also include any mention of God
- does not have to only be related to recovery
- “Mother Nature cleans herself up in her own way, and now she’s letting things grow back, and the timing of moisture has been good.”
- “No we have not had those huge rains like we got last year. Mother nature in the raw can be pretty ugly. The first one that came down brought all the ash and black and crap. It over ran all the approaches here, that coulee out here was completely full and it was such a mucky mess it didn’t even drain right away…. But it was, after that it was done it was kind of like mother nature knew, and how she cleaned that, and it left probably close to a foot and a half of silt in this coulee.”
- “I think it’s a great thing. Other people will argue this point. But it’s mother nature’s way of cleaning it out. The areas that have not had fires or have not been logged, the forest there is in poor condition. To keep a healthy forest, you either need to log it or have a fire.”
- “We were hoping to get a lot more of those trees down. We’ll just let nature take its course and it will eventually rot over time and we will have good grass and everything else.”
- “That might enrich the soil here and there or whatever, but I’m not looking at it from nature’s standpoint, I’m looking at it from my own personal standpoint, that’s what we enjoy is the trees.”

Historical landscape
- description of the landscape before (any) fire
- includes aesthetics or what the landscape and/or the Bull Mountains looked like in the past
- not mitigation efforts, basically just what it looked like before the fire (usually the Dahl, but could be other fires too)
- “This is way back in the turn of the century when he came up here. He told me that his grand dad told him that there wasn’t hardly a tree in these bull mountains because the Indians burned it off. Every time they leave they set a fire to it, because they knew it would be better next year with new growth and stuff. He said there was hardly a pine tree up here, but when the white man settled they quit burning and the pine trees kept growing, and you look around, so these pine trees are so thick, you know where it had never burned, it was so thick, choked all the grass and everything out.”
- seeing photos from earlier generations, ancestors or historical documents
- 1900’s
- Native Americans and Indians use of the landscape (usually in terms of fire)
- Smokey bear

- “Good for cows. The Indians used to burn all this. It burned this for hundreds of years they burned it. That’s why they call it the Bull Mountains, there’s always bulls up there, bull elk and bull buffalo. They burned it. They burned it all the time. This always burned. People don’t realize that. Once it burns, there was always water running. This creek ran year round at one time, with all the trees it sucked all the water up. I noticed more water. I think there’s a lot more water now after those fires around here anyway.”
- That would be awesome, like I say I don’t know this forestry guy I was talking to, his whole you’re not going to get any trees, maybe he is thinking of the reseeding as far as natural reseeding. So maybe they came in and tried to reseed. If you look at pictures from this area from like 1901 there were like no trees here. It’s amazing. Little tiny clumps of a little pine tree here and a little pine tree here. But if you go back and look at the Bull Mountains in the early 1800s, they were not here.”
- “Yeah, because it was before the homesteader period so it was burning on a natural cycle until the homesteaders came in then the homesteader were like well we can’t, they couldn’t lose their grass for a year cause their wasn’t enough. So they kept putting it out and pretty soon they put it out put it, then that fucking smokey the bear showed up. He put the last nail in the coffin. He bit us all in the ass, it was a terrible idea. Everybody should say save the forest and throw a cigarette butt out.”

Attitudes about fires and people (or forest and fire management)

- whether or not fire should be used in areas where people live (wilderness, national forest, wui)
- more general
- can be past, present, or future
- local forests or anywhere else
- doing prescribed burns
- suppression vs letting fires burn
- Statements related to ‘it’s just something you live with’ (could overlap with other disturbances)

- “That’s kind of the same thing but you know what there’s the human element involved, there’s the danger involved, there’s the expense involved, and you know, maybe if it’s in a certain area and you expect it, I don’t know.”
- “No, I do not believe in let it burn. It gets too out of control, and I’m an animal lover and animals die in that, a lot of them die in that.”
- “I think yes, I think they should attack it as quickly as possible and put it out. I’d rather see them log it than burn it. Use it. Even if they sell it for firewood to people in town, pulp mills, paper.”
- “I think it has a purpose, they can be a very good tool used at the right time and in a controlled environment. I think if we had more of them, you wouldn’t have situations like you had in the Dahl fire where you just can’t stop it because it’s so thick and there’s no access out there was another issue in these subdivision areas.”
- “Well I know they’ve come down with the policy, and they’ve done this with the park (Yellowstone) because of the fire in 88, let it burn, and they’re doing
that to rejuvenate the forest and I can understand them doing that, I can see it’s beneficial especially if nobody lives around it or can be affected by it. I can see the point of it. Some of the problems with that is when you get into some of these contained fires they have things get away from them. I don’t know if it’s 40% or 30% of the time. It’s a good thing but it’s not something they have a handle on, to control it effectively all the time. I guess it’s a necessary evil. It’s done wonders in the park where they had the fire.

- “There’s no way that you’re going to control it or fight it or whatever, just let it burn out. That’s the drawback. I like the idea of the controlled burns and that, I like what that can do to the health of the forest, but it’s kind of flipping a coin, you’re taking a chance.”

Mitigation activities (pre-fire)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>thinning and logging, any defensible space measures (to homes/building or property)</td>
<td>“We did everything we could to prevent that, but there was no way to prevent an inferno like we had. It was 150 foot flames, you just don’t stop that. Now a ground fire, we had a good shot at it, I had my limbs cut off the ground, I kept the weeds trimmed down, stacked and burned all my brush, we mowed, we had gravel around our house, rock around our house, metal roof, you couldn’t, we had done everything right, except have big balloon over head with a million gallons of water.”</td>
</tr>
<tr>
<td>includes whether or not it is responsibility of land owner or government</td>
<td>“All you can do is try to keep that thinned out as much as you can. Although as dense of a forest or trees that I had in the region that burned where I was at, that’s just about an insurmountable thing to do. I had one outfit come out there and clearcut, of course they were going after a certain type of tree, and that helped a little bit. Bottom line it didn’t keep the fire out. I guess if you’re gonna have trees of any density in the area, for fire coming through, decimating it. You would have to do a lot of work.”</td>
</tr>
</tbody>
</table>

Post-fire land management

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>salvage logging, seeding, planting, erosion control on own property, and other’s property</td>
<td>“If the government can, if there’s a cost share to cut some of the expense down, that is probably good, otherwise I think it is your own responsibility. The government can only do so much and it’s your own property you have a responsibility to take care of it yourself, that’s my feeling.”</td>
</tr>
<tr>
<td>also includes discussion of NOT doing these activities as well</td>
<td>“I think they should have seeded it. You know they have all these programs.”</td>
</tr>
<tr>
<td>whether or not it is responsibility of landowner or government</td>
<td>“Oh yeah. I think these real thick burn areas it’s fantastic, there was nothing in there as a seed base so it has to creep in and the weeds will come first and then the grass. But this way [seeding] you help it. The creeping is faster and you can get what you want in there.”</td>
</tr>
<tr>
<td>includes mitigation for the NEXT fire</td>
<td>“Forest Service should have been in here replanting trees for us, they have a service that does that, they do it in the national forest. We used to know a guy...”</td>
</tr>
</tbody>
</table>
who strapped a pack on he was out there planting trees all day long, they paid him to do it. We get nothing out here. The amount of money that they wanted us to invest to plant trees that we had to go out and water every day, how in the hell are we gonna do that on 20 acres!".

**Future fires**
- discussion about the likelihood of future fires, often related to the probability of dead trees and grasses burning
- could relate to beetle kill, fire potential after the burn (dead trees lead to more beetles which could lead to fires)
- described mental model of fuels and/or climate and leading to FUTURE fires
- includes mitigation for the next fire

  - “All the grass we got this year, with the rain. If it stays hot, this thing will be a cracker box here. With the dead timber still around and the grass and weeds.”
  - “I think anywhere, especially anymore as the weather patterns change and there’s more drought. Anybody that lives anywhere that’s as heavily treed as this area, it’s just something you have to anticipate is gonna happen.”
  - “Oh yeah, everybody is concerned with the weeds. If this grass dries out and catches fire like it did 2 years ago this ground I’m sure it will be pretty devastated because it will burn it down to white powder like charcoal ash from all these trees.”

**Social Capital and/or community aide**
- discussion about help from other people and organizations (e.g. Red Cross) to help people recover losses and rebuild
- includes discussion about having insurance or not

  - “We had a family, good friends of ours, from north Dakota one day with their cat, early in the morning. Brought a bunch of groceries and spent the entire day cleaning up. Wouldn’t even take a dime for it. Left that night. Their neighbor heard where they were going and said well they must be good folks and handed them $400 to give to us. All this furniture in here was mostly given to us from people. 90% of what is in here is gifts. And (name) we have another pasture, he lived next door and his did not burn out. He’s been down here, sawing almost for a year every day and he would bring his tractor. And my son came down from Alaska and spent two months. And local people would stop by and do what they could and bring groceries or whatever. Get a check in the mail when we least expected it, funds would get low then wow. God was taking care of us.”

**Dahl fire PHOTOS**
- when I show them and we discuss dahl fire pictures (ID letter: S, K, N, E, and G)

**Hawk Creek PHOTOS**
- when I show them and we discuss hawk creek pictures (ID letter: H and A)

**Subdivision resident**
- people who live in the subdivided areas of the Bull Mountains, does not include ranchers
- select/code the very top/name of the interview, no text

**Rancher/farmer**
- use this for ranchers, farmers, loggers, current or retired
- select/code the very top/name of the interview, no text
Appendix E. Map of the 25 fires and key (Chapter 4) (see proceeding table for key)

Figure A.1 Map of the 25 fires for Chapter 4 research
### Appendix E Continued

**Table A1** Map identifier, fire name, year, state, duration, and size of the 25 fires

<table>
<thead>
<tr>
<th>Map identifier and wildfire name</th>
<th>Year</th>
<th>State</th>
<th>Duration (days)</th>
<th>Size (acres)</th>
<th>Evaluations of landscape recovery *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pony</td>
<td>2012</td>
<td>MT</td>
<td>14</td>
<td>5,156</td>
<td>0.46 ± 0.90</td>
</tr>
<tr>
<td>2 Sheep</td>
<td>2012</td>
<td>ID</td>
<td>61</td>
<td>48,636</td>
<td>0.07 ± 1.14</td>
</tr>
<tr>
<td>3 Cascade Creek</td>
<td>2012</td>
<td>WA</td>
<td>33</td>
<td>20,098</td>
<td>0.57 ± 0.81</td>
</tr>
<tr>
<td>4 West Garceau</td>
<td>2012</td>
<td>MT</td>
<td>11</td>
<td>9,862</td>
<td>0.68 ± 0.92</td>
</tr>
<tr>
<td>5 Manila Creek</td>
<td>2012</td>
<td>WA</td>
<td>3</td>
<td>1,620</td>
<td>-0.02 ± 0.81</td>
</tr>
<tr>
<td>6 Antoine 2</td>
<td>2012</td>
<td>WA</td>
<td>4</td>
<td>6,838</td>
<td>0.54 ± 0.93</td>
</tr>
<tr>
<td>7 Springs</td>
<td>2012</td>
<td>ID</td>
<td>18</td>
<td>6,154</td>
<td>0.07 ± 0.90</td>
</tr>
<tr>
<td>8 Buffalo Lake Road</td>
<td>2012</td>
<td>WA</td>
<td>5</td>
<td>11,302</td>
<td>0.52 ± 0.79</td>
</tr>
<tr>
<td>9 Hickey</td>
<td>2012</td>
<td>OR</td>
<td>3</td>
<td>2,805</td>
<td>0.37 ± 0.71</td>
</tr>
<tr>
<td>10 St Mary’s Mission Road</td>
<td>2012</td>
<td>WA</td>
<td>12</td>
<td>16,853</td>
<td>0.83 ± 0.63</td>
</tr>
<tr>
<td>11 Nineteen Mile</td>
<td>2012</td>
<td>MT</td>
<td>9</td>
<td>4,233</td>
<td>0.42 ± 0.92</td>
</tr>
<tr>
<td>12 Taylor Bridge</td>
<td>2012</td>
<td>WA</td>
<td>15</td>
<td>28,077</td>
<td>0.45 ± 0.88</td>
</tr>
<tr>
<td>13 Pine Creek</td>
<td>2012</td>
<td>MT</td>
<td>2</td>
<td>9,589</td>
<td>0.45 ± 0.90</td>
</tr>
<tr>
<td>14 McCall</td>
<td>2012</td>
<td>WA</td>
<td>2</td>
<td>1,031</td>
<td>-0.33 ± 0.99</td>
</tr>
<tr>
<td>15 Sawtooth</td>
<td>2012</td>
<td>MT</td>
<td>56</td>
<td>5,927</td>
<td>-0.25 ± 1.06</td>
</tr>
<tr>
<td>16 Highway 141</td>
<td>2012</td>
<td>WA</td>
<td>8</td>
<td>1,635</td>
<td>0.62 ± 0.77</td>
</tr>
<tr>
<td>17 Wenatchee Complex</td>
<td>2012</td>
<td>WA</td>
<td>83</td>
<td>95,090</td>
<td>0.44 ± 0.80</td>
</tr>
<tr>
<td>18 Corral</td>
<td>2012</td>
<td>MT</td>
<td>7</td>
<td>1,851</td>
<td>0.14 ± 0.83</td>
</tr>
<tr>
<td>19 High Cascade Complex</td>
<td>2011</td>
<td>OR</td>
<td>43</td>
<td>44,498</td>
<td>-0.13 ± 0.58</td>
</tr>
<tr>
<td>20 Salmon</td>
<td>2011</td>
<td>WA</td>
<td>5</td>
<td>2,014</td>
<td>0.44 ± 0.85</td>
</tr>
<tr>
<td>21 Monastery Complex</td>
<td>2011</td>
<td>WA</td>
<td>14</td>
<td>3,683</td>
<td>0.39 ± 0.92</td>
</tr>
<tr>
<td>22 Pole Creek</td>
<td>2012</td>
<td>OR</td>
<td>39</td>
<td>26,795</td>
<td>0.16 ± 0.89</td>
</tr>
<tr>
<td>23 Alder Springs</td>
<td>2011</td>
<td>OR</td>
<td>4</td>
<td>1,588</td>
<td>0.48 ± 0.88</td>
</tr>
<tr>
<td>24 Elk</td>
<td>2011</td>
<td>OR</td>
<td>1</td>
<td>1,167</td>
<td>0.49 ± 0.60</td>
</tr>
<tr>
<td>25 West Riverside</td>
<td>2011</td>
<td>MT</td>
<td>24</td>
<td>3,566</td>
<td>0.32 ± 0.87</td>
</tr>
</tbody>
</table>

*This is the mean and SD, for each fire, of the factor created from the three items measuring perceptions of landscape recovery. Higher means correspond to more positive evaluations of landscape recovery.*
Appendix F. Initial cover letter sent to questionnaire participants (Chapter 4)

Unique ID: XXXXXX
Address
Address line two
Address line three

Hello,

My name is Sara Gress. I am a graduate student at the University of Idaho conducting a study about peoples’ perceptions of social and ecological impacts from wildfires, including attitudes towards wildfire management. Your name was randomly selected to take part in my study, and I would like to invite you to participate by completing a survey about your perceptions of the XXX Fire, which burned near your community.

Your answers will provide fire managers and community leaders with important information about public perceptions of wildfire impacts, and how to best incorporate your thoughts and concerns into future fire management and public communication.

The survey should take about 20 minutes to complete. Your participation is voluntary, and you are free to stop completing the survey at any time. Your answers will be kept strictly confidential. Your name will not be connected to any of your responses. To take the survey, please enter the following link into the address line of your web browser: www.link.com

Please make sure to enter your UNIQUE ID (located at the top of this letter) into the first question of the survey, and please remember that the questions ask about this specific fire. Please complete the questionnaire by August XX, 2013. As a gesture of thanks for your valuable time and help, your name will automatically be entered into a drawing for one of ten $50 Visa Prepaid cards when you complete and submit the survey.

If you have any questions about this project, please contact me or Dr. Troy Hall. Thank you for your time and participation.

Sincerely,

Sara Gress, University of Idaho
Dept. of Conservation Social Sciences
Ph. 208-885-7911, Email: saragress@uidaho.edu

Dr. Troy Hall, University of Idaho
Dept. of Conservation Social Sciences
Ph. 208-885-7911

To enrich education through diversity the University of Idaho is an equal opportunity/affirmative action employer
Appendix G. First reminder postcard sent to participants in the Chapter 4 research

Dear Resident,

We contacted you about a week ago to participate in our study about people’s perceptions of impacts from the XXXX fire, including opinions on wildfire management. If you have already followed the link to the online survey and filled it out, thank you very much for your time and input! Your input will help inform wildfire and forest management decisions in the future.

If you have not yet had the opportunity to complete this survey, please do so. Remember that when you complete the survey, your name is entered into a lottery for one of ten $50 Visa Pre-paid cards.

SURVEY LINK: www.tinyurl.com

Please enter the link located above into your internet browser address bar and enter the Unique ID into the survey when prompted. Please complete the questionnaire by August XX.

Feel free to contact us if you have any questions. Thank you in advance for your help!

Sara Gress

Dr. Troy Hall
Appendix H. Second letter sent to participants with questionnaire hard copy in Chapter 4 research

Hello <<firstName>>,

You should have received a letter and a postcard during the past few weeks inviting you to participate in our study about your perceptions of wildfire impacts and opinions on wildfire management. If you have already completed our survey, thank you very much! I really do appreciate your feedback. Your responses will assist fire managers and community leaders with future wildfire management decisions and effective public communication.

If you have not yet had the opportunity to complete this survey, I have enclosed a paper version of the survey for your convenience. The questionnaire should only take about 20 minutes to complete and you can simply mail it back to me in the enclosed pre-paid return envelope.

Remember that you will be answering about impacts from the <<fireName>> fire, which burned near your community. Even if you feel that you were not personally impacted by the wildfire, your answers will still be helpful and we will appreciate your response. Please complete the survey by October 24, 2013.

We understand that this requires some time and effort on your part, so in a gesture of thanks, after you complete the survey your name will be entered into a drawing for one of ten $50 cash gift cards.

Your responses are completely confidential, and your name will not be released to anyone. Please feel free to contact either myself or Dr. Troy Hall if you have any questions, concerns or comments about this survey or project. Thank you in advance!

Sincerely,

Sara Gross, University of Idaho
Dept. of Conservation Social Sciences
Moscow, ID 83844-1139
Ph. 208-885-7911, Email: saragress@uidaho.edu

Dr. Troy Hall, University of Idaho
Dept. of Conservation Social Sciences
Ph. 208-885-7911
Appendix I. Final reminder postcard sent to participants in Chapter 4 research

Hello,

I have been inviting you during the past few weeks to participate in our study about impacts from the XXXXX fire. Thank you for your feedback if you have completed the survey! Your help is much appreciated. Your input will help inform wildfire and forest management decisions in the future.

If you have not had the chance to complete the survey, you can still send in the paper version of the survey that was mailed to you. Please contact me if you misplaced the survey or did not receive a paper copy in the mail. The completion deadline is October 24. Even if you feel that you were not personally impacted by the wildfire, your answers will still be helpful. The questionnaire will only take about 20 minutes, and once completed your name will be entered into a drawing for one of ten $50 cash gift cards.

Thank you again for your time and participation!

Sara Gress, M.S. student
Dr. Troy Hall, Professor
Appendix J: Questionnaire for research Chapter 4

Your Attitudes and Perceptions of Wildfire Impacts

Unique ID: <<XXXX>>
This survey asks questions about your personal experience with wildfire and about your perceptions of wildfire impacts. The questions will ask you to consider a certain wildfire that occurred in your area, which is listed on the cover letter we enclosed with this survey. Please think only about that wildfire as you complete the survey. So we can be sure we're talking about same fire, please write the name of the specific wildfire below.

Wildfire name (from cover letter): __________________________________________

The following questions ask about your opinions and feelings prior to the wildfire.

**Question 1.** Prior to the wildfire, how unimportant or important were forested and wildland areas in your decision to live in the area where the wildfire burned?

- [ ] Very unimportant
- [ ] Moderately unimportant
- [ ] Neither important or unimportant
- [ ] Moderately important
- [ ] Very important

**Question 2.** Prior to the wildfire, which of the following best describes your personal experience with wildfire? *Mark all that apply.*

- [ ] I had no experience with wildfires
- [ ] I understood that there was a risk from wildfires in this area
- [ ] I had seen wildfires in this area
- [ ] I had been negatively impacted by wildfire
- [ ] I had fought wildfires in this area
- [ ] I did not believe that wildfires were likely to impact me personally
**Question 3.** How ineffective or effective were communications from professional fire authorities about wildfire risk in this area prior to the wildfire?

- [ ] Very ineffective
- [ ] Somewhat ineffective
- [ ] Neither ineffective or effective
- [ ] Somewhat effective
- [ ] Very effective
- [ ] Not applicable

**Question 4.** To what extent do you disagree or agree with the following statements?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I felt informed about what would happen in the event of a wildfire.</td>
<td></td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) I felt prepared to act if a wildfire impacted my household.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

The following questions ask about your perceptions of the wildfire characteristics and behavior during the event and threats/damages to property.

**Question 5.** In your opinion, how typical or atypical was the wildfire for the area where you live?

- [ ] Very typical
- [ ] Somewhat typical
- [ ] Somewhat atypical
- [ ] Very atypical
- [ ] Don't know
**Question 6.** To what extent do you disagree or agree about the following statements about the wildfire characteristics?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The size was bigger than a typical wildfire in the area</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) The wildfire was closer to homes than a typical wildfire in the area</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c) The wildfire burned more intensely than a typical fire in the area</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>d) The wildfire spread more rapidly than a typical wildfire in the area</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>e) The wildfire burned longer than a typical fire for this area</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>f) The wildfire conditions (e.g. wind, temperature) were unusual</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>g) The wildfire exhibited unusual behavior</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

**Question 7.** Did the wildfire suddenly threaten homes and property?

- □ Yes
- □ No
- □ Don’t know
**Question 8.** How much do you disagree or agree with the following statements about the wildfire?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The total amount of damage to property caused by the wildfire surprised me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Firefighting authorities were overwhelmed by the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) My household had very little time to prepare for the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) I felt that firefighters would protect people and property from being harmed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Private homeowners' actions before the wildfire (for example, removing vegetation, installing a metal roof) were ineffective in preventing damage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following questions ask about your opinions on wildfire management *during* the wildfire.

**Question 9.** How displeased or pleased were you with authorities' communication about the following topics during the wildfire event?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Very displeased</th>
<th>Somewhat displeased</th>
<th>Neutral</th>
<th>Moderately pleased</th>
<th>Very pleased</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Information about potential risk to people and property</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Information about mandatory evacuations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Information about road closures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Status updates about damages to private property</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Firefighting briefings for the public</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Information about recreation area or public lands closures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Plans for or status of vegetation restoration efforts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Availability of aid for people impacted by the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Information about the cause of the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Question 10.** To what extent were you displeased or pleased with the following aspects of the way the wildfire was managed?

<table>
<thead>
<tr>
<th></th>
<th>Very displeased</th>
<th>Somewhat displeased</th>
<th>Neutral</th>
<th>Somewhat pleased</th>
<th>Very pleased</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Initial efforts to put out the wildfire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Protection of private property</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) Use of local help to fight the wildfire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) Community member efforts to work together to organize, communicate, and provide support for each other during or immediately after the wildfire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Question 11.** If you have any other comments about the management of THIS wildfire, please use the space below to explain.
The following questions ask about personal and community impacts resulting from the wildfire.

**Question 12.** To what extent did the following events negatively impact you personally? For each item, please indicate whether or not it happened to you. If it did happen, please also mark how much you were negatively impacted.

<table>
<thead>
<tr>
<th>Did it happen to you?</th>
<th>If yes, how much were you impacted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Loss of income due to wildfire or its impacts</td>
<td>No</td>
</tr>
<tr>
<td>b) Discomfort from smoke</td>
<td></td>
</tr>
<tr>
<td>c) Health problems from smoke</td>
<td></td>
</tr>
<tr>
<td>d) Inability to go to work</td>
<td></td>
</tr>
<tr>
<td>e) Planned for evacuation</td>
<td></td>
</tr>
<tr>
<td>f) Evacuation from home</td>
<td></td>
</tr>
<tr>
<td>g) Sustained injury or death</td>
<td></td>
</tr>
<tr>
<td>h) Death of animals, livestock, and/or pets</td>
<td></td>
</tr>
<tr>
<td>i) Reduced home or property value</td>
<td></td>
</tr>
<tr>
<td>j) Damage to your home</td>
<td></td>
</tr>
<tr>
<td>k) Home was destroyed</td>
<td></td>
</tr>
<tr>
<td>l) Suffered property damage other than to your home</td>
<td></td>
</tr>
</tbody>
</table>
**Question 13.** Did *someone you know* experience the following impacts from the wildfire? Please mark *yes* or *no* for each item.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Loss of income due to wildfire or its impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Discomfort from smoke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Health problems from smoke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Inability to go to work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Planned for evacuation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Evacuation from home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Sustained injury or death</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Death of animals, livestock, and/or pets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Reduced home or property value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j) Damage to a home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k) Home was destroyed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l) Suffered property damage other than to the home</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question 14. To what extent do you disagree or agree with the following statements about the impact of the wildfire on you and your community?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I quickly recovered from the impacts of the wildfire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Everyone in this area has recovered from the wildfire</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) The wildfire did not have much impact on my life</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) The wildfire resulted in long-term changes to the way people here live</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Question 15. Are residents in the process of rebuilding or have they rebuilt any homes or structures that were destroyed by the wildfire? Mark one.

☐ No homes or structures were destroyed by the wildfire
☐ None of the homes or structures destroyed by the wildfire have been rebuilt or are in the process of being rebuilt
☐ Yes, some of the homes or structures destroyed by the wildfire have been rebuilt or are in the process of being rebuilt
☐ All homes or structures destroyed by the wildfire have been rebuilt
☐ I don't know
These questions ask about your perceptions of the landscape and ecosystem after the wildfire.

**Question 16.** How much do you disagree or agree with the following statements about your connection to the landscape after the wildfire?

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The wildfire made this area less attractive</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) The impact of the wildfire on forests and/or rangelands made me less happy about living here</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c) I feel less of a connection to the landscape after the wildfire</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>d) My outdoor recreational habits were negatively impacted by the wildfire</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>e) Places in the landscape that I care a lot about were negatively impacted by this wildfire</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>f) I felt a sense of loss as a result of impacts to the landscape</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>g) The wildfire improved the look of the landscape</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>h) Although the wildfire changed the landscape, I still feel very attached to it.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>i) The wildfire caused erosion problems</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
**Question 17.** To what extent do you disagree or agree with the following statements about the ecosystem functions after the wildfire?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Moderately disagree</th>
<th>Neither agree nor disagree</th>
<th>Moderately agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I am concerned that the landscape will not recover from the wildfire impacts for at least a generation</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>b) This wildfire improved the health of the landscape</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>c) The wildfire helped restore wildlife habitat</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>d) I considered moving from this area because of the wildfire impacts</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>e) The wildfire was a natural and healthy part of the landscape</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>f) I am concerned that the ecosystem components (for example, wildlife, plant species) and processes (for example, water and nutrient cycling) will never be the same after this wildfire</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>g) The landscape is recovering from the wildfire more quickly than I had anticipated</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
<tr>
<td>h) Vegetation is coming back, but it consists of different types of plants than before</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
<td>![Box]</td>
</tr>
</tbody>
</table>
**Question 18.** Have any of your perceptions about wildfire impacts to the landscape changed since immediately after the wildfire? If so, please explain.

The following question addresses the wildfire's impact on your well-being.

**Question 19.** Mark the extent to which you experienced the following as a result of the wildfire.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>A lot</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I felt helpless as a result of the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) I lost sleep as a result of the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) I felt anxiety about the wildfire damaging my property</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) I felt anxiety about the wildfire injuring me or my family</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) My health suffered as a result of the wildfire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following questions ask about the effect of the fire on the local economy and your daily routines.

**Question 20.** To what extent did the wildfire negatively or positively impact the local economy?

<table>
<thead>
<tr>
<th>During Fire</th>
<th>Large negative impact</th>
<th>Moderate negative impact</th>
<th>No impact</th>
<th>Moderate positive impact</th>
<th>Large positive impact</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Fire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 21.** How long were you evacuated from your home as a result of the wildfire?

- I was not evacuated
- Less than one day
- 1 – 6 days
- 1 – 4 weeks
- More than 1 month

**Question 22.** How long did impacts from the wildfire affect your daily routines?

- Not at all
- Less than one day
- 1 - 6 days
- 1 - 4 weeks
- 1 - 5 months
- 6 months - 2 years
- It still affects my daily routine
Question 23. Please use the space below to provide any additional comments about wildfires, wildfire management or any topic relating to this survey.

To understand more about your community, we have a few questions about you.

Question 24. Are you male or female?

- [ ] Male
- [ ] Female

Question 25. What year were you born?

Question 26. Please indicate the highest level of education that you have completed.

- [ ] Less than a high school degree
- [ ] High school degree or GED
- [ ] Some college or post high school training
- [ ] Two year technical or associate degree
- [ ] Four year college degree (BA/BS)
- [ ] Advanced degree (Master’s, JD, MD, Ph.D.)
Question 27. Are you a permanent (year-round) or part-time resident of the community where the wildfire burned?

☐ Permanent  ☐ Part-time

Question 28. How many years have you lived (even if part-time) at this residence?

______________ years

Question 29. How close was the wildfire to your house?

☐ More than 10 miles  ☐ 5 – 10 miles  ☐ 1 – 4 miles  ☐ Half mile – 1 mile  ☐ Quarter mile – half mile  ☐ Less than quarter mile  ☐ The wildfire burned through or around my property

Question 30. What is the approximate size of your property that is near where the wildfire burned?

______________ acres

Question 31. Do you live in or within one mile of a community with a population of at least 2,500 people?

☐ Yes  ☐ No
Question 32. How close is your nearest neighbor to your property line?

- Less than 100 ft
- 100 - 500 ft
- 500 ft - 1/4 mile
- 1/4 to 1/2 mile
- 1/2 to 1 mile
- More than 1 mile

Question 32. Is your employment or any source of income related to forests and/or rangelands?

- Yes
- No

Question 33. Please indicate the level of your current household income before taxes.

- Less than $20,000 per year
- $20,000 to $39,999 per year
- $40,000 to $59,999 per year
- $60,000 to $79,999 per year
- $80,000 to $99,999 per year
- $100,000 to $149,999 per year
- $150,000 or above

Question 34. Please check the box that most accurately describes your political orientation on the following scale:

Strongly Liberal

Strongly Conservative
Question 35. Please indicate your race/ethnicity below. You may select more than one.

- Black/African-American
- White/Caucasian
- Hispanic, Latino, or Spanish Origin
- American Indian or Alaskan Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Other or Unknown

Question 36. To better understand people’s answers on this survey, we may want to contact you in the future. Would you be willing to participate in a phone interview (it would last about 30 minutes)?

YES_____ If so, what is the best phone number or email where you can be reached?

_____________________________________________________

Is there a particular day of the week or time of the day that works best for you?

Day_________________________ Time_______________________

NO_____, I do not wish to participate in an interview.

Thank you for your help! Please feel free to contact Sara Gress, Dr. Hall or Dr. Paveglio if you have any concerns or additional comments regarding this survey.

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Edward R. Murrow College of Communication
Pullman, WA 99164-2520
Email: TravisPaveglio@wsu.edu
Appendix K. Ranges of means and standard deviations across fires for the outcome variable and the predictor variables

Table A.2 Ranges of means and standard deviations across fires for the outcome variable and the predictor variables

<table>
<thead>
<tr>
<th>Item (or factor)</th>
<th>Mean*</th>
<th>SD*</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Perceptions of landscape recovery (factor)</td>
<td>-0.33</td>
<td>0.83</td>
<td>.58</td>
</tr>
<tr>
<td>Beliefs about ecological role and forest health (factor)</td>
<td>-0.61</td>
<td>0.64</td>
<td>.70</td>
</tr>
<tr>
<td>Post-fire landscape attachment (factor)</td>
<td>-0.79</td>
<td>0.37</td>
<td>.69</td>
</tr>
<tr>
<td>Employment or income dependence on the landscape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceptions of biophysical characteristics of the fire (factor)</td>
<td>-0.43</td>
<td>1.00</td>
<td>.51</td>
</tr>
<tr>
<td>Had seen fires before</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years lived in the area</td>
<td>9.63</td>
<td>29.05</td>
<td>4.58</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>-0.33</td>
<td>1.30</td>
<td>.73</td>
</tr>
</tbody>
</table>

*Scale of -2 to 2 for variables measured with a Likert scale. See respective Tables 1-5 in text for additional information. *Note, Min mean is for the fire with the lowest overall mean of that item or factor; Max mean is the fire with the highest overall mean of the item or factor. Similar interpretations apply to the SD columns. The column with % yes/no shows the maximum % of people on any fire who answered yes, and the maximum % of people on any fire who answered no.