The Influence of Communication for Perceptions of Smoke Emissions and Prescribed Fires in Fire Dependent Areas

Thesis

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By

Kathleen M. Rose, B.S.

Graduate Program in Environment and Natural Resources

The Ohio State University

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Master's Examination Committee:

Eric Toman, Advisor

Robyn Wilson

P. Charles Goebel

Abstract

In recent years, wildland fires have increased in extent and magnitude. At the same time, the number of people living in fire prone ecosystems has increased dramatically, placing more people and private property at risk from future fire events. Prescribed fires are important ecosystem management tools as they efficiently reduce fuel loadings and the risk and damage from wildfire outbreaks. Substantial research has demonstrated consistent public support for the use of prescribed fires in fuels reduction efforts. However, continuing and significant public concern regarding smoke emissions and negative air quality impacts remains and has the potential to negatively influence public acceptance of prescribed fires. These concerns also provide an opportunity to examine the impact of communication approaches on variables influencing perceived risks and benefits that may contribute to support for smoke management and prescribed fires. This presentation reports results from two studies designed to assess the influence of information on beliefs and attitudes towards smoke emissions and acceptability of prescribed fire.

In the first study, a mail-back/internet survey was sent to residents living nearby four National Parks in high fire risk areas. Path analysis was used to apply the Risk Information Seeking and Processing (RISP) model to the hazard of smoke emissions in order to examine the motivating factors behind information seeking behaviors. The second study employed an experimental design to test the influence of message frames based on Construal Level Theory and Hazard Acceptance models. An online pre-test/post-test survey with an experimental message frame was sent to residents living near three of the National Parks included in the previous study. Message frame influence was tested for a few variables, including prescribed fire and smoke emissions acceptance and participant knowledge.

A number of important findings resulted from the studies. First, participants in both studies indicated they were concerned about smoke emissions from prescribed fires. Second, general support for the RISP model was found and residents indicated they intended to seek more information about smoke emissions, with a number of factors contributing to this intention. Finally, information exposure and message frames were found to impact the tested variables, including worry about and acceptance of smoke emissions. The factors that encourage residents to seek information and the message frames examined here offer important insights for fire managers intending to communicate about prescribed fire and smoke emissions management.

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Vita

2008..Bishop Watterson High School

2012..B.S. Environment and Natural Resources,
The Ohio State University

2012 to present ....Graduate Fellow, School of
Environment and Natural Resources,
The Ohio State University

Fields of Study

Major Field: Environment and Natural Resources

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Chapter 1: Introduction

Introduction

In certain ecosystems, fire is a natural disturbance and plays an important ecological role by encouraging regeneration and removing invasive species (Agee, 1996; USEPA, 1992). However, years of active fire suppression by land managers have caused many of these natural systems to become "unhealthy" with unnaturally dense vegetation sometimes dominated by non fire-adapted species (Agee, 2005; Hardy, 2005; USDA, 2004). Despite ongoing fire suppression efforts, the last few decades have seen an increase in the number of acres burned by wildfires and, in many cases, the severity of resulting impacts (Hardy, 2005; NIFC, 2013). At the same time, the number of individuals living in the wildlife-urban interface (WUI), the area where human development and structures intermix with natural areas, has also increased dramatically, resulting in more individuals and private property potentially at risk from future fire events (Radeloff et al., 2005; Hammer, Stewart, & Radeloff, 2009). In response, natural resource management agencies such as the U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land Management (BLM), and state forest agencies are actively managing vegetation in fire-adapted ecosystems to restore conditions and reduce the likelihood of wildfires (defined as an "unplanned, unwanted wildland fire… where the objective is to put the fire out" (NWCG, 2012). Prescribed fires are one management technique commonly used in these efforts.

Prescribed fire is "any fire ignited by management actions to meet specific objectives" (NWCG, 2012). Among the goals that can be accomplished through the use of prescribed burns are: reducing excess fuel loading, restoring more natural conditions by spreading seeds and creating forest openings to encourage new growth, and controlling pests or invasive species (Agee, 1996; USEPA, 1992).

Active fire suppression over the years has contributed to several changes in fire-adapted ecosystems including dead tree branches, needles, and other litter accumulating on the forest floor. Meanwhile, the composition of the vegetation was often altered to include a greater density of understory vegetation, increase prevalence of non fire-adapted species, and a substantially greater density of trees. These changes have increased the likelihood and intensity of fires by providing a more continuous fuel bed to carry fire through the system as well as ladder fuels that can enable flames to climb from the forest floor into the canopy (Agee 1996; USDA, 2004; USEPA, 1992). Prescribed fires are designed to remove the excess fuel loads and shift the species composition towards more natural levels; accordingly, these fires can help decrease the risk of wildfires (Agee, 1996; USEPA, 1992). To address wildfire impacts, agencies have increased their use of prescribed fire over the last two decades (NIFC, 2013).

However, prescribed fires carry their own risks as well. First and foremost, nearby communities have expressed concerns with the potential for escaped prescribed fires that may threaten lives, damage private properties, and result in negative ecological impacts (Blanchard & Ryan, 2007; Brunson & Evans, 2005; Martin, Bender, & Raish, 2007). In addition, even when prescribed fires are completed within planned parameters, the resulting smoke emissions may negatively affect nearby communities (Brunson & Evans, 2005; McCaffrey, 2006; Shindler, Toman, & McCaffrey, 2009). Such concerns may be exacerbated when local residents lack confidence in the ability of agency managers to effectively implement prescribed fire treatments (Brunson, 2008; Shindler et al., 2009; Winter, Vogt, & McCaffrey, 2006).

As the number of prescribed burns and wildfires rises, it is crucial to involve the public, particularly WUI residents, in fire and fuels management decisions. Considerable research has demonstrated high levels of support among the WUI residents for the use of prescribed fire (e.g., Bowker et al., 2008; Cvetkovich & Winter, 2008; Shindler et al., 2009). But this research also has identified resident concerns about resulting smoke emissions and their impacts on air quality (e.g., Brunson & Evans, 2005; McCaffrey, 2006; Shindler & Toman, 2003; Shindler et al., 2009). Indeed, Shindler and Toman (2003) found that over a period from 1996 to 2000, residents were more likely to indicate that smoke emissions were a problem and less likely to agree that emissions were acceptable if prescribed burns have positive outcomes.

Smoke emissions can result in a number of negative air quality impacts, including deleterious health effects (such as eye, airway, or sinus irritation, coughing, chest pain, or headaches), unpleasant odors and discomfort, visibility reduction, road closures or traffic delays, building evacuations, and personal property damage (Monroe, Watts, & Kobziar, 1999). Importantly, smoke emissions have more severe impacts on sensitive populations, such as older adults, children, or those with respiratory conditions including asthma, allergies, or heart or lung disease (USEPA, 2003; Winter, Vogt, & Fried, 2002). Several studies have also found that approximately 30% of households in the WUI contained at least one member with a health problem which could be exacerbated by exposure to smoke emissions (Frederick, 2013; McCaffrey, 2006; McCaffrey & Olsen, 2012). Given existing concerns for smoke emissions, the significant number of households with related respiratory ailments, and the potential large number of people impacted by smoke emissions, effective management of smoke emissions and communication of smoke risks are critical to continued acceptance of prescribed fire programs.

Communication

Communication efforts have long accompanied agency fire management programs. Research has identified a strong association between participant understanding of prescribed fire treatments (i.e., those who are more knowledgeable about prescribed fires and their impacts) and acceptance of their use (see review in Toman, Stidham, McCaffrey, & Shindler, 2013). Several studies have also found that providing information on prescribed fires (through a variety of methods) can influence participant understanding and/or acceptance of prescribed fire use (e.g., Bright, Manfredo, Fishbein, & Bath, 1993; Loomis, Bair, & González-Cabán, 2001; McCaffrey, 2004; Toman & Shindler, 2006a; Toman, Shindler, & Brunson, 2006). The influence of this information on beliefs and attitudes towards prescribed fire may be affected by a number of factors, including the information source, the method of communication, or prior support or opposition to the issue (Bright et al., 1993; McCaffrey, 2004; Toman & Shindler, 2006b; Toman et al., 2006).

Three communication theories can contribute to a more robust understanding of resident interactions with smoke emissions and prescribed fire information: the Risk Information Seeking and Processing (RISP) model, Psychological Distancing and Construal Level Theory (CLT), and Hazard Acceptance Models. These theories are briefly introduced here and discussed in greater detail within the subsequent chapters.

The Risk Information Seeking and Processing (RISP) model is used to examine the factors that motivate individuals to seek additional information on a perceived risk and employ more effort to process the information. The model posits that such behaviors are influenced by knowledge levels, hazard perceptions, and views about the information source, among other factors (Griffin, Dunwoody, & Neuwirth, 1999).

Psychological Distancing and Construal Level Theory (CLT) are related theories that examine how perceived distance between an individual and ideas, experiences, or others may influence an individual's consideration of those entities. Generally, these theories postulate that entities more removed from the self (temporally, spatially, socially, or in terms of likelihood of experiencing a particular event) cannot be directly experienced and are considered more abstractly (Trope & Liberman, 2010).

Lastly, Hazard Acceptance Models examine the acceptance of a hazard as a function of the perceived risks and benefits of that hazard. People are more likely to accept a particular hazard when the hazard is perceived as having high benefits and low risks. Furthermore, the risks and benefits are inversely related and cannot be considered independently; that is, hazards that are perceived as highly beneficial tend to be perceived as low risk, and vice versa (Siegrist, 1999).

Rationale

The increasing prevalence of wildfires, use of prescribed fires, and population in the WUI have strengthened the need to better understand the factors that motivate people to seek information regarding smoke emissions and management and how risk communication efforts may influence beliefs and attitudes towards prescribed fires and smoke management. This study seeks to examine how WUI residents interact with information on smoke emissions and prescribed fires. More specifically, we examine the information seeking behaviors and motivators of residents and the influence of message framing on public perceptions of smoke emissions and prescribed fires. Discovering how residents use and interact with smoke emissions information can help guide future communication efforts and help agency managers seeking to build knowledge and support of fuels treatments among WUI residents. The objectives of this research are to:

1. Assess information seeking intent and motivating factors regarding smoke emissions and management through model development.
2. Develop and examine the effectiveness of various communication message frames on hazard perceptions, beliefs, and knowledge toward smoke emissions and their management.

Study Area

Data for this project was collected in four study areas further described below (Figure 1.1).

1. *California, the Shasta-Trinity National Forest*. Located in northern California, this National Forest consists of chaparral and conifer forests. Fire regimes in this forest include both infrequent, stand-replacing fires and frequent, low to moderate severity fires (JFSP, 2011a; JFSP, 2011b).
2. *Montana, the Kootenai National Forest*. Located in northwest Montana, this National Forest consists of mixed conifer forests including douglas-fir, lodgepole pine, and spruce-fir. Fire regimes include a mix of infrequent, low to stand-replacing severity fires (JFSP, 2011a; JFSP, 2011b).
3. *Oregon, the Fremont-Winema National Forest*. Located in southern Oregon, this National Forest consists of ponderosa, lodgepole pine, and mixed conifer forests. The ecosystem experiences moderate frequency, low to mixed severity fires (JFSP, 2011a; JFSP, 2011b).
4. *South Carolina, the Francis-Marion National Forest*. Located in southeastern South Carolina, this National Forest consists of longleaf pine and hardwood forests and the fire regime consists of high frequency, low severity fires (JFSP, 2011b).

The study sites include adjacent private lands surrounding each of these National Forests and contain substantial WUI communities. Active fuels reduction programs are underway at all sites to reduce the likelihood of fire and restore forest conditions. As such, residents are likely to have previous experience with fire and smoke emissions.

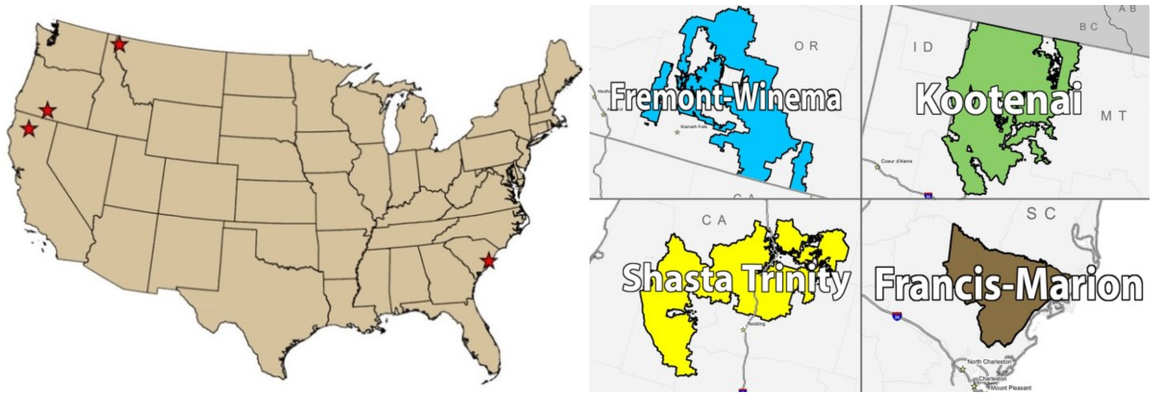


Figure 1.1. Study site locations (clockwise from top left): Fremont-Winema National Forest, Oregon; Kootenai National Forest, Montana; Francis-Marion National Forest, South Carolina; Shasta-Trinity National Forest, California.

Project Overview

The study is the final phase of a collaborative research project led by researchers at The Ohio State University and Oregon State University. The overall goal of the group's work is to determine what factors influence public acceptance of smoke and examine how acceptance is influenced by different communication strategies. The research project outlined here builds on the previous work of the research team and was completed in two stages.

Stage 1: Seeking Smoke Emissions Information: Application of the Risk Information Seeking and Processing (RISP) Model

The first study involves the development of a risk information seeking and processing (RISP) model to examine the factors that encourage individuals to seek information about smoke emissions and management. The model was developed based on responses to a mail-back/internet survey completed at all four study sites: California, Montana, Oregon, and South Carolina. Four RISP models examining smoke information-seeking behaviors were tested to determine the best representation of both the RISP model and the survey data, with the further development of the model balancing these criteria.

Stage 2: Framing Messages about Prescribed Fire and Smoke Emissions

The second study involves testing the influence of communication messages on participant knowledge, beliefs, and attitudes toward smoke emissions, smoke management, and the use of prescribed fires. We developed an experiment comprising a pre- and post-test survey with exposure to a communication message. The survey and messages were administered online in three of the previous study sites: California, Oregon, and South Carolina. A total of seven informative message treatments were developed based on risk communication literature, the Hazard Acceptance Model, Psychological Distancing, and Construal Level Theory.

Conclusion

The two studies described above seek to increase the body of knowledge concerning smoke emissions from fire by applying psychological theories of risk to the context of fire management. Results from this work will add to the existing literature on the social science aspects of fire and fuels management (see recent review in Toman et al., 2013). Moreover, we anticipate this research will also provide on-the-ground benefits as managers seek to better engage their local communities in fire and smoke management decisions.

Chapter 2: Seeking Smoke Emissions Information: Application of the Risk Information Seeking and Processing (RISP) Model

Introduction

Smoke emissions from prescribed and wildfires are an important issue for many Wildland Urban Interface (WUI) residents. Over the last two decades, the number of acres treated by prescribed fires in the United States has increased (NIFC, 2013). However, despite the rise in prescribed fire use, the last few decades have seen an increase in the number of acres burned and both the intensity and magnitude of wildfires (Hardy, 2005; NIFC, 2013). Over the same time the population in the WUI has also grown, resulting in more residents that may be potentially exposed to smoke emissions (Hammer et al., 2009; Radeloff et al., 2005). Smoke emissions may result in irritated sinuses, coughing, and headaches among exposed populations; such impacts may be particularly significant for the approximately 30% of WUI households that contain individuals who have additional health problems that may be exacerbated by smoke (Frederick, 2013; McCaffrey, 2006; McCaffrey & Olsen, 2012; Winter et al., 2002). How these local residents perceive the management of smoke emissions is likely to be an important influence in the continued support for the use of prescribed fires. Should WUI residents decide the negative costs associated with smoke emissions outweigh the benefits offered by prescribed burns, it may become difficult for land managers to implement prescribed burns in the area (McCaffrey, 2006; Weisshaupt et al., 2005). Accordingly, resource managers are looking for ways to more effectively manage smoke emissions and potential impacts on nearby populations.

One such effort is through development of messages that provide information regarding the benefits of prescribed fires, describe actions taken by fire managers to reduce smoke emissions, or identify potential behaviors of residents that may minimize the impact of emissions, among others. Previous research has found that a variety of information on prescribed fires and communication methods may influence public attitudes and beliefs towards the use of prescribed fires (e.g., Bright et al., 1993; Bright, Carlos, Vaske, & Absher, 2006; Loomis et al., 2001; McCaffrey, 2004; McCaffrey, 2006; McCaffrey & Olsen, 2012; Shindler & Toman, 2003; Toman et al., 2006). Substantial research has found that fuel treatment acceptance is positively associated with greater understanding of the treatment and likely outcomes of its use (e.g., Absher & Vaske, 2006; Blanchard & Ryan, 2007; McCaffrey, 2004; Shindler & Toman, 2003). However, little research has examined the relationships between informational messages and beliefs or attitudes toward smoke emissions.

Such communication efforts can be informed by the substantial prior research in risk communication. A "risk" is defined as "the chance, within a time frame, of an adverse event with specific consequences" (Burgman, 2005, p. 1). Risk perceptions are intuitive judgments about a risk that are a function of two general components: how much the hazard posing the risk is feared or how catastrophic the outcomes are likely to be ("dread") and how much is unknown about the hazard (Burgman, 2005; Slovic, 1987).

Substantial research has discovered that risk perceptions can be affected, either positively or negatively, by the provision of information designed to evoked specific feelings (e.g., Keller, Siegrist, & Gutscher, 2006; Slovic, Finucane, Peters, & MacGregor, 2004). Keller et al. (2006) found that risk perceptions can be increased by providing information which results in negative emotions or causes potential negative outcomes to be considered or recalled. However, limited research has examined the factors that motivate residents to seek information about smoke emissions. The purpose of this paper is to begin to address this research gap by examining the information seeking behaviors of WUI residents regarding smoke emissions from wild and prescribed fires. Specifically, we apply the Risk Information Seeking and Processing (RISP) model to better understand the underlying variables that motivate information seeking behaviors of residents in four study locations.

Background

Risk Tolerance

Research suggests that individual tolerance is influenced by the magnitude of the risk (lower tolerance when consequences are perceived as severe), the visibility of the hazard (less tolerance for high profile risks), how the risk is distributed (lower tolerance when impacts are perceived as falling unequally on some individuals rather than being distributed equally across society), the ability of the individual to control their exposure and resulting impacts (greater tolerance for risks that can be easily controlled), and whether the risk can be entered into voluntarily (more tolerance for voluntary risks) (Burgman, 2005; Slovic, 1987; Slovic et al., 2004). As noted above, prior research has also found that tolerance is influenced by the level of uncertainty and dread associated with the consequences (Burgman, 2005; Slovic, 1987; Slovic et al., 2004).

Applying these findings to the use of prescribed fire and resulting smoke emissions suggests that a prescribed burn may be perceived as a high magnitude event due to potential smoke inundation or the potential for the fire to escape containment. There is evidence that prescribed fires may be viewed as difficult to control, resulting in uncertainty regarding outcomes, and that negative effects, including smoke emissions, may be inequitably distributed with greater impacts to unhealthy or sensitive individuals (Winter et al., 2002). Residents' risk tolerances for prescribed fire and smoke emissions may also be reduced by perceived low levels of personal control over burn plans and the involuntary nature of resulting risks; this particularly seems to the be case when residents feel they were not involved in the decision making process prior to a burn or when they have limited trust in fire managers (McCaffrey, 2006; Shindler & Toman, 2003; Vaske, Absher, & Bright, 2007; Winter et al., 2006).

Prescribed burns also have the potential for highly dreaded and visible consequences. Potential consequences may include damage to private properties, negative health effects of smoke inhalation, or traffic accidents resulting from reduced visibility (Winter et al., 2002). Moreover, aesthetic impacts to natural areas due to fire may be highly visible following fires and contribute to concerns about negative ecological effects of fire use. Smoke emissions in particular have the potential to not only influence those near the treatment site, but also others who may be far removed as weather patterns may disperse smoke across the landscape.

While the actual number of prescribed burns that result in escapes may be quite low (some estimates place the rate at 0.08%) (WFLLC, 2013), those that do escape or result in heavy, long lasting smoke events are likely to be publicized and raise the profile of potential negative impacts of prescribed fire use. For instance, in 2012, ten people were killed and 21 were hospitalized in a multi-vehicle crash in Florida following an accident caused by smoke emissions from a nearby brush fire in combination with fog blanketing the highway. The story made national news (CNN, 2012) and highlighted potentially severe consequences of smoke emissions.

Affect and Availability Heuristics

Heuristics are a type of information processing which relies on simple “gut reactions” or peripheral cues (such as the credibility or mannerisms of the communicator) to make judgments about the messages or determine agreement rather than the merits of argument itself (Fishbein & Ajzen, 2009). Generally, individuals tend to be “cognitive misers” who limit the amount of effort employed to process information whenever possible (Fiske & Taylor, 2013; Griffin et al., 1999). By relying on cues within the messages themselves, individuals use shortcuts (or heuristics) to make quick judgments about presented information rather than carefully considering the embedded arguments or information (Fiske & Taylor, 2013). While such an approach is adaptive and helps individuals manage the vast amounts of information they are exposed to daily without being overwhelmed (Fiske & Taylor, 2013), it limits the depth at which individuals are likely to process information about smoke emissions or any other topic. Moreover, heuristics are also susceptible to cognitive biases that may limit their effectiveness in evaluating risk information (Fishbein & Ajzen, 2009; Slovic et al., 2002). Two cognitive biases, affect and availability, appear particularly influential for risk perceptions toward prescribed fires and smoke emissions.

The affect heuristic occurs when an individual relies on the emotional experience or response (affect) associated with an event to develop a judgment of the related risk (Keller et al., 2006; Plous, 1993; Slovic et al., 2002). If individuals have negative feelings towards an event, they are likely to consider the event as being high risk (and hence low benefit). Similarly, when affective judgment is negative, individuals are also likely to expect few benefits will be provided, making the perceived risk relatively high.

The availability heuristic occurs when decisions about the probability of an event are made based on how easy it is to recall an example of the event (Keller et al., 2006; Slovic et al., 2004). Generally speaking, events that occur more frequently are more likely to come readily to mind than those that occur less frequently; however, events with particularly severe consequences or those that are highly vivid (defined as being easy to imagine or picture and influenced by factors such as the closeness in space or time to the individual and strength of associated emotions) may be readily recalled even if they happen infrequently (Slovic et al., 2004).

Moreover, these two heuristics may interact; perceived affect has been shown to influence the perceived probability of an event (Keller et al., 2006; Plous, 1993). Strongly emotional events, whether negative or positive, are likely to be more vivid and more available in memory and, thus, they are likely to be recalled more easily than less vivid events (Plous, 1993).

Applying the availability and affect heuristics to smoke emissions demonstrates the complicated nature of risk perceptions. If a resident has a very negative experience due to a smoke event (such as a car accident or an asthma attack) or if a local prescribed fire escaped control resulting in substantial negative impacts, those events may be easier to recall than a number of prescribed burns that may have been completed in the area with minimal negative effects. In such a case, residents would likely overestimate the frequency and severity of negative impacts from prescribed burns; thus, potentially increasing the perceived risk they associate with these treatments.

Risk Information Seeking and Processing

The Risk Information Seeking and Processing (RISP) model was developed by communication scholars to better understand what motivates individuals to seek additional information regarding perceived risks (Griffin et al., 1999; Kahlor, Dunwoody, Griffin, & Neuwirth, 2006; Trumbo, 1999). RISP was originally intended to address direct personal risks (risks with firsthand impacts on an individual, such as drinking contaminated water or experiencing floods) and was based on two existing theoretical models: the Heuristic-Systematic Model and the Theory of Planned Behavior (Ajzen,

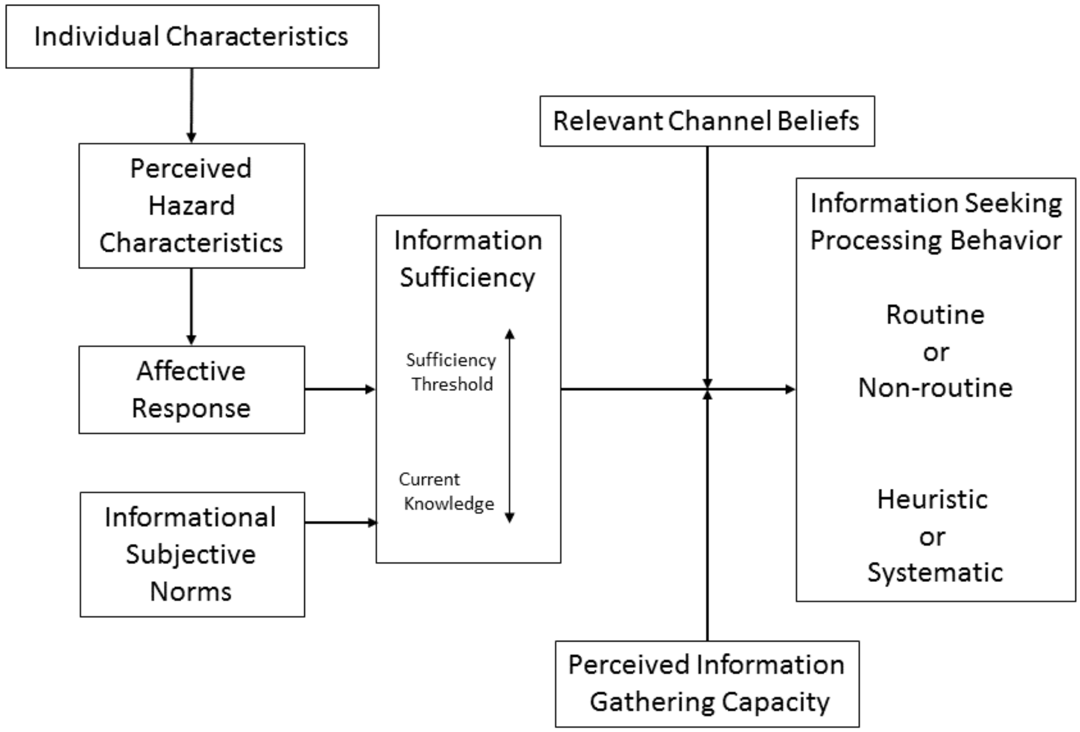


Figure 2.1. Modified RISP model based on Griffin et al. (2008) showing the relationships between the influences on information seeking and processing behaviors (Griffin et al., 1999).

1991; Eagly & Chaiken, 1993). The proposed relationships specified in the RISP model (Figure 2.1) have primarily been applied within the context of health risks related to environmental issues (e.g., Clarke, 2009; Griffin et al., 1999; Griffin et al., 2002; Johnson, 2005; Kahlor, Dunwoody, Griffin, Neuwirth, & Giese, 2003; Trumbo, 1999; Trumbo, 2002). Recent work has also examined the model in the context of impersonal risks, or those that focus on societal-level impacts (Kahlor et al., 2006). This work is significant for the study as smoke emissions may be perceived as leading to both personal (e.g., causing breathing issues for an individual) and impersonal (e.g., aesthetic damage to an area) impacts.

The RISP model describes the theoretical relationship between several variables that are conceptualized to interact to influence information seeking and processing behaviors; most variables in the model are proposed as both a dependent variable (influenced by preceding variables) and independent variables that influence subsequent model components. Hypothesized relationships are noted by the arrows in Figure 2.1 and the variables are defined in Table 2.1. The model begins with **individual characteristics**, which are conceptualized as independent variables that directly influence **perceived hazard characteristics**, **informational subjective norms**, **relevant channel beliefs**, and **perceived information gathering capacity**. Recent work has modeled individual characteristics as only impacting perceived hazard characteristics (e.g., Griffin et al., 2008). This approach was followed for the study.

Perceived hazard characteristics are then viewed as directly influencing the individual's **affective response**. The relationship hypothesizes that individuals who believe they are more at risk from a hazard, or that the hazard will have a large impact on them, are more likely to have a strong emotional response to that hazard (Kahlor, 2007). **Affective response** along with **informational subjective norms** are both conceptualized to have a positive influence on **information (in)sufficiency**. Increasing differences between *current knowledge* levels and the level an individual desires to have, known as the *sufficiency threshold*, are predicted to cause individuals to seek additional information, use active seeking, and systematically process information (Kahlor, 2007).

Variables	Definitions	
Individual characteristics	Demographic information; past experiences with a risk	
Perceived hazard characteristics	Judgments about a risk or feelings of dread	
Affective response	Emotional responses to a risk (e.g., fear, worry, anger)	
Informational subjective norms	Individual's perception about the level of knowledge they are expected to have about a risk	
Information (in)sufficiency	*Sufficiency Threshold*	Amount of information desired to appropriately deal with a risk
	Current Knowledge	Amount of information perceived to be held
	More effortful information seeking and processing when the sufficiency threshold is much higher than the current knowledge	
Relevant channel beliefs	Beliefs about quality of risk information sources (e.g., usefulness, trustworthiness)	
Perceived information gathering capacity	Beliefs about individual's own ability to learn about a risk (access and understand the appropriate information)	

Table 2.1. RISP variables (Griffin et al., 1999).

Next, **relevant channel beliefs** and **perceived information gathering capacity** are hypothesized to moderate the relationship between **information (in)sufficiency** and **information seeking** and **processing** behaviors. Research has suggested that if individuals believe information is of high quality (**relevant channel beliefs**), they may be motivated to process it more carefully and effortfully (McLeod, Kosicki, & Pan, 1991). Finally, if individuals believe they are capable of finding and understanding information on an issue (**perceived information gathering capacity**) or the source of the information is trustworthy and useful (**relevant channel beliefs**), they are more motivated to actively seek and process information (Griffin et al., 1999; Kahlor et al., 2006; Kahlor, 2007).

Lastly, the model concludes with the dependent variables of **information seeking** and **processing**. **Information seeking** can be characterized as either *passive* (information is gathered from sources an individual uses on a regular basis) or *active* (gathering information from sources an individual does not use on a regular basis). **Information processing** can occur either systematically or heuristically (e.g., Chaiken, 1980). When information is processed *systematically*, more effort is used to analyze and understand the information. This critical analysis requires more cognitive resources and information is judged based on the argument quality. Conversely, *heuristic processing* requires less cognitive effort and information is judged based on peripheral characteristics of the message, provider, and/or methods of communication. More recent work has found that the RISP model explains *systematic processing* better than *heuristic processing* (Yang, Aloe, & Feeley, 2014). As motivation to learn more about a risk increases, individuals are expected to both seek out additional information about the risk and employ more effort to process the information they locate (Fiske & Taylor, 2013).

Research Methods

Research Objectives and Hypotheses

The objective of the study described here is to assess information seeking behaviors regarding smoke emissions and management for residents of select WUI areas. Our hypotheses were: 1) the proposed relationships outlined in the RISP model would be represented for smoke emissions and prescribed fires (i.e., positive relationships between perceived hazard characteristics and affective response, affective response and information (in)sufficiency, informational subjective norms and information (in)sufficiency, relevant channel beliefs and information seeking intent, and perceived information gathering capacity and information seeking intent). 2) Information-seeking behaviors would be positively influenced by perceived information (in)sufficiency (that is, individuals who perceived they needed more information would be more likely to seek that information). 3) Perceived hazard characteristics would be positively associated with information seeking behaviors (individuals who perceive greater risk from prescribed fire treatments or smoke emissions would seek more information).

Study Sites and Populations

Four study sites were used in this study. As described in Chapter 1, the study sites included the counties adjacent to each of the National Forests: the Shasta-Trinity National Forest in northern California; the Kootenai National Forest in northwest Montana; the Fremont-Winema National Forest in southern Oregon; and the Francis-Marion National Forest in southeastern South Carolina. Each of these sites include human populations in close proximity to fire dependent ecosystems where active fuels reduction programs are underway to reduce the likelihood of fire and restore forest conditions (JFSP, 2011a; JFSP, 2011b).

WUI residents may also be considered as part of the "knowledgeable" or "informed" public. Previous studies have found that residents of fire dependent areas generally recognize the complexity of fuel hazards and have a sophisticated understanding of prescribed fires and fire risks (Brunson & Shindler, 2004; McCaffrey, 2006; McCaffrey & Olsen, 2012; Shindler & Toman, 2003). As such, residents will likely view prescribed fires and smoke emissions as highly relevant.

Research Design

The data used in this study were collected from a mail-back/internet survey. The survey employed a random sampling design using a sample purchased from a professional sampling company, Marketing Systems Group (MSG), consisting of adult residents within each of the study areas (Frederick, 2013). Survey items measured a number of items related to wild and prescribed fires and resulting smoke emissions, including those variables described in the RISP model that provide the basis for our analysis here.

The survey was conducted between March and June 2012 following a modified "tailored design method" (Dillman, Smyth, & Christian, 2009). First, all sample members were sent a postcard notifying them of the coming survey packet. A few days later, a complete survey packet, consisting of a cover letter, questionnaire, and pre-paid postage return envelope, was sent to all participants. The cover letter contained a link directing participants to an online version of the survey. After two weeks, a reminder postcard was sent to participants who had not yet responded. After an additional three weeks, the complete survey packet was once again sent to all who had not yet responded. No incentive was provided to participate in the study.

A total of 4,800 questionnaires (1,200 per site) were mailed to residents across the four study sites (Table 2.2). Approximately 10% of these were returned with incorrect addresses resulting in an adjusted sample size of 4,325. Of these, 992 surveys were completed; nearly all were returned by mail, only 9% of the returned surveys were completed online. The overall, adjusted response rate for the survey was 23% and varied from a high of 30% ($n = 323$) in Montana to a low of 13% ($n = 147$) in South Carolina.

A non-response bias check was completed by conducting a truncated version of the survey via telephone with a subset of non-respondents in each location. Results revealed no statistically significant differences when compared to the survey responses for either demographic or survey questions (Frederick, 2013).

Site	Mailed Questionnaires	Delivered Questionnaires	Completed Questionnaires (*n*)	Response Rate (%)
California	1200	1072	252	24
Montana	1200	1094	323	30
Oregon	1200	1070	270	25
South Carolina	1200	1089	147	13
Total	4800	4325	922	23

Table 2.2. Response rates and sample sizes by study site.

Data Analysis

Data were analyzed using both SPSS (Statistical Package for Social Sciences, Version 21) and LISREL (Linear Structural Relations, Version 9.1). Data were examined in the aggregate across all of the study sites. Our analysis began by developing descriptive statistics for the items, combining items into scales, and calculating correlations. A series of linear regressions were then run to examine relationships between variables of interest to initially examine relationships between the RISP variables. We then developed path models and additional linear regressions using LISREL to further investigate relationships between variables as described in the RISP model. Path analysis is used to test the hypothesized relationships among multiple variables within the model rather than examining each individual relationship by itself (as in linear regressions). A total of four RISP models were developed and tested: one that followed the specific relationships described in the RISP model and three additional models designed to better fit the data.

The goodness of fit for each model was examined through several measures including Chi-squared (X^2), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI) (Hu & Bentler, 1999; Kline, 2011; Steiger, 1990). For the chi-squared test, a value close to zero and not significant ($p > 0.05$) indicates a good fit (Kline, 2011; Schmitt, 1978; Schmitt & Stults, 1986). However, as the chi-squared value is highly sensitive to sample size, a modified chi-square value (X^2/df) has been developed (Kline, 2011; Schmitt, 1978; Schmitt & Stults, 1986). A modified chi-square value of less than five ($X^2/df < 5$) indicates a good fit, values between five and ten are considered acceptable, and values above ten are inadequate ($X^2/df > 10$) (Kline, 2011; Schmitt, 1978). For the RMSEA measure, values less than 0.05 indicate a very good model fit, values in the range of 0.05 to 0.08 indicate a good or reasonable fit, while values above 0.10 indicate a poor fit (Steiger, 1990). Finally, for the CFI measure, a value of one represents a "perfect" fit, while those above 0.90 are acceptable fits (Hu & Bentler, 1999).

Variable Information

The variables used in the development of the RISP model are described below and presented in Table 2.3. Most measures used a seven-point scale with a neutral midpoint while also allowing "Don't know" responses ("Don't know" responses were excluded list-wise from the analyses); additional information on the scales used to assess each variable is located in the table. The individual variable statistics and reliability calculations for the RISP models can be found in Table 2.3. For scales containing four or more items, the internal consistency was measured using Cronbach's alpha with a designated $\alpha = 0.75$. The reliability for scales of less than four items was measured using Pearson correlations, with an acceptable level of $r = \pm 0.2$ and a significance of $p < 0.05$. In the next section, primary variables are presented in **bold** and component items are <u>underlined</u>.

Individual characteristics were measured by three variables: <u>age</u>, <u>gender</u>, and <u>acceptability of smoke</u>. While several potential individual characteristics were present in the data, these three variables resulted in the best model fits. Using age and gender as individual characteristics is consistent with previous research (e.g., Griffin et al., 2008; Kahlor et al., 2006; Yang et al., 2011). The index variable <u>acceptability of smoke</u> assesses the acceptability of smoke from a variety of different sources (e.g., wildfires or prescribed burns) and under various conditions (e.g., suppression or natural ignition). Consistent with more recent work, **individual characteristics** were only modeled as impacting **perceived hazard characteristics** (e.g., Griffin et al., 2008).

Four separate variables represented the **perceived hazard characteristics**. First, <u>smoke impact likeliness</u> is an index variable assessing the perceived likelihood that smoke emissions would impact participant health and ability to participate in common activities, such as work or travel. <u>Smoke impact severity</u> assesses the perceived severity of smoke emissions on these same health and activity items. <u>Impact in next 5 years</u> measures the perceived likelihood of a wildfire occurring near the participant's home. Lastly, <u>proximity to potential fire</u> measures the distance between participants' homes and a natural area where a fire might burn. All of the **perceived hazard characteristics** variables were independently tested in the model.

RISP variables Separate component variables	Items	Scales	Cronbach's alpha (α)	Pearson correlation (r)
Individual characteristic				
Age	1	Years		
Gender	1	0 “Male” and 1 “Female”		
Acceptability of smoke	8	7 point; “Strongly disagree” to “Strongly agree”	0.855	
Perceived hazard characteristics				
Smoke impact likeliness	8	7 point; "Very unlikely" to "Very likely"	0.930	
Smoke impact severity	8	7 point; "No impact" to “Very severe impact"	0.944	
Impact in next 5 years	1	4 point; "Very unlikely" to "Very likely"		
Proximity to potential fire	1	Miles; 0 "Right next door (or less than 1 mile)"		
Affective response	1	7 point; “Strongly disagree” to “Strongly agree”		
Informational subjective norms	2	7 point; “Strongly disagree” to “Strongly agree”		0.601**
Information (in)sufficiency	2	200 point; -100 "Too much information" to 100 "Need more information"		
Current knowledge	1	100 point; "Know nothing about smoke" to "Everything		
Sufficiency threshold	1	that could possibly be known about smoke"		
Relevant channel beliefs				
Number of sources	16	16 total sources	0.824	
Usefulness of sources	16	5 point; "Not useful" to "Very useful"	0.933	
State information score	3	7 point; “Strongly disagree” to “Strongly agree”		0.898**
(best, enough, and timely				0.886**
information provision)				0.911**
Federal information score	3	7 point; “Strongly disagree” to “Strongly agree”		0.858**
(best, enough, and timely				0.850**
information provision)				0.879**
Perceived information gathering capacity	2	7 point; “Strongly disagree” to “Strongly agree”		0.296**
Information seeking behaviors	3	7 point; “Strongly disagree” to “Strongly agree”		0.351**
				0.276**
				0.656**

Note: ** $p < 0.001$

Table 2.3. RISP variables, scales, and reliability tests (Cronbach's alpha, Pearson correlation) used in analysis.

The **affective response** component assesses participant worry about smoke emissions. The **informational subjective norms** index addresses participants' perceptions of how knowledgeable important others (e.g., family and friends) expect they should be about smoke emissions. **Information (in)sufficiency** was calculated by subtracting the current knowledge (self-reported level of knowledge participants indicated they already had regarding smoke) from their sufficiency threshold (self-reported level of knowledge participants felt they would need to make an informed decision about smoke emissions).

Relevant channel beliefs were assessed using four separate variables. Number of sources is a simple count of how many sources participants indicated they used when learning about smoke emissions, with usefulness of sources representing an overall average of the usefulness ratings for each of those sources. Federal and state information scores each assess the quality of information provided by state and federal agencies. All of the **relevant channel beliefs** variables were independently tested in the model.

The **perceived information gathering capacity** assessed the perceived ease of finding information on smoke emissions. Finally, the **information seeking behaviors** questions address participants' assessment of their need and intention to find more information about smoke emissions.

Results

Demographics and Variable Introduction

We begin with an overview of our study participants (Table 2.4). Participants were generally similar between states. A majority of participants were male with an average age of 60. More than two-thirds had attended at least some college (71.9%). Just over a quarter of participants (26.7%) had experienced personal health effects from smoke in the past, with 12.2% indicating they had experienced personal health effects from prescribed fire smoke and 16.0% from wildfire smoke. Just under half of the residents (45.7%) indicated they worry about smoke emissions from fire.

Variables	All	CA	MT	OR	SC
Age (median years)	62.0	64.0	61.0	61.5	57.0
	%	%	%	%	%
Gender (male)	57.9	60.4	57.4	58.4	54.0
Education					
High school or less	28.1	21.0	35.2	27.5	25.9
Some college	25.9	29.6	21.9	27.9	24.4
Bachelor's or Associate's degree	29.6	32.5	26.9	28.3	32.6
Some graduate or graduate degree	16.5	16.9	15.9	16.4	17.0
Personal health effects from smoke					
Any source	26.7	29.4	32.6	27.3	16.0
Prescribed fires	12.2	13.4	17.6	9.3	3.4
Wildfires	16.0	22.4	18.9	13.1	4.1
Worry about smoke	45.7	46.0	43.2	44.4	53.2
Heard or read about…					
Prescribed fires	93.4	93.2	96.9	92.8	87.8
Impacts of smoke	81.6	80.9	82.8	83.4	76.9
Reported information (in)sufficiency	51.7	56.2	49.5	45.6	59.0
Intend to seek additional smoke information	28.5	32.2	23.2	28.2	34.6

Note: Variable scale information can be found in Table 2.3.

Table 2.4. Descriptive statistics for demographic information.

The vast majority of respondents (93.4%) have heard or read about prescribed burns. Slightly fewer respondents (81.6%) reported having either heard or read about impacts from smoke emissions. Most (51.7%) indicated they required some additional information to have a comfortable understanding of smoke emissions, and more than a quarter (28.5%) indicated they intended to seek additional smoke information.

Lastly, the skewness and kurtosis measurements were examined for variables that would be further considered in the RISP analysis; only two variables displayed unacceptable levels of kurtoses and skewness. <u>Proximity to potential fire</u> had unacceptable levels of both kurtosis and skewness while the <u>impact in next 5 years</u> variable had unacceptable kurtosis. It is likely that the skewness and kurtosis of each of these variables was influenced by our research design. By focusing on residents living in fire dependent areas with ongoing fire and fuels management activities, it was extremely unlikely that responses would be normally distributed on either of these items. Accordingly, we feel these responses are adequate and no additional action is required.

Mean comparisons and linear regressions

A series of mean comparisons and linear regressions were performed to examine the relationships among the RISP variables. First, <u>current knowledge</u> was compared to the <u>sufficiency threshold</u> to determine current levels of **information (in)sufficiency**. Next, the relationship of **information seeking** with the direct predictors was examined. Lastly, the relationship of **information seeking** to the **perceived hazard characteristics** was analyzed to better understand which hazard perceptions may be directly impacting information seeking, without the effects of affective response and information needs.

Information (in)sufficiency. The **information (in)sufficiency** variable was analyzed by comparing respondents' perceived current knowledge and perceived level of knowledge required, or sufficiency threshold. The comparison revealed a significant difference between the two knowledge level means, $t(924) = -7.88$, $p < 0.001$. There was a significant difference between current knowledge and sufficiency threshold in each location with participants expressing a desire for greater knowledge.

Information seeking. Next, a linear regression model was developed to examine the relationship between **information seeking** intentions and the direct predictors: **information (in)sufficiency**, **relevant channel beliefs**, and **perceived information gathering capacity** (Table 2.5). The resulting regression model was significant and explained 12.7% of the variance, $F(6, 771) = 18.673$, $p < 0.001$.

Three predictor variables were significant: the number of sources (**relevant channel belief**), **information (in)sufficiency**, and **perceived information gathering capacity**. These results provided support for the first and second hypotheses. For the first hypothesis, relationships consistent with the RISP model were found for **information seeking** with **information (in)sufficiency**, one **relevant channel belief**, and **perceived information gathering capacity**. The second hypothesis was supported as **information seeking** had a strong, positive relationship with **information (in)sufficiency**.

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta (*b*)	*t*	Sig. (*p*)
Constant	4.216	0.196		21.492	<0.001*
RCB: Number of sources	0.055	0.014	0.146	4.101	<0.001*
RCB: Usefulness of sources	0.012	0.046	0.009	0.267	0.790
RCB: State information score	-0.025	0.048	-0.029	-0.528	0.598
RCB: Federal information score	0.054	0.048	0.061	1.120	0.263
Information (in)sufficiency	0.013	0.002	0.299	8.650	<0.001*
Perceived information gathering capacity	-0.160	0.033	-0.173	-4.842	<0.001*

Note: Dependent variable: **information seeking intent**
RCB: **relevant channel beliefs**
* significance at $p < 0.05$

Table 2.5. Coefficient variables from **information seeking** linear regression analysis.

A second linear regression was run to examine the relationship between **information seeking** intention and **perceived hazard characteristics** (Table 2.6). The model was significant and explained 9.3% of the variance, $F(4, 792) = 20.362$, $p < 0.001$. Only one predictor variable was significant in this model; as smoke impacts were viewed as more likely, they positively influenced **information seeking** intent. The third hypothesis was moderately supported as **information seeking** was significantly related to **perceived hazard**

characteristics with only one significant predictor, smoke impact likeliness, demonstrating a strong positive relationship.

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta (*b*)	*t*	Sig. (*p*)
Constant	3.184	0.143		22.298	<0.001*
Smoke impact likeliness	0.232	0.067	0.298	3.486	0.001*
Smoke impact severity	0.005	0.067	0.007	0.079	0.937
Impact in next 5 years	-0.019	0.029	-0.023	-0.671	0.502
Proximity to potential fire	0.005	0.006	0.025	0.723	0.470

Note: Dependent variable: **information seeking intent**
* significance at $p < 0.05$

Table 2.6. Coefficient variables from **perceived hazard characteristics** and **information seeking** linear regression analysis.

RISP Analysis

Lastly, path analysis was used to examine the relationships proposed by the RISP model. Descriptive information for the included variables is provided in Table 2.7. Briefly, respondents indicated acceptance of smoke emissions (*M* = 4.80), had moderate expectations of impacts (*M* = 3.47), lived very close to areas which might burn (*M* = 3.44 miles), and worried about smoke (*M* = 4.31). Respondents indicated they needed more information than they currently held (*M* = 7.59) and used few sources to find additional smoke information (*M* = 4.76 out of 16 possible sources). Lastly, respondents were generally neutral about whether they intended to seek additional smoke information (*M* =

3.99). Around 29% of respondents intended to seek more information, 39% did not intend to do so, and the remaining 33% did not have any intentions either way.

Variables	All Mean	CA Mean	MT Mean	OR Mean	SC Mean
Individual characteristic					
Acceptability of smoke	4.80	4.73	4.84	4.75	4.92
Perceived hazard characteristics					
Smoke impact likeliness	3.67	3.71	3.62	3.61	3.80
Smoke impact severity	3.47	3.50	3.40	3.46	3.57
Impact in next 5 year	3.43	3.50	3.34	3.49	3.39
Proximity to potential fire (miles)	3.44	3.56	0.61	4.81	7.22
Affective response	4.31	4.48	4.12	4.21	4.61
Informational subjective norms	3.49	3.47	3.56	3.36	3.59
Information (in)sufficiency	7.59	9.05	6.14	5.06	12.58
Current knowledge	58.78	58.25	61.27	58.53	54.53
Sufficiency threshold	66.12	67.18	66.99	63.34	67.10
Relevant channel beliefs					
Number of sources	4.76	4.93	5.21	4.53	3.87
Usefulness of sources	3.05	2.92	3.07	3.09	3.15
State information score	3.94	3.75	3.85	4.09	4.20
Federal information score	3.72	3.64	3.64	3.79	3.91
Perceived information gathering capacity	4.33	4.28	4.46	4.30	4.22
Information seeking behaviors	3.99	4.11	3.85	3.91	4.25

Note: Variable scale information can be found in Table 2.3.
Please see Table 2.4 for age and gender descriptive information.

Table 2.7. Descriptive statistics for RISP variables.

List-wise deletion was employed for missing responses as respondents who were missing data for any variable were removed from that particular analysis resulting in an effective sample size of 652 for the path analysis. The model fits can be found in Table

2.8 (see Data Analysis section above for goodness of fit descriptions). The Baseline Model followed the relationships described in the theoretical RISP model most closely, but it exhibited poor fit and was not consistent with the observed data (X^2= 1331.41, *df* = 60, $p < 0.001$, X^2/df = 22.190, RMSEA = 0.180). Following standard path analysis procedure, the Baseline Model served as a reference point for the subsequent models. Variables without significant relationships were removed one at a time, beginning with component items which only partially represented their respective RISP variables, and the data was once again tested to examine the impact on fit (Kline, 2011; Yang et al., 2010). Testing continued until the model fit measures were acceptable or good and did not substantially improve with further variable removal.

Models	X^2	*df*	*p*	X^2/df	RMSEA	CFI
Baseline	1331.41	60	<0.0001	22.190	0.180	-
1	1197.83	54	<0.0001	22.182	0.180	0.616
2	357.54	49	<0.0001	7.297	0.098	-
3	231.90	44	<0.0001	5.270	0.081	0.901

Note: LISREL was unable to provide CFI values for Baseline and Model 3 due to multicollinearity.

Table 2.8. Goodness of fit for each RISP model.

Model 1 removed only **informational subjective norms** resulting in a slight improvement in model fit, although the overall fit was still very poor (Table 2.8). Model 2 removed the **perceived hazard characteristic** smoke impact severity. The goodness of fit for Model 2 improved substantially, with the modified chi-squared and RMSEA measures indicating acceptable fits. Model 3 removed both **informational subjective norms** and smoke impact severity, once again resulting in an improved goodness of fit with modified chi-squared, RMSEA, and CFI values all indicating acceptable fits (X^2= 231.90, df = 44, $p < 0.001$, X^2/df = 5.270, RMSEA = 0.081, CFI = 0.901). See Figure 2.2 for a diagram of Model 3. As Model 3 best maintained relationships which were representative of the RISP model while achieving a good model fit, this model was examined in greater depth. A number of significant relationships were found and will be considered in light of the study's hypotheses.

Model 3 had eight significant relationships (Table 2.9). Two of the **individual characteristics**, acceptability of smoke and gender, had a significant influence on the **perceived hazard characteristics** smoke impact likeliness. That is, females and those with lower acceptability of smoke are predicted to view smoke as a greater hazard. Next, **affective response** was significantly influenced by the **perceived hazard characteristics** smoke impact likeliness and proximity to potential fire. Residents who believed they were likely to be impacted by smoke and who indicated they live close to an area that might burn have a higher affective response. **Information (in)sufficiency** was significantly influenced by **affective response**; individuals who indicated they worry about smoke felt they did not have enough information.

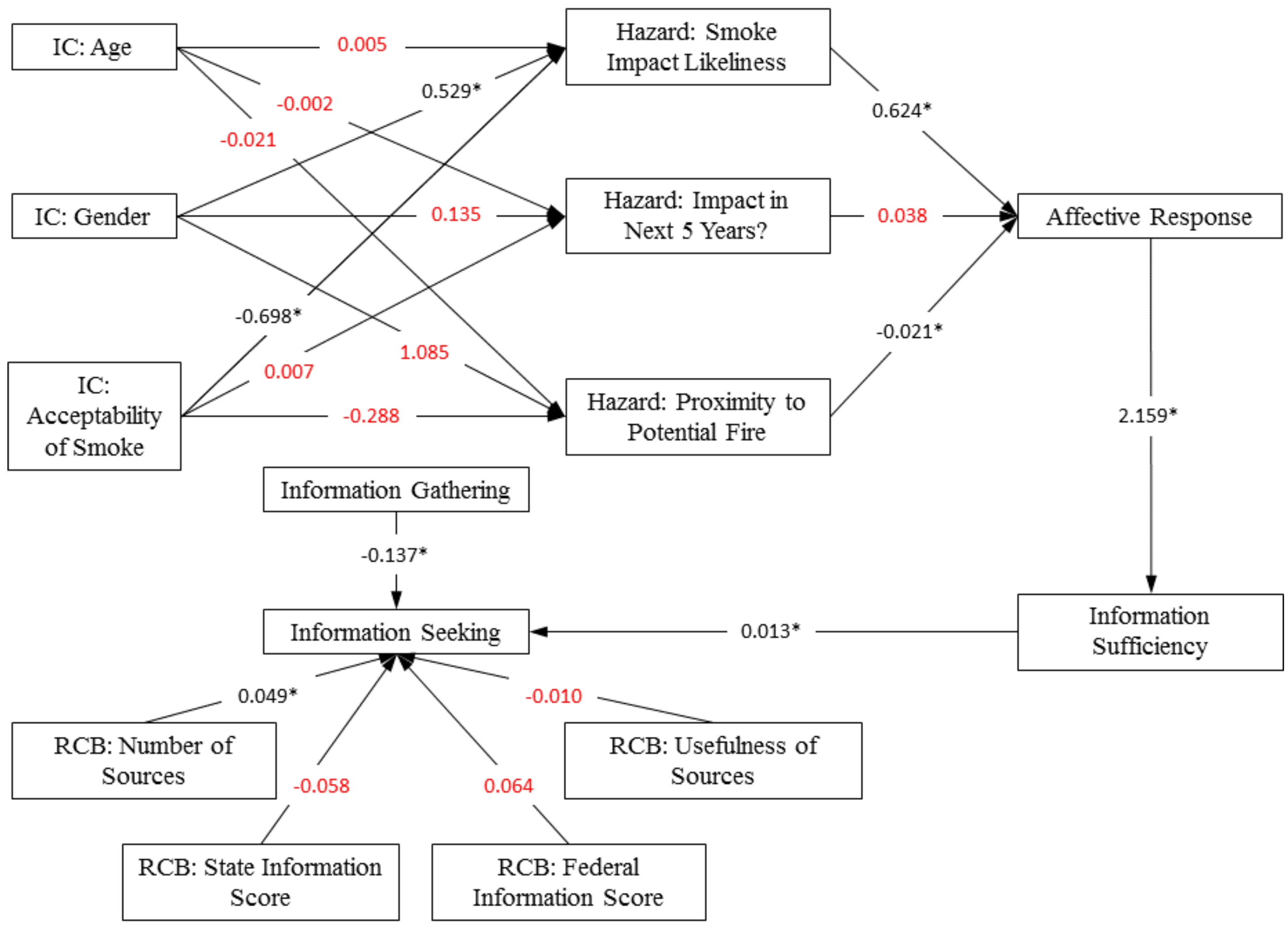
Lastly, **information seeking** intention was significantly influenced by **information (in)sufficiency**, **information gathering capacity**, and the number of sources (**relevant channel belief**). Respondents who believed they did not currently have enough information, already used more sources of information, and indicated it was difficult to find information intended to seek more smoke emissions information. RISP Model 3 presented here explained 11.8% of the variance in **information seeking** behaviors, $p < 0.001$ (Table 2.9).

	Variables	Coefficient B	Std. Error	p	R^2	p
Smoke impact likeliness	Age	0.005	0.004	0.233	0.329	<0.001
	Gender	0.529	0.110	<0.001*		
	Acceptability of smoke	-0.698	0.042	<0.001*		
Impact in next 5 years	Age	-0.002	0.004	0.683	0.003	<0.001
	Gender	0.135	0.114	0.237		
	Acceptability of smoke	0.007	0.044	0.870		
Proximity to potential fire	Age	-0.021	0.021	0.314	0.010	<0.001
	Gender	1.085	0.574	0.059		
	Acceptability of smoke	-0.288	0.221	0.192		
Affective response	Smoke impact likeliness	0.624	0.043	<0.001*	0.248	<0.001
	Impact in next 5 years	0.038	0.050	0.451		
	Proximity to potential fire	-0.021	0.010	0.034*		
Information sufficiency	Affective response	2.159	0.535	<0.001*	0.025	<0.001
Information seeking	Information sufficiency	0.013	0.002	<0.001*	0.118	<0.001
	RCB: Number of sources	0.049	0.015	0.001*		
	RCB: Usefulness of sources	-0.010	0.051	0.850		
	RCB: Federal information score	0.064	0.054	0.240		
	RCB: State information score	-0.058	0.054	0.280		
	Information gathering capacity	-0.137	0.037	<0.001*		

Note: * significance at $p < 0.05$

Table 2.9. Structural equations for RISP Model 3.

Model 3 provided some support for the first hypothesis as the path analysis relationships were generally consistent with the RISP model. While some of the component items of the RISP variables were not significant (e.g., the **individual characteristic** age or the **perceived hazard characteristic** impact in next 5 years), all but two of these RISP variables were represented within the model by other variable measures (e.g., the **individual characteristic** acceptability of smoke or the **perceived hazard characteristic** proximity to potential fire). Of note, the RISP variable **informational subjective norms** was removed to increase the goodness of fit and was not represented in the model. The hypothesized relationship between information sufficiency and informational subjective norms was not supported.



Note: * significance at $p < 0.05$ level; red is not significant

Figure 2.2. RISP Model 3; variables removed are **informational subjective norms** and <u>smoke impact severity</u>.

Discussion

Applying the Risk Information Seeking and Processing model has provided a basis to examine the motivations for residents to gather additional information about smoke emissions. Several key findings that merit further discussion emerge from this analysis.

First, both the path analysis and linear regressions generally supported the current RISP literature and the study hypothesis that information seeking behaviors would align with the RISP relationships proposed in the literature and previous studies. Specifically, both the models presented here and literature support positive relationships between: 1) perceived hazard characteristics and affective response (Kahlor, 2007), 2) affective response and information (in)sufficiency (Griffin et al., 2008; Kahlor, 2007), and 3) information (in)sufficiency and information seeking (Griffin et al., 2008; Kahlor et al., 2006).

Moreover, consistent with previous literature, the relationship between information seeking and relevant channel beliefs was inconsistent (Clarke & McComas, 2012; Griffin et al., 2008). Previous research has found relevant channel beliefs to be a weak and inconsistent predictor for information seeking as there is no clear positive or negative relationship and significance has been difficult to find. In part, this is hypothesized to be a result of relevant channel beliefs acting as a direct predictor of information seeking rather than a predictor of the relationship between information seeking and information (in)sufficiency as proposed in the theoretical model (Griffin et al., 2008).

A few surprising differences from previous literature were found. Prior studies have demonstrated the expected positive relationship between information seeking and perceived information gathering capacity, with those who believe they are able to find and understand information being more likely to seek it (Griffin et al., 2008). However, a negative relationship was demonstrated in this study, with those who believed it was difficult to find information intending to seek additional information.

One possible explanation of this difference could be due to the nature of the risk and the availability of information. While smoke emissions are a concern for residents, there has typically been limited information available on smoke emissions. As such, while residents are motivated to learn more and seek more information, it may be difficult to find appropriate smoke information. This may cause motivated residents to put forth more effort and search through information only tangentially related to smoke emissions, which is supported by their already using more informational sources as well. Notably, residents who still intend to seek additional information additionally already use a large number of informational sources. Alternatively, while the RISP model focuses on those intending to seek information, it could indicate that those who believed it was easy to find information have already met their informational needs.

Of note, many of the previous RISP studies have focused on the seeking and processing behaviors of the general public (e.g., Griffin et al., 1999; Kahlor et al., 2006; Kahlor, 2007). Instead, the population studied here consisted of the informed public. Some of the differences in the motivators of information seeking may be due to our focus on the seeking intentions of residents who already have prior knowledge of smoke emissions and prescribed fires. Residents are more likely to already be aware of these issues and have sought information in the past.

Similar to the differences found with perceived information gathering capacity, informational subjective norms were previously demonstrated to have a positive relationship with information (in)sufficiency (Clarke & McComas, 2012; Griffin et al., 2008; Kahlor et al., 2006; Kahlor, 2007). Kahlor et al. (2006) found a surprisingly strong relationship between the two variables within the context of an impersonal environmental risk, suggesting that when a hazard does not cause direct personal harm, the expectations of important others become more important than the risk posed by the hazards. However, we failed to find a significant relationship between informational subjective norms and information (in)sufficiency and, in fact, removing the informational subjective norms variable resulted in improved goodness of fit. The lack of a significant relationship may be due to the inconsistency with the theoretical RISP model. Although generally not adhered to in RISP model analysis, the theoretical RISP model proposes informational subjective norms are influenced by individual characteristics (individual characteristics are related only to perceived hazard characteristics in tested models based on Griffin et al., 2008). It is possible that removing the influence of individual characteristics limited the impact informational subjective norms could have within the model.

Second, more than one-fourth of participants indicated they intended to seek more information about smoke emissions. However, almost half indicated that they needed more information than they already had. In light of this, information seeking clearly depends on more than just information need. Additionally, residents generally felt it was easy to find smoke emissions information and they used a small number of sources, indicating that the mechanics of finding new information should not be a barrier to closing their information (in)sufficiency gap. But, the model demonstrated that those who did intend to seek more information already used more sources of information and indicated it was difficult to find. This may point to differences in how residents (those who intend to seeking information compared with those who do not) interact with available information. There may also be a larger influential factor not examined by this study causing residents to not seek more information when they reported both needing it and having few mechanical barriers to finding it, while causing residents who intend to seek information to perceive larger barriers to information seeking.

Lastly, the analysis also emphasized the importance of both the direct and indirect relationships among risk perceptions and information seeking. While perceived hazards were found to predict information seeking behaviors, this relationship seemed to be primarily driven by one variable—smoke impact likeliness. Smoke impact likeliness indirectly influenced information seeking through the affective response and information (in)sufficiency variables. Interestingly, the counterpart of this variable, smoke impact severity, performed very poorly in the model and was removed from model analysis to improve goodness of fit. A potential explanation for this difference is that residents may view any impact of smoke emissions as equally severe, or undesirable, causing them to focus on whether any smoke impacts at all are likely to occur. Generally, the third hypothesis that individuals with higher perceived hazard characteristics will seek more smoke emissions information (matching the relationship found in previous literature) was supported (Griffin et al., 1999; Kahlor, 2007). Respondents who judge smoke to be a larger hazard believe they need more information to understand the risk offered by smoke emissions.

Conclusion

Although a large portion of WUI residents in fire dependent areas have heard or read about smoke emissions from fires, the study also demonstrates that smoke emissions and their impacts are important to WUI residents and that they would like more information. Almost half of the residents indicated they worry about smoke emissions, while almost a third indicated personal health effects due to smoke in recent years. As such, residents may have a high risk perception of wild and prescribed fire emissions. Additionally, this signifies that smoke emissions can influence public perceptions and support of prescribed fires. Moving forward, smoke emissions are an issue that may need to be addressed to maintain public acceptance of prescribed fire and alleviate residents' concerns.

The study offers support for the RISP model presented in the literature, as well as the specific application of the model to members of the informed public. Of note, the findings suggest those who intend to find more information were strongly motivated by feeling as though they required more information. However, the discrepancy between those who indicated they needed additional information and information seeking intent warrants further exploration to determine why residents who feel they need more information may not intend to seek it.

There are several important implications from this research for fire managers in WUI areas. First, although a seemingly straightforward finding, it must be reiterated that it is important to keep in mind that individual characteristics and risk perceptions will influence how individuals assess smoke emissions and their impacts. There is no universal risk rating among WUI residents. Second, managers cannot assume that residents who already use multiple information resources do not need any more information. Indeed, findings here suggest that the opposite may be true in some cases as individuals who use more sources already also intend to do additional research and believe it is difficult to find information on smoke emissions. Finally, these findings indicate that smoke emissions information currently available to residents may not be sufficient, especially in consideration of the large discrepancy between information need and seeking intention. Residents of fire dependent areas are in need of relevant and useful smoke emissions information.

Chapter 3: Framing Messages about Prescribed Fire and Smoke Emissions

Introduction

In the Wildland Urban Interface (WUI), smoke emissions from prescribed and wildfires may result in a variety of impacts, including irritated sinuses, coughing, and headaches (Monroe et al., 1999; USEPA, 2003; Winter et al., 2002). In addition to these general impacts some residents may experience more acute negative effects; approximately 30% of WUI households include at least one member with a prior health condition which may be exacerbated by smoke emissions (Frederick, 2013; McCaffrey, 2006; McCaffrey & Olsen, 2012). Beyond health impacts, smoke emissions can also negatively affect WUI residents' daily lives through unpleasant odors and discomfort, visibility reduction, road closures or traffic delays, building evacuations, and personal property damage (Monroe et al., 1999; USEPA, 2003; Winter et al., 2002). Not surprisingly, residents have expressed concerns about smoke emissions; recent research in four WUI locations found just under half of participants were concerned about smoke emissions from fire (Chapter 2).

Ultimately, prescribed fires themselves as well as the resulting smoke emissions can be viewed as posing a risk to WUI residents. A "risk" can be defined as "the chance, within a time frame, of an adverse event with specific consequences" (Burgman, 2005, p.

1). Risk perceptions, then, are intuitive judgments about a risk which are a function of two general components: how much the hazard posing the risk is feared or how catastrophic the outcomes are likely to be ("dread") and how much is unknown about the hazard (Slovic, 1987).

Despite the negative effects of smoke emissions, prescribed fires are an important management tool for land managers in fire dependent areas. Prescribed fires offer many ecological benefits and can help reduce forest fuel loadings that contribute to large fires (Agee, 2005; Hardy, 2005; USDA, 2004). The WUI population has substantially increased in recent decades (Radeloff et al., 2005; Hammer et al., 2009) and residents have begun to play an increasingly important role in determining the acceptability of fuels management practices (McCaffrey, 2006; Weisshaupt et al., 2005). Given the potentially large numbers of residents that may be affected by smoke, effective management of emissions will be increasingly important for maintaining resident acceptance of prescribed fire practices.

Several prior studies have found that general information on prescribed fires (provided through a variety of methods) can influence the beliefs about and acceptance of prescribed fire (e.g., Bright et al., 1993; Bright et al., 2006; Loomis et al., 2001; McCaffrey, 2004; McCaffrey, 2006; McCaffrey & Olsen, 2012; Shindler & Toman, 2003; Toman et al., 2006). The influence of this information on beliefs and attitudes towards prescribed fire may be affected by a number of factors, including the information source, the method of communication, or prior support or opposition to the issue (Bright et al., 1993; McCaffrey, 2004; Toman et al., 2006).

In the broader communication literature, substantial research has assessed the influence of different message frames on message success (e.g., Gamson & Modigliani, 1989; Maheswaran & Meyers-Levy, 1990; Nisbet & Huge, 2006). Message framing is "the process by which a communication source constructs and defines a social or political issue for its audience" (Nelson, Oxley, & Clawson, 1997, p. 221). More simply, framing is used by communicators to focus a receiver's attention on one desired interpretation over alternative potential interpretations (Gamson & Modigliani, 1989; Nisbet & Huge, 2006). To do so, framing relies on selection and salience (Entman, 1993). A communicator selects a specific aspect of a larger issue and builds a salient focus around that aspect in a way which "promote(s) a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman, 1993, p. 52). This can be achieved through a number of means, including selecting the specific information that is provided, using key words or images to promote a particular interpretation, and text phrasing (Entman, 1993). Almost every message undergoes framing as communicators attempt to use arguments to achieve their communication intents.

Research has found that selecting particular message frames can influence its effects on an audience. Different frames can result in belief and risk perception differences among those who receive the message (e.g., Maheswaran & Meyers-Levy, 1990; Nelson et al., 1997; Slagle, Zajac, Bruskotter, Wilson, & Prange, 2013). However, to date, little research has addressed the influence of message framing on residents' acceptance of smoke emissions from wild and prescribed fires. The purpose of this paper is to examine the relationship between message framing and perceptions of smoke emissions and management among WUI residents. In particular, we assess the influence of seven different frames on smoke emissions and prescribed fire acceptance, hazard perceptions, positive beliefs, perceived knowledge, and information needs. Responses are compared to examine differences in the effectiveness of each frame.

Background

Fire Communication

Public acceptance of prescribed fire and smoke emissions can be influenced by the ways fire managers interact with the public and the messages they send to WUI residents and the public. By communicating with the local community, agencies can achieve a number of positive outcomes. Communication efforts have been found to increase support for and perceptions of prescribed fire (McCaffrey, 2006; Shindler et al., 2009; Weisshaupt et al., 2005). Communication and active engagement with the local community can also increase trust in agencies to perform various fuel reduction methods, including prescribed burns (Paveglio et al., 2009a; Shindler et al., 2009; Toman & Shindler, 2006b). Finally, in some cases, communication efforts have been found to increase knowledge about prescribed burns (Loomis et al., 2001; Parkinson et al., 2003; Toman & Shindler, 2006a). Several studies have shown that increased prescribed fire and fire hazard knowledge is associated with increased acceptance of the use of prescribed fire (e.g., Absher & Vaske, 2006; Blanchard & Ryan, 2004; Brunson &

Shindler, 2004; McCaffrey, 2004; Shindler & Toman, 2003). In one study, respondents with higher knowledge levels also reported less concern with the risks associated with prescribed fires, including smoke emissions impacts (Blanchard & Ryan, 2004).

In order for prescribed fire communication to achieve these benefits, the communication activities must be effectively planned and implemented. For instance, studies have found that successful communication occurs when clear, understandable language is used to explain fire management options (e.g., Ryan & Hamin, 2006). Communication methods generally fall into two categories: one-way (unidirectional; e.g., informational mailings or the use of media, such as television) and two-way (interactive; e.g., discussions, meetings, or workshops with time for questions and public input). The two communication approaches can be used to meet different communication objectives. While one-way forms of communication have been shown to be less effective than two-way forms for disseminating information, addressing the concerns and interests of the public, and increasing public perceptions of agencies and prescribed burns, they are more effective for building issue awareness and are rated as more trustworthy (Toman et al., 2006; Toman et al., 2008b). Flexible one-way communication strategies combined with two-way strategies work best to increase overall public support (Toman & Shindler, 2006a; Toman & Shindler, 2006b).

Land managers can influence public perceptions and actions regarding fuel reduction efforts by remaining aware of the individual communities they are interacting with and considering community differences when determining their communication strategies (Absher et al., 2009). Studies have indicated that communication efforts which rely on methods and messages developed on a local basis will be more successful than generic messages (Brenkert-Smith et al., 2006; Olsen & Shindler, 2007; Olsen & Shindler, 2010; Paveglio et al., 2009a; Shindler et al., 2009; Toman et al., 2006; Winter et al., 2006). This type of localized communication can increase public understanding of prescribed burns as well as acceptance of prescribed burns and agency management policies (Shindler et al., 2009; Toman & Shindler, 2006a; Toman & Shindler, 2006b).

Construal Level Theory and Psychological Distance

The perceived distance between an individual and ideas, experiences, or others may influence an individual's consideration of those entities (Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2010). The effect of this distance (or the removal from the present reality of an individual) on an individual's perception of an entity is described by both psychological distance and Construal Level Theory (CLT) (Trope & Liberman, 2010). While these two theories are highly related, indeed, psychological distance is considered a type of Construal Level, they are not the same. These constructs differ in how an entity and its distance from an individual are perceived. As Trope and Liberman (2010) state,

> Psychological distance refers to the perception of *when* an event occurs, *where* it occurs, to *whom* it occurs, and *whether* it occurs. Construal levels refer to the perception of *what* will occur…. Thus, psychological distance from an event should be more closely related to the spatiotemporal distance of the event from the self than to its inherent properties, whereas the construal of the event should

be more closely related to its inherent properties than to its spatiotemporal distance from the self. (p. 442)

Therefore, while psychological distance is more concerned with the tangible qualities of an entity which may distance them from an individual, CLT focuses on the conceptual representation evoked by the entity. The two theories share the same cognitive reference point of the "self" from which entities are cognitively distanced and they are also affected in related ways by this distance.

As mentioned above, psychological distance focuses on the perceived distance between an individual and an entity. Psychological distance is a subjective experience and is closely related to the spatiotemporal distance, or the physical space and time (Trope & Liberman, 2010). It centers on an individual's *personal relevance* to the topic and whether some event occurs to them or someone like them (Trope & Liberman, 2010). As such, psychological distance uses the egocentric reference point of here, now, and self. Relative to the reference of an individual's "self," the "entity" can thus be removed on four dimensions: spatially (located near or far), temporally (past, now, or future), socially (self or other), or hypothetically (probability of an event occurring). Thus, entities which are farther removed from the self on those dimensions cannot be directly experienced and are considered more psychologically distant.

CLT takes psychological distance a step further and applies it to the level of construal. According to the CLT, *high-level*, or *abstract*, construals are formed for psychologically distal entities (Trope & Liberman, 2010). High-level construals are formed when an individual has less direct knowledge about the entity and instead must rely on their general knowledge about the entity to make a judgment about it (Bar-Anan, Liberman, & Trope, 2006; Liberman, Trope, & Stephan, 2007). Alternatively, entities which are psychologically near form *low-level*, or *concrete*, construals. As the individual has more direct experience and knowledge of the entity, they do not need to "fill in" (or construe) information about the entity (Bar-Anan, Liberman, & Trope, 2006; Liberman, Trope, & Stephan, 2007). Thus, CLT focuses more on the mental representation of an entity, or its inherent properties (Trope & Liberman, 2010).

As the construal level varies, the focus of the mental construal varies as well. Abstract (high-level) construals tend be more general categories or terms (e.g., an "animal" rather than a "dog") and characteristics of entities which are unlikely to change. For instance, a more high-level construal could be to "eat lunch" rather than "eating at a certain restaurant at a specific time." The goal of "eating lunch" is more likely to remain over time whereas the actual restaurant or the time of lunch may change (Bar-Anan, Liberman, & Trope, 2006; Liberman et al., 2007; Trope & Liberman, 2010). Abstract construals also tend to contain more information about the value of the entity or the meaning (e.g., "having fun" rather than "watching a movie"), are simpler (e.g., "playing" rather than "throwing a Frisbee"), and more prototypical (e.g., a good day next year is conjectured to be better than a good day tomorrow) (Liberman, Sagristano, & Trope, 2002; Trope & Liberman, 2010). Instead, concrete construals focus on the dynamic or contextual characteristics of an entity (Liberman et al., 2007). Concrete construals contain more specific details about an entity (e.g., a "chair" rather than "something to sit on"), its context (e.g., "playing at a park" rather than "playing outside"), and idiosyncratic or subsidiary information (e.g., a "yellow dog" rather than a "dog") (Trope & Liberman, 2010).

As introduced above, psychological distance and CLT are linked, with the level of construal influencing the psychological distance and vice versa. More abstract construal occurs for distal entities and distal entities are more commonly considered at abstract construal levels (Trope & Liberman, 2010). This means that when abstract terms are used to describe activities, there is typically a larger perception of temporal distance. For instance, using terminology which frames activities in general terms (e.g., terms which would answer the question "why"), as relevant to others, and abstractly will act as cues that indicate the activities will happen in a more distant way (Liberman et al., 2007). Lastly, there is an implicit association for abstract construal with psychological distance and concrete construal with psychological proximity (Bar-Anan, Liberman, & Trope, 2006; Trope & Liberman, 2010). In other words, individuals intuitively correlate higher construals levels with greater psychological distance.

According to psychological distancing, objects which are more removed, or distal, from the reference point tend to be more discounted. As such, objects will be discounted if they are a greater distance away in space, further into the future or past, disconnected or unrelated to the individual, or less probable (Trope & Liberman, 2010). The result is that short-term outcomes, or risks, will be weighed more heavily than long-term outcomes, or risks (Milfont & Gouveia, 2006). As short-term outcomes are closer in time to the present, they will be less discounted and long-term outcomes which are more distal in time from the reference point will be more discounted.

However, according to CLT, with high-level (abstract) construal, the benefits of distal outcomes become more important and with low-level (concrete) construal, the benefits of proximal outcomes are more important (Trope & Liberman, 2010). For instance, an individual getting a dog next week might focus more on the positive characteristics of various dog breeds while an individual getting a dog in a year might focus more on the benefits of having a companion (Trope & Liberman, 2010). Along these lines, CLT states that high-level (abstract) construals encourage individuals to reflect on an entity within a larger context, while considering tradeoffs and long term goals (Zwickle & Wilson, 2013).

Hazard Acceptance

Several studies have examined the acceptance of a hazard as a function of the perceived risks and benefits of that hazard (e.g., Alhakami & Slovic, 1994; Siegrist, 1999; Siegrist, 2000; Siegrist, Cvetkovich, & Roth, 2000; Siegrist, Keller, & Kiers, 2005). While the specific measures may vary across these studies, the relationships between risk, benefits, and acceptance are consistent (Figure 3.1). Applying the model to the context of this study, the acceptance of smoke emissions and prescribed fires is a function of their risks and benefits.

The hazard acceptance models propose two relationships: 1) a positive relationship between perceived benefits and hazard acceptance and 2) a negative relationship between perceived risks and hazard acceptance. As such, the models propose that higher hazard acceptance will occur when the hazard is perceived as having high benefits and low risks (Siegrist, 1999). Throughout the studied hazard acceptance models, various researchers have proposed different factors to influence the perceived risks and benefits, including trust and worldviews (Siegrist, 1999; Siegrist, 2000; Siegrist & Cvetkovich, 2000; Siegrist, Cvetkovich, & Roth, 2000; Zajac et al., 2012).

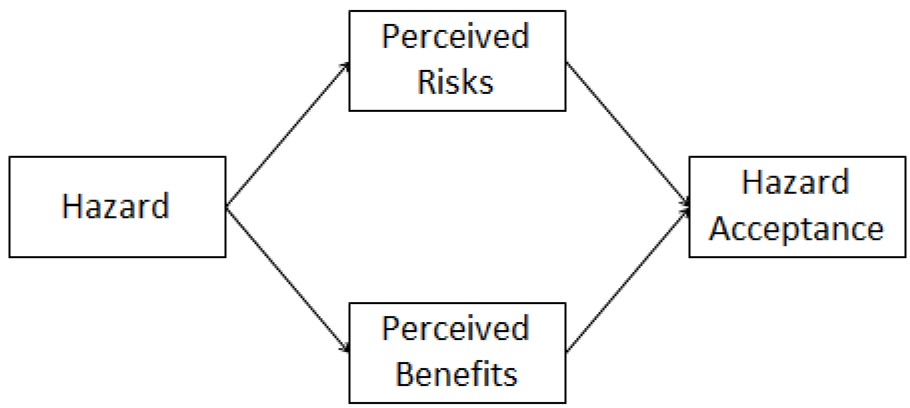


Figure 3.1. General outline of a hazard acceptance model showing general relationships between perceived risks and benefits and hazard acceptance.

According to the hazard acceptance models, the perceived risks and benefits of an activity are inversely related and are not considered on their own. That is, hazards that are perceived as highly beneficial tend to be perceived as low risk while those perceived as high risk tend to be perceived as having few benefits (Alhakami & Slovic, 1994; Siegrist, 1999). In part, this may be due to individuals' inherent need to be consistent in their beliefs (Alhakami & Slovic, 1994; Festinger, 1957). As outlined in cognitive dissonance theories, when individuals have conflicting beliefs they experience mental discomfort. As such, individuals strive to avoid holding conflicting beliefs and will work to reconcile these beliefs through self-justification, change, or denial (Festinger, 1957).

Slagle et al. (2013) applied the hazard acceptance models to communication efforts related to an environmental topic by developing message frames based on the perceived risks and benefits of black bears. The study found that providing information on the benefits of black bears increased acceptance, while providing information on controlling hazard exposure decreased acceptance. Interestingly, they found that providing both benefits and risks information caused the largest increase in hazard acceptance.

Research Methods

Research Objectives and Hypotheses

The objectives of this study are to develop and examine the effectiveness of different message frames on participant acceptance, perceived knowledge, positive beliefs, and hazard perceptions associated with smoke emissions and prescribed burns. Using an experimental design, we tested how the above variables changed following exposure to one of seven different message frames. Participants received a pre-test survey, followed by a communication message, and lastly a post-test survey. Message frames were designed to manipulate an individual's 1) construal of smoke emissions, 2) perception of benefits associated with prescribed fires, and 3) perception of control over smoke emissions exposure. Messages were also compared to a single control group to analyze changes.

Our hypotheses were: 1) messages with a **concrete** frame were expected to increase participant acceptance of smoke emissions and lead to more positive beliefs towards prescribed burn use compared to **abstract** frames; 2) messages that provided **both perceived control and benefits** information were hypothesized to increase acceptance of smoke emissions and lead to more positive beliefs towards prescribed burn use compared to messages with only a **perceived control** frame or **benefits** frame; 3) hazard perceptions were hypothesized to become more negative due to the **concrete-perceived control** frame; and 4) the perceived current knowledge and perceived desired knowledge levels were expected to increase due to any of the message frames.

Study Sites and Populations

Three study sites were examined in this study. The study sites included counties adjacent to the Shasta-Trinity National Forest in northern California, the Fremont-Winema National Forest in southern Oregon, and the Francis-Marion National Forest in southeastern South Carolina (further described in Chapter 1). The Kootenai National Forest, Montana study site was not included as we were unable to achieve a sufficiently large sample size. Each of these sites is characterized by a fire dependent ecosystem where active fuels reduction programs are underway to reduce the likelihood of fire and restore forest conditions (JFSP, 2011a; JFSP, 2011b).

WUI residents may also be considered as part of the "knowledgeable" or "informed" public. Previous studies have found that residents of fire dependent areas generally recognize the complexity of fuel hazards and have a sophisticated understanding of prescribed fires and fire risks (Brunson & Shindler, 2004; McCaffrey, 2006; McCaffrey & Olsen, 2012, Shindler & Toman, 2003). As such, residents will likely view prescribed fires and smoke emissions as highly relevant.

Research Design

The data used in this study were collected from an online panel survey. A sample of adults residing in the zip codes adjacent to the above identified National Forests was purchased from a professional sampling company, Marketing Systems Group (MSG). The survey was developed and hosted using Qualtrics. Participants were randomly assigned to the control or a treatment group. The survey company was provided with a link to the survey which they then distributed. Survey items consisted of questions about smoke emissions and prescribed fire, including experience, acceptability, attitudes and beliefs, and risk perceptions. Additional questions addressed information seeking and processing behaviors and information needs, as well as agency perceptions and trust.

The survey was conducted in May 2014. The impact of message framing was tested using an experimental design. The experiment was administered online with participants first receiving a pre-test survey, followed by a randomly assigned informational message treatment, and finally a post-test survey. Six different message treatments (including perceived control and benefits as well as concrete and abstract frames) and one control message were administered at each of the three study sites (see Informational Message section below). Participants were provided with an incentive of approximately two dollars to complete the survey.

A total of 1,438 surveys were started and 1,009 were completed. Of those who started the survey, approximately 11% lived outside of the selected counties, 4% declined to participate in the study, and another 13% began but did not complete the survey. Incomplete surveys were not included in analysis. Of the 1,009 completed surveys, there were approximately 340 participants at each of the study sites, with at least 45 participants per treatment.

Category	Surveys
Incompletes	194
Incorrect state	161
Declines	63
Control	145
Abstract-benefits	143
Abstract-PC	145
Abstract-BBPC	146
Concrete-benefits	143
Concrete-PC	142
Concrete-BBPC	145
Total Completed	1009

Note: PC: perceived control
BBPC: both benefits and perceived control

Table 3.1. Sample sizes by message category.

Treatments: Informational Messages

Using a 2×3 design outlined in Figure 3.2 below, six treatment groups emerged, in addition to a single control (Table 3.2). Message frames were developed using Hazard Acceptance Models, Psychological Distancing, and Construal Level Theory. Based on Hazard Acceptance Models, three frames were developed: **benefits, perceived control** (**PC**; or control over a risk), and a combination of **both benefits and perceived control** (**BBPC**). As Psychological Distancing and CLT are highly related, only two frames were developed based on the combined theories: **abstract** (paired with psychologically distant) and **concrete** (paired with psychologically near or local).

		Hazard Acceptance frames		
		Benefits	**Perceived control (PC)**	**Both benefits and perceived control (BBPC)**
CLT frames	**Abstract** (distant; National US)			
	Concrete (local; CA, OR, SC)			

Figure 3.2. Diagram showing the treatment design for the informational messages. A single control was also used.

Each treatment first included the **control**, or introductory, information. The control message included basic information about fire and smoke emissions with no further manipulations. This was the only information received by those in the control group. The **benefits** message frame provided additional information about the benefits of prescribed fires, including their potential positive impacts on smoke emissions (e.g., reducing the amount of smoke emissions in the long-term). The **perceived control** (**PC**) frame included information describing how individuals can reduce their risk from the impacts of smoke emissions by limiting their exposure to smoke. Lastly, the **both benefits and perceived control** (**BBPC**) frame included information from both frames.

Further manipulation of the benefits, PC, and BBPC frame information was used to develop the final treatments. The majority of the benefits and risks text remained the same for the **abstract** and **concrete** frames; however, the construal level was manipulated by varying a few terms. The **abstract** frame used general terms that were further removed from the self (e.g., referenced future times, other people, and used less probability) and focused at the national U.S. level for geographic specific information. Alternatively, the **concrete** frames included terms that were more specific to the self (e.g., referenced the now, the individual, and used more certainty) and focused on the individual study sites for location specific information. Due to the location specific information, three different versions of the concrete frame were created to account for the local information, one for each California, Oregon, and South Carolina. The results of these different study site specific versions were all combined to form the concrete frame category. An example of the term manipulation is provided: "Knowing when and where smoke emissions (might/will) [abstract/concrete] occur and taking proper steps to limit exposure can help protect (United States/California/Oregon/South Carolina)'s [distant/local] residents." Please see Appendix A for more example messages.

Treatment	Frame	Included Information
Control	None	Basic introductory information concerning fire and smoke emissions
		No further manipulation
Abstract-benefits	Abstract/distant	Abstract terms; US location specific
	Benefits	Benefits of prescribed burns
Abstract-PC	Abstract/distant	Abstract terms; US location specific
	Perceived control	Risk reduction suggestions to limit smoke exposure
Abstract-BBPC	Abstract/distant	Abstract terms; US location specific
	Benefits	Benefits of prescribed burns
	Perceived control	Risk reduction suggestions to limit smoke exposure
Concrete-benefits	Concrete/local	Concrete terms; study site location specific (CA, OR, or SC)
	Benefits	Benefits of prescribed burns
Concrete-PC	Concrete/local	Concrete terms; study site location specific (CA, OR, or SC)
	Perceived control	Risk reduction suggestions to limit smoke exposure
Concrete-BBPC	Concrete/local	Concrete terms; study site location specific (CA, OR, or SC)
	Benefits	Benefits of prescribed burns
	Perceived control	Risk reduction suggestions to limit smoke exposure

Table 3.2. Treatment group descriptions listing the frames used for each treatment.

Data Analysis

Data was analyzed using SPSS (Statistical Package for Social Sciences, Version 21). Data analysis began by calculating descriptive statistics. Message effects were examined by calculating paired samples t-tests, one way analysis of variance (ANOVA), and post-hoc comparisons (Tukey) in pre and post-test responses.

Variable Information

The variables used in this analysis are described below. Unless otherwise noted, the measures included a seven-point scale from 1 "Strongly disagree" to 7 "Strongly agree," with 4 being "Neutral," while also allowing "Don't know" responses ("Don't know" responses were excluded from the item analyses). List-wise deletion was used for missing responses as respondents who were missing data for any variable were removed from that particular analysis.

Most of the variables were measured twice, both before and after participants received their message treatments. Variables measured before exposure to a message are designated as *pre* and variables measured after exposure are designated as *post*. Variables designated as *change* (or *message effectiveness*) measured the difference between the pre and post values for each respondent (pre-test subtracted from post-test). The *change* variables were used to evaluate the effectiveness of the message treatments by comparing the relative sizes and directions of the message effects. For instance, a positive *change* value for a variable would indicate the variable increased in the post-test compared to the pre-test for the specific treatment. The *change* value for that particular treatment can then be compared to the *change* value for other treatments to determine if the treatments all caused similar differences.

Variables examined in the study include:

Informational Messages. *Message exposure* is a measure of which treatment, or informational message, participants received. Messages were considered two separate ways: in the original treatment categories (e.g., "**concrete-benefits**" or "**abstract-BBPC**") and by separating participants into groups based on the message frames they received (e.g., all participants who had received the "**benefits**" information, including concrete-benefits or abstract-benefits; or all those who had received the "**concrete**" information, including concrete-benefits, concrete-PC, and concrete-BBPC). For each of the messages, exposure was simply measured as 1 "Exposure" or 0 "No exposure."

Acceptance. *Acceptance* was examined through two separate variables included in both the pre- and post-tests. Prescribed fire acceptance measured the acceptance level of prescribed burns. Smoke from prescribed fire acceptance measured the acceptance level of smoke emission from prescribed fires.

Hazard Perceptions. *Hazard perceptions* were examined through nine variables within three general categories: *worry*, *expected impact,* and *expected harm*. *Worry* was examined for smoke emissions from wildfires (worry wildfire smoke) and prescribed fires (worry prescribed fire smoke).

The expected *Impact* was examined for smoke emissions. The impact on participant's own personal health (personal impact) and the health of their household members (household impact) were measured separately. The expected impact was measured on a seven-point scale, with 1 "No impact" to 7 "Very large impact."

Finally, the *Expected Harm* was examined for smoke emissions from prescribed fires. This measured the level of harm that smoke emissions were expected to cause for the participant (personal harm), the participant's family (family harm), the participant's neighbors (neighbors harm), the participant's community (community harm), and other communities (others harm). The amount of harm was measured on a four-point scale with 1 "No harm at all" to 4 "A great deal of harm."

Beliefs. *Beliefs* were examined through three separate variables. Prescribed fire overall smoke measured whether participants believed prescribed fires created less smoke overall compared to wildfires. Prescribed fire benefits measured whether participants believed prescribed fires have more benefits than costs. Finally, smoke negative measures whether participants believed the negative effects of smoke emissions outweigh any benefits prescribed burns provide.

Knowledge. *Knowledge* was examined through four variables in two general categories: *information* and *importance*. *Information* examined participant's knowledge levels and needs. Current information measured how much participants felt they knew about smoke emissions, while needed information measured how much participants felt they needed to know about smoke emissions in order to have a comfortable understanding. Both of these variables were measured on a 100-point scale from 0 "Know nothing about smoke" to 100 "Know everything that could possibly be known about smoke." Information sufficiency measured the actual amount of information participants required to meet their information goals. Information sufficiency was calculated by subtracting the current information from the needed information, with a 200-point scale ranging from -100 "Too much information" to 100 "Need more information."

Lastly, *Importance* measured the importance of smoke emissions for participants. Smoke emissions importance was measured on a seven-point scale of 1 "Not important" to 7 "Very important."

Results

Demographics

A large majority of study participants were female with an average age in the mid to late forties (Table 3.3). More than three fourths had attended at least some college. Just under one fourth of participants had prior experience with fire while more than a third had prior experience with smoke emissions. More than two thirds had experienced some negative impact of smoke emissions in the past, with around one forth indicating experience with personal negative health effects. Around a third of participants indicated that at least one person in their household suffered from a respiratory ailment.

Variables	All %	CA %	OR %	SC %
Experienced in last 5 years				
Fire	22	30	20	15
Smoke emissions	38	49	44	22
Any negative experience with smoke (5 years)	70	78	74	58
Personal health effect	22	31	25	11
Household member with a respiratory ailment	35	37	37	30
Worry about smoke				
Any source	64	69	61	62
Wildfires	65	72	66	59
Prescribed fires	48	49	50	45
Gender (male)	29	31	28	28
Education				
High school or less	22	21	22	24
Some college	30	32	32	27
Bachelor's or Associate's degree	35	35	35	34
Some graduate or graduate degree	13	12	11	15
	Median	Median	Median	Median
Age (years)	47	44	51	46

Table 3.3. Participant demographic information.

Notably, prior to receiving any informational messages, a large percent of residents indicated they worried about smoke emissions (Table 3.3). Around two-thirds of residents indicated they worried at least a little about smoke emissions generally (no specified source of smoke) (64.0%) and from wildfires (65.3%). Although fewer worried about smoke from prescribed fire, nearly half (47.9%) still worried about these emissions. Overall, 82.6% of residents indicated that they worried about smoke emissions from at least one of the above sources.

In the following sections, the informational messages are considered in two ways: 1) messages were tested to the control and against each other specific to their individual theories within the construal (**abstract**, **distant**) and hazard acceptance frames (**benefits**, **PC**, **BBPC**) and 2) messages were compared across all seven of the treatments (e.g., **abstract-benefits**, **concrete-PC**, **control**).

Acceptance

Prior to exposure to the information messages, participants were generally willing to accept the use of prescribed fire (M = 4.94 out of 7). Acceptance was slightly lower for smoke emissions from prescribed fire, but participants were still generally willing to accept such emissions (M = 4.57 out of 7). Following exposure to all informational messages (including the control message), participants expressed greater acceptance of both the use of prescribed fire and resulting smoke emissions (Table 3.4).

To examine differences in effects between the different messages, we compared responses using ANOVA (to assess mean differences), Contrasts (to assess the change in each messages compared to the **control**), and Tukey Post Hoc comparisons (to assess where the specific change occurred by comparing each of the categories one-on-one). As outlined above, c*hange* variables (or *message effectiveness*) were created for both <u>prescribed fire acceptance</u> and <u>smoke from prescribed fire acceptance</u> by subtracting the *pre-test* values from the *post-test*. The *change* variables were used in the comparison analysis of the control contrast, message frames, and message treatments.

Variable		Acceptance Pre-test	Acceptance Post-test	Change
Prescribed fire[1]	Mean	4.94	5.20	0.26
	t	6.830*		
	p	<0.001		
Smoke from prescribed fire[1]	Mean	4.57	4.78	0.21
	t	5.281*		
	p	<0.001		

Note: * $p < 0.05$
[1] 7-point scale; 1 "Strongly disagree" to 7 "Strongly agree"

Table 3.4. Mean comparisons for acceptance of prescribed fires and smoke emissions (Paired samples t-test).

First, the *change in acceptance* of each message frame was *compared to the control* (Table 3.5). The change in prescribed fire acceptance following exposure to any message did not significantly differ from the **control**. For change in smoke emissions acceptance, participant acceptance decreased after exposure to the **control**. The **control** differed significantly from the following frames and treatments (participant acceptance of smoke emissions increased for each): **concrete**, **abstract**, **benefits**, **BBPC**, **abstract-benefits**, and **concrete-benefits**.

Second, the *change in acceptance* between the different message frames was compared (Table 3.6; Appendix B). An ANOVA analysis showed the *change in* *acceptance* of prescribed fire and smoke from prescribed fire was consistent between construal frames. However, a post hoc comparison revealed significant differences in change in smoke emissions acceptance for those who received the **control** and **abstract** frames, with an increase in acceptance for **abstract**. There was a significant difference in change in smoke emissions acceptance due to the hazard acceptance frames, $F(3, 1003) = 4.362$, $p = 0.005$. The post hoc comparison revealed significant differences in change in smoke emissions acceptance for those who received the following frames: **benefits** compared to both **control** and **PC**. That is, participants' acceptance of smoke emissions increased more than the increase caused by the **PC** frame and the decrease caused by the **control**.

Lastly, the *change in acceptance* due to the various message treatments was compared (Table 3.6). The change in smoke emissions acceptance was significantly different among the message treatments, $F(6, 1000) = 2.364$, $p = 0.028$. However, the post hoc comparison revealed no specific differences.

Exposure to information generally had a positive effect on acceptance of both prescribed fires and their smoke emissions; only the **control** message had a negative effect on smoke emissions acceptance. While the size of the change in prescribed fires acceptance was consistent following exposure to any of the messages, there were significant differences in the amount of smoke emissions acceptance change between messages. Compared to other frames, the **abstract** and **benefits** frames generally resulted in larger increases in smoke emissions acceptance. The first and second proposed hypotheses (smoke emissions acceptance would increase due to 1) the **concrete** frame compared to the **abstract** frame and 2) the **BBPC** frame compared to either the **PC** or **benefits** frame) were not supported by these findings.

Change variable		Control *M*	Concrete *M*	Abstract *M*	Benefits *M*	PC *M*	BBPC *M*	Abstract-benefits *M*	Abstract-PC *M*	Abstract-BBPC *M*	Concrete-Benefits *M*	Concrete-PC *M*	Concrete-BBPC *M*
Acceptance	Smoke from prescribed fire [a, b, c]	-0.01 [1, 2, 3, 4, 5]	0.23 [1]	0.29 [2]	0.42 [3]	0.12	0.24 [3]	0.40 [4]	0.18	0.28	0.44 [5]	0.05	0.19
Hazard	Health impact - Personal [a, b, c]	-0.01 [1, 2, 3, 4]	-0.14	-0.24 [1]	-0.35 [2]	-0.10	-0.11	-0.40 [3]	-0.20	-0.12	-0.30 [4]	0.00	-0.10
Knowledge	Current information [a]	8.24 [1]	9.86	11.30	9.61	11.30	10.84	7.93	10.47	15.45 [1]	11.29	12.14	6.23
	Information sufficiency [a, b, c]	-4.65 [1, 2]	-9.22 [1]	-7.87	-8.83	-8.67	-8.14	-5.24	-7.31	-11.01	-12.41 [2]	-10.05	-5.26
	Smoke emissions importance [b, c]	-0.08 [1, 2]	0.07	0.08	0.04	0.14 [1]	0.05	0.06	0.12	0.06	0.01	0.16 [2]	0.04

Note: [a] Responses significantly different between control and CLT message frames (based on ANOVA, $p < 0.05$)
[b] Responses significantly different between control and Hazard Acceptance Model message frames (based on ANOVA, $p < 0.05$)
[c] Responses significantly different between control and message treatments (based on ANOVA, $p < 0.05$)
Means with different numbered superscripts within each row are significantly different at $p < 0.05$ based on Contrast comparisons

Table 3.5. Control comparisons to message frames and treatments for the amount of change between the pre- and post-tests for significant variables only (ANOVA and Contrasts).

Change variable		Control	Concrete	Abstract	Benefits	PC	BBPC	Abstract-benefits	Abstract-PC	Abstract-BBPC	Concrete-Benefits	Concrete-PC	Concrete-BBPC
		M	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Acceptance	Smoke from prescribed fire [a, b, c]	-0.01 [1, 2]	0.23	0.29 [1]	0.42 [2, 3]	0.12 [3]	0.24	0.40	0.18	0.28	0.44	0.05	0.19
Hazard	Health impact - Personal [a, c]	-0.01 [1]	-0.14	-0.24	-0.35 [1]	-0.10	-0.11	-0.40	-0.20	-0.12	-0.30	0.00	-0.10
Knowledge	Current information [c]	8.24	9.86	11.30	9.61	11.30	10.84	7.93 [1]	10.47	15.45 [1, 2]	11.29	12.14	6.23 [2]

Note: [a] Responses significantly different between CLT message frames (based on ANOVA, $p < 0.05$)
[b] Responses significantly different between Hazard Acceptance Model message frames (based on ANOVA, $p < 0.05$)
[c] Responses significantly different between message treatments (based on ANOVA, $p < 0.05$)
Means with different numbered superscripts within each row are significantly different at $p < 0.05$ based on Tukey post hoc comparisons

Table 3.6. Comparison of the effects of message frames and treatments on the amount of change between the pre- and post-tests for significant variables only (ANOVA and Tukey Post Hoc).

Hazard Perceptions

Before receiving any information, participants already generally worried about smoke emissions from both wildfires (M = 5.01 out of 7) and prescribed fires (M = 4.50). Participants expected moderate health impacts both personally and for their families (both M = 4.09) and that smoke emissions would cause harm to themselves, their families, and others. After exposure to information (including the **control**), participants expressed greater worry about smoke emissions from wildfires, but were less worried about emissions from prescribed fire (Table 3.7).

The effectiveness of message frames and treatments were compared. First, the message effectiveness for hazard perceptions was compared to the **control** and revealed four differences (Table 3.6). Compared to the **control**, the change in personal impact differed significantly for the following frames and treatments: **abstract**, **benefits**, **abstract-benefits**, and **concrete-benefits**. That is, when exposed to information with any of those frames or treatments, participants' expected personal health impacts from smoke emissions decreased more than the decrease caused by the **control**.

Second, the *change in hazard perceptions* following message frame exposure was compared (Table 3.6; Appendix B). Results were similar for the different construal frames. There was a significant difference for change in personal impact due to the hazard acceptance frames, $F(3, 1004) = 3.794$, $p = 0.010$. A post hoc comparison revealed a significant difference for participants who received the **benefits** frame and the **control**, with the expected **personal health impact** lowered more for those who received the **benefits** frame.

Lastly, the *change in hazard perceptions* due to the various message treatments was compared (Table 3.6). Only change in personal health impacts was significantly different among the message treatments, $F(6, 1001) = 2.342$, $p = 0.030$. However, no specific differences were found in the post hoc comparison.

Variable			Hazard perception Pre-test	Hazard perception Post-test	Change
Smoke worry	Wildfire	Mean	5.01	5.16	0.15
		t	-3.746*		
		p	<0.001		
	Rx fire	Mean	4.50	4.17	-0.33
		t	6.699*		
		p	<0.001		
Health impact of smoke emissions[1]	Personal	Mean	4.09	3.93	-0.16
		t	4.426*		
		p	<0.001		
	Household	Mean	4.09	3.91	-0.18
		t	4.982*		
		p	<0.001		
Expected harm for smoke emissions[2]	You personally	Mean	2.58	2.52	-0.06
		t	3.074*		
		p	0.002		
	Your family	Mean	2.58	2.53	-0.05
		t	2.438*		
		p	0.015		
	Neighbors	Mean	2.56	2.53	-0.03
		t	1.450		
		p	0.147		
	Your community	Mean	2.63	2.58	-0.05
		t	2.047*		
		p	0.041		
	Other communities	Mean	2.70	2.65	-0.05
		t	2.094*		
		p	0.037		

Note: * $p < 0.05$
[1] 7-point scale; 1 "No impact" to 7 "Very large impact"
[2] 4-point scale; 1 "No harm at all" to 4 "A great deal of harm"

Table 3.7. Hazard perception mean comparisons (Paired samples t-test).

Exposure to information had a mixed effect on hazard perceptions. While most hazard perceptions generally decreased, specifically those related to harm and prescribed fire smoke emissions (participants viewed the hazards as less dangerous or worrisome), the hazard perception for wildfire smoke increased. Messages had similar impacts on hazard perceptions, but one main difference was found. The **benefits** frame was more effective at decreasing the expected level of personal health impact from smoke emissions. The third hypothesis (hazard perceptions would become more negative with the **concrete-PC** frame) was not supported by these findings.

Beliefs

In the pre-test, participants generally believed that "prescribed fires create less smoke overall compared to wildfires" (prescribed fire overall smoke), "prescribed fire has more benefits than costs" (prescribed fire benefits), and "the negative effects of smoke outweigh any benefits prescribed fires provide" (smoke negative). After exposure to the informational messages (including the **control**), participant beliefs became more positive for both prescribed fire overall smoke and prescribed fire benefits (Table 3.6).

The *change in beliefs* was not affected by the message frames and treatments (Appendix B). All of the frames and treatments, including the **control**, caused similar changes for each of the beliefs.

Generally, beliefs concerning prescribed burns became more positive after exposure to any information. The increase in agreement with the belief statements remained similar across all message frames and treatments, including the **control**. These findings did not support the first and second hypotheses (more positive beliefs would result from 1) the **concrete** frame compared to the **abstract** frame and 2) the **BBPC** frame compared to either the **PC** or **benefits** frame).

Variable		Beliefs		
		Pre-test	Post-test	Change
Rx fire creates less smoke overall compared to wildfires	Mean	4.73	5.11	
	t	-8.261*		0.38
	p	<0.001		
Rx fire has more benefits than costs	Mean	4.83	5.16	
	t	-8.386*		0.33
	p	<0.001		
Negative effects of smoke outweigh any benefits Rx fires provide	Mean	3.75	3.70	
	t	1.013		-0.05
	p	0.311		

Note: * $p < 0.05$

Table 3.8. Beliefs mean comparisons (Paired samples t-test).

Knowledge

Prior to exposure to the messages, participants generally felt they had a moderate amount of information about smoke emissions (M = 42.58 out of 100); however, most also indicated they needed more information than they had (M = 63.49 out of 100) (Table 3.9). Following exposure to all informational messages (including the **control**), the gap between <u>current</u> and <u>needed information</u> levels became smaller; on average, participants' current knowledge increased by 10 points while the desired knowledge increased as well by a significant, but much smaller 3 points. That is, after exposure to any information, participants believed they both knew more about smoke emissions and needed more information to have a comfortable understanding. Participants rated smoke emissions as important in both the pre and post-tests.

Variable		Knowledge		Change
		Pre-test	Post-test	
Current information[1]	Mean	42.58	52.82	10.24
	t	-15.441*		
	p	<0.001		
Needed information[1]	Mean	63.49	65.74	2.25
	t	-3.264*		
	p	0.001		
Information sufficiency	Mean	20.87	12.89	-7.98
	t	9.001*		
	p	<0.001		
Smoke emissions importance[2]	Mean	4.75	4.80	0.05
	t	-1.756		
	p	0.079		

Note: * $p < 0.05$
[1] 100-point scale; 0 "Know nothing about smoke" to 100 "Know everything that could possibly be known about smoke"
[2] 7-point scale; 1 "Not important" to 7 "Very important"

Table 3.9. Knowledge mean comparisons for smoke emissions (Paired samples t-test).

The *effectiveness* of the message impacts on *knowledge* was compared to the **control** (Table 3.5). Participant change in current knowledge experienced a larger increase with the **abstract-BBPC** treatment compared to the increase with the **control**. Compared to the **control**, the change in information sufficiency differed significantly for the following message frames and treatments (participant information sufficiency decreased more for each): **concrete** and **concrete-benefits**. Lastly, the change in smoke emissions importance due to the following frame and treatment had a larger increase compared to the **control**: **PC** and **concrete-PC**. The reported importance of smoke emissions decreased after exposure to the **control**.

Next, all of the message frames resulted in similar changes for most *knowledge* measures and reported *smoke importance* (Appendix B). However, the message treatments did cause the level of change to vary for current information, $F(6, 997) = 3.162$, $p = 0.004$ (Table 3.6). The **abstract-BBPC** treatment significantly differed from both the **abstract-benefits** and **concrete-BBPC** treatments. In each situation, the **abstract-BBPC** treatment caused a greater increase in current information.

Information generally had a positive effect on participant knowledge. However, participants' current information grew more than their information need, resulting in a shrinking information sufficiency. Across the message frames, the *changes in knowledge* remained at similar levels. But, the **abstract-BBPC** treatment caused the largest increases in current knowledge. The findings supported the fourth hypothesis (increase in current and needed information levels with any of the message frames).

Discussion

Consistent with previous research, this study found that information on the benefits of prescribed fires or perceived control over smoke emissions at various construal levels impacted acceptance, risk perceptions, beliefs, and knowledge. The messages resulted in increased support for prescribed fire and smoke emissions and mostly decreased risk perceptions (Blanchard & Ryan, 2004). Information exposure caused residents to indicate higher knowledge about smoke emissions (McCaffrey, 2006; Shindler et al., 2009). Moreover, residents reported they held more positive beliefs about prescribed burns after receiving any of the informational messages (Bright et al., 1993; Bright et al., 2006; Loomis et al., 2001; McCaffrey, 2004; McCaffrey, 2006; McCaffrey & Olsen, 2012; Shindler & Toman, 2003; Toman et al., 2006).

Interestingly, while McCaffrey (2004) found fire risk perceptions increased with information exposure, we found mixed results as hazard perceptions towards prescribed fires decreased while those specific to wildfires increased. The contrasting findings may in part be due to methodological differences as McCaffrey relied on self-reported informational usage rather than measuring change following exposure to specific messages. Additionally, much of the information provided in this study was specific to prescribed burns and smoke emissions, which could account of the decreased hazard perception towards them, while the hazard perceptions towards wildfires increased.

Second, the hazard perceptions of residents regarding prescribed burns and their smoke emissions decreased at a relatively similar rate between all of the message frames used here. This is contrary to previous research by Spence and Pidgen (2010) who found that exposure to a psychologically distant (abstract) frame increased the hazard perceptions individuals held concerning climate change. For this study, these results suggest that differences in message effectiveness were not due to some messages causing residents to feel more at risk. That is, none of the messages caused a larger increase or decrease in participant's risk perceptions, rather the risk perceptions stayed at similar levels across messages. Had some of the messages caused a larger change in risk perceptions, resident acceptance and beliefs concerning prescribed fires and smoke emissions could have been greatly affected.

Third, acceptance levels for smoke emissions and positive beliefs concerning prescribed burns were expected to increase more due to **concrete** framing and frames which included **both benefits and perceived control** (**BBPC**) information compared to the others. While acceptance and positive beliefs concerning both smoke emissions and prescribed burns did increase, the **concrete** and **BBPC** frames did not lead to larger increases. Rather, acceptance of smoke emissions increased more with **abstract** and **benefits** frames, while prescribed fire acceptance changed at a similar rate for each message frame. Based on CLT, it was expected that a **concrete** frame would increase acceptance and positive beliefs by providing more personally relevant information, thus helping residents to understand how prescribed burns and smoke emissions impact them and encouraging them to pay more attention to the information. However, the findings suggest that the opposite response occurred.

One potential explanation for this may be that the **concrete** frame may have encouraged residents to concentrate on the negative personal impacts smoke emissions may cause while the more distant (**abstract**) frame may have encouraged residents to consider prescribed burns and smoke emissions as occurring somewhere else or more hypothetically, thus cognitively distancing themselves from the negative impacts. Additionally, an **abstract** frame may have encouraged residents to consider prescribed fires and smoke emissions in a broader context (e.g., a higher construal level) and focus on the long-term management goals and outcomes of prescribed burns (Zwickle & Wilson, 2013). At a higher construal level, residents may consider the benefits of more distal outcomes of prescribed burns as more important compared to the proximal benefits, such as reduced smoke emissions in the long term or healthier natural areas (Trope & Liberman, 2010). While more concrete thinking at lower construal levels would instead cause residents to consider the risk and benefits of proximal outcomes of prescribed fires as more important than the distal outcomes. However, as most of the benefits of prescribed fires are more distal, while the risks may be experienced in the near-term, this may enable the potential and more proximal risks (such as traffic accidents or coughing fits) to become more important. Additionally, Zwickle (2014) found that for the attentive public, abstract frames had a greater impact on improving public support for policies related to a hazard and that construal framing works more effectively when the frame provided is on the same construal level of the hazard of interest. In addition to the results found in this study, his work suggests that abstract frames may more effectively impact the informed and relevant public.

Lastly, based on hazard acceptance models, it was expected that providing more balanced information with **both benefits and perceived control** (**BBPC**) information would increase acceptance of smoke emissions and positive beliefs towards prescribed burns. Indeed, Slagle et al. (2013) found that a combination of perceived control and benefits information increased hazard acceptance more than one or the other. However, such results were not evident in this study. The **benefits** frame caused a larger increase in smoke emissions acceptance than the **PC** frame. Differences in the hazards examined by each study may account for the dissimilar results. Experiencing smoke emissions may be more probable and occur with greater frequency than the human-bear conflicts examined by Slagle et al. (Slovic et al., 2004; Trope & Liberman, 2010). As such, the smoke emissions hazard may be more concrete and psychologically near. This could mean that while residents are already considering smoke emissions at low construal levels, providing information on smoke emissions risks or benefits cause the respective outcomes to become more important. Furthermore, residents may view smoke emissions as a necessary inconvenience compared to human-bear conflicts. This may be supported by the **benefits** and **BBPC** frames performing similarly with regard to smoke emissions acceptance compared to the **control**. When balanced information was provided, the benefits of prescribed fires were more important than the risks. Lastly, it is possible that the various frames did not have a large effect on prescribed fire acceptance as WUI residents may already be familiar with prescribed fires and recognize their importance.

Compared to providing more neutral information (the **control**), residents who received information manipulated using any of the message frames reported larger impacts on their levels of smoke emissions and prescribed fire acceptance, hazard perceptions, and knowledge. The effects of the various frames become more important depending on the overall goal a communicator wishes to achieve through providing information. Communicators seeking to increase acceptance of smoke emissions and those seeking to decrease hazard perceptions can achieve their goals more effectively by using different communication frames; the benefits frame may cause a larger decrease in hazard perceptions, while the abstract frame may cause a larger increase in acceptance.

Conclusion

Results from this study demonstrated relatively high levels of concern and perceived personal impacts from smoke emissions among WUI residents. As such, it is important to consider how fire and smoke emissions information is presented to residents and the role of framing in potentially reducing concerns and providing residents with information to better consider these emissions within the larger context of fire and smoke management.

The significant role framing plays in information provision can be recognized when using frames based on the principles outlined in both CLT and hazard acceptance models. WUI residents generally already view smoke emissions and fire as important issues and do not need to be "sold" on their importance. This means that less personally relevant information is more helpful as residents are encouraged to look at the big picture surrounding emissions and fire hazards. Similarly, residents may already be aware of smoke emissions risks and know how to respond to it, so refocusing to information on why smoke emissions are necessary or why prescribed burns are important (i.e., a benefits or balanced perceived control and benefits frame) may be more beneficial.

Lastly, several implications for fire managers stand out. Managers should frame informational messages to be consistent with their communication goals. While exposure to any information on prescribed fires and smoke emissions can be helpful for residents and help improve views of prescribed burns and smoke emissions, there is not a silver bullet approach to fire communication. Different frames are more effective at achieving different goals (e.g., improve understanding of fire hazards, increase support for prescribed fires, or encourage positive beliefs about prescribed fires) and there may be tradeoffs involved depending on the goals and frames used.

Chapter 4: Conclusion

The rise in the average annual acres burned in the United States (NIFC, 2013) combined with more individuals living in the wildlife-urban interface (WUI) has resulted in more individuals potentially at risk from future fire events and exposure to smoke emissions (Radeloff et al., 2005). Residents may experience several negative effects due to smoke emissions, including coughing, headaches, unpleasant odors, road closures, or traffic delays (Frederick, 2013; Monroe et al., 1999). A further 30% of WUI households are placed at further risk as they contain individuals who have health problems that can be exacerbated by smoke (Chapter 3; Frederick, 2013; McCaffrey, 2006; McCaffrey & Olsen, 2012).

Public support for fire management activities is key to the implementation of prescribed fires as they may not be applied in areas where residents view the negative costs associated with smoke emissions as too high (McCaffrey, 2006; Weisshaupt et al., 2005). Communication efforts provide fire managers with an opportunity to influence resident perceptions of smoke emissions and their potential impacts on nearby communities. Such efforts may include providing information on the benefits of prescribed fires or behaviors residents can engage in which may minimize the impact of emissions.

The purpose of this paper was twofold. First, we examined the information seeking behaviors of WUI residents regarding smoke emissions from fires by drawing on the Risk Information Seeking and Processing (RISP) model to assess the influence of potential common variables that motivate information seeking behaviors. Second, we examined the relationship between message framing and perceptions of smoke emissions and prescribed fires for WUI residents based on Construal Level Theory (CLT) and Hazard Acceptance Models. Of note, the populations used in these studies included can be considered members of the knowledgeable, or informed, public.

First, we found that around half of the residents in each of the studies indicated they worried about smoke emissions, while a third to a half indicated they had experienced personal health effects due to smoke emissions in recent years. Clearly, smoke emissions are an important issue to those living in WUI areas. The large number of residents who reported concern indicates that smoke emissions are an issue which needs to be addressed by fire managers. As such, it is important to consider how fire and smoke emissions information is presented to these residents as framing can have a significant influence on residents' views towards these issues.

Second, residents generally indicated that they needed additional information on smoke emissions. However, there was a discrepancy between those who indicated they needed information and those who intended to seek information. That being said, information seeking was motivated when residents believed they would be impacted by smoke, worried about smoke emissions, felt they did not have enough information, used more information sources, and found it difficult to find information. Clearly, information seeking is reliant on more than just information need. But, these findings also suggest that barriers exist which prevent residents from intending to seek information, even if they believe more information is required in order to comfortably understand the risk smoke emissions poses to them. Further research should be done to explore this potential barrier and examine why some residents who feel they need more information than they currently have do not intend to seek it.

Finally, consistent with previous research, we found that providing any information to residents can help improve views of prescribed burns and smoke emissions (Absher & Vaske, 2006; Blanchard & Ryan, 2004; Brunson & Shindler, 2004; McCaffrey, 2004; Shindler & Toman, 2003). However, there is no universal frame that should be used for all fire communication. Different frames are more effective at producing different results (e.g., increased support or increased knowledge) and must be considered in light of the overall communication goals. For instance, we found that using an abstract message frame may increase public acceptance and knowledge concerning smoke emissions more effectively than other frames, while simply providing basic information with no further manipulation (the experimental control message) may cause a slight decrease in acceptance. Therefore, if a fire manager wants to increase public acceptance for smoke emissions in the area, an abstract frame should be implemented. Had only basic information (control message) been used, the fire manager may have achieved the opposite effect from the communication goal.

However, we found that a large number of WUI residents have already heard or read about prescribed fires and smoke emissions and generally viewed both issues as important. Thus, residents are aware of the personal impacts smoke emissions and fire hazards can have on them and do not need to be convinced to pay attention to these issues. Rather than using a concrete frame which may encourage residents to focus on the negative personal impacts they might experience from smoke or fires, an abstract frame may be more useful for fire managers. With an abstract frame, residents are encouraged to look at the "big picture" surrounding emissions and fire hazards and focus on the societal, long term impacts of prescribed fires. Most of the benefits offered by prescribed fires occur at the society level and are not felt immediately. Furthermore, WUI residents may already be aware of smoke emissions risks and familiar with how to respond. As such, refocusing communication messages to information on why smoke emissions are necessary or why prescribed burns are important (i.e., a benefits or balanced perceived control and benefits frame in addition to the abstract) may be more beneficial. Further research should be done to explore the impacts of abstract informational frames which encourage residents to consider smoke emissions in a larger context.

Overall, this project provides insight into how WUI residents use and interact with information regarding smoke emissions and prescribed fires. Moving forward, the findings suggest that future research should focus on refining the impact of message frames on perceptions of smoke emissions and prescribed fires. Given the potential influence on future communication efforts, the relationship between information and WUI resident perceptions of smoke emissions warrants further exploration.

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Appendix A: Communication Message Examples

Both of the examples provided here are sections of the same message. The first example is only the text from the benefits frame and includes both construal manipulation terms. The second example is part of the Concrete-benefits treatment which was included in the survey for California residents.

Example 1: Benefits of Prescribed Burns

Fires and associated smoke emissions (can/will) [abstract/concrete] occur in fire dependent areas, including

- **National (abstract construal)**
  - many forested areas across the United States (US)
- **Local (concrete construal)**
  - Shasta-Trinity National Forest's chaparral and conifer forests (CA)
  - Fremont-Winema National Forest's ponderosa, lodgepole pine, and mixed conifer forests (OR)
  - Francis Marion National Forest's longleaf pine and hardwood forests (SC)

Compared to uncontrolled fires, prescribed burns (can/will) [abstract/concrete] provide more control over when and where fire and smoke occur. By reducing the amount of flammable vegetation in natural areas, prescribed burns help prevent (potential/BLANK) [abstract/concrete] future wildfire outbreaks.

Overall, prescribed burns (can/will) [abstract/concrete] mean: [abstract/concrete]

a. Fewer negative health impacts / Less airway, eye, or sinus irritation
b. Less physical discomfort / Fewer headaches and coughing
c. Better visibility / Better visibility during smoke and fire events
d. Fewer travel disruptions / Fewer road closures and traffic delays
e. Fewer smoke disruptions / Fewer building and location evacuations
f. More natural conditions / More natural and healthy conditions in fire dependent natural areas
g. Greater potential for natural vegetation / Improved conditions for natural vegetation

Controlled burns help (United State/California/Oregon/South Carolina)'s [distant/local] natural areas and residents stay healthy.

Example 2: Concrete-benefits for California Residents

Benefits of Prescribed Burns

Forest and Fire

Smoke Emissions

Benefits of Prescribed Burns

Fires and associated smoke emissions will occur in fire dependent areas, including Shasta-Trinity National Forest's chaparral and conifer forests. Compared to uncontrolled fires, prescribed burns will provide more control over when and where fire and smoke occur. By reducing the amount of flammable vegetation in natural areas, prescribed burns help prevent future wildfire outbreaks.

Overall, prescribed burns will mean:

- Less airway, eye, or sinus irritation
- Fewer headaches and coughing
- Better visibility during smoke and fire events
- Fewer road closures and traffic delays
- Fewer building and location evacuations
- More natural and healthy conditions in fire dependent natural areas
- Improved conditions for natural vegetation

Controlled burns help California's natural areas and residents stay healthy.

Figure A.1. Section from the Concrete-benefits treatment received by California residents.

Appendix B: Post Hoc Comparisons for Construal and Hazard Acceptance Frames

	Variable	Control (M)	Concrete (M)	Abstract (M)	F	p
Acceptance	Prescribed fire	0.21	0.24	0.29	0.275	0.760
		(0.93)	(1.24)	(1.23)		
	Smoke from prescribed fire	-0.01a	0.23ab	0.29b	2.863	0.058
		(1.09)	(1.32)	(1.37)		
Hazard	Health impact - Personal	-0.01	-0.14	-0.24	2.390	0.092
		(0.95)	(1.09)	(1.28)		
	Health impact - Household	-0.10	-0.16	-0.22	0.652	0.521
		(0.85)	(1.07)	(1.29)		
	Smoke worry - Wildfire	0.01	0.14	0.21	1.450	0.235
		(1.24)	(1.25)	(1.28)		
	Smoke worry - Rx fire	-0.26	-0.30	-0.38	0.506	0.603
		(1.52)	(1.57)	(1.54)		
	Expected harm for smoke emissions - You personally	-0.06	-0.05	-0.07	0.126	0.882
		(0.68)	(0.56)	(0.57)		
	Expected harm for smoke emissions - Your family	-0.04	-0.04	-0.06	0.092	0.912
		(0.66)	(0.58)	(0.64)		
	Expected harm for smoke emissions - Neighbors	-0.03	-0.02	-0.04	0.181	0.834
		(0.67)	(0.58)	(0.65)		
	Expected harm for smoke emissions - Your community	-0.05	-0.03	-0.05	0.139	0.870
		(0.67)	(0.59)	(0.65)		
	Expected harm for smoke emissions - Other communities	-0.01	-0.05	-0.06	0.287	0.751
		(0.62)	(0.66)	(0.71)		
Beliefs	Rx fire creates less smoke overall compared to wildfires	0.37	0.37	0.38	0.015	0.986
		(1.25)	(1.44)	(1.51)		
	Rx fire has more benefits than costs	0.34	0.25	0.40	1.605	0.201
		(0.95)	(1.29)	(1.24)		
	Negative effects of smoke outweigh any benefits Rx fires provide	0.08	-0.10	-0.04	0.756	0.470
		(1.66)	(1.48)	(1.59)		
Knowledge	Current information	8.24	9.86	11.30	1.269	0.281
		(17.12)	(21.59)	(21.62)		
	Needed information	3.50	0.60	3.47	2.124	0.120
		(19.69)	(23.43)	(20.87)		
	Information sufficiency	-4.65	-9.22	-7.87	1.434	0.239
		(20.29)	(30.77)	(27.51)		
	Smoke emissions importance	-0.08	0.07	0.08	1.489	0.226
		(0.93)	(0.95)	(1.04)		

Note: * $p < 0.05$

The standard deviation is located in parentheses beneath the mean

Means with different subscripts within each row are significantly different at $p < 0.05$ based on Tukey post hoc comparisons

Table B.1. Comparison of the effects of Construal message frames on the amount of change between the pre- and post-tests (ANOVA and Tukey Post Hoc).

	Variable	Control (*M*)	Benefits (*M*)	Risks (*M*)	Both (*M*)	*F*	*p*
Acceptance	Prescribed fire	0.21	0.36	0.24	0.20	1.030	0.378
		(0.93)	(1.08)	(1.37)	(1.24)		
	Smoke from prescribed fire	-0.01z	0.42y	0.12z	0.24zy	4.362 *	0.005
		(1.09)	(1.38)	(1.39)	(1.25)		
Hazard	Health impact - Personal	-0.01z	-0.35y	-0.10zy	-0.11zy	3.794 *	0.010
		(0.95)	(1.21)	(1.14)	(1.21)		
	Health impact - Household	-0.10	-0.29	-0.18	-0.11	1.511	0.210
		(0.85)	(1.13)	(1.12)	(1.30)		
	Smoke worry - Wildfire	0.01	0.18	0.11	0.23	1.174	0.318
		(1.24)	(1.16)	(1.21)	(1.41)		
	Smoke worry - Rx fire	-0.26	-0.37	-0.24	-0.40	0.674	0.568
		(1.52)	(1.52)	(1.57)	(1.57)		
	Expected harm for smoke emissions - You personally	-0.06 (0.68)	-0.04 (0.60)	-0.03 (0.53)	-0.10 (0.56)	0.927	0.427
	Expected harm for smoke emissions - Your family	-0.04 (0.66)	0.00 (0.66)	-0.06 (0.55)	-0.08 (0.61)	0.774	0.508
	Expected harm for smoke emissions - Neighbors	-0.03 (0.67)	0.00 (0.65)	-0.02 (0.57)	-0.07 (0.62)	0.532	0.661
	Expected harm for smoke emissions - Your community	-0.05 (0.67)	-0.03 (0.64)	-0.04 (0.57)	-0.06 (0.64)	0.096	0.962
	Expected harm for smoke emissions - Other communities	-0.01 (0.62)	-0.03 (0.66)	-0.01 (0.71)	-0.12 (0.68)	1.311	0.270
Beliefs	Rx fire creates less smoke overall compared to wildfires	0.37 (1.25)	0.52 (1.52)	0.24 (1.54)	0.36 (1.36)	1.812	0.143
	Rx fire has more benefits than costs	0.34 (0.95)	0.48 (1.24)	0.24 (1.35)	0.24 (1.21)	2.518	0.057
	Negative effects of smoke outweigh any benefits Rx fires provide	0.08 (1.66)	-0.02 (1.41)	-0.06 (1.56)	-0.13 (1.63)	0.624	0.600
Knowledge	Current information	8.24	9.61	11.30	10.84	0.836	0.474
		(17.12)	20.27	20.33	23.99		
	Needed information	3.50	0.79	2.63	2.70	0.653	0.581
		(19.69)	21.74	22.45	22.48		
	Information sufficiency	-4.65	-8.83	-8.67	-8.14	0.819	0.483
		(20.29)	29.04	28.25	30.27		
	Smoke emissions importance	-0.08 (0.93)	0.04 1.02	0.14 0.99	0.05 0.97	1.592	0.190

Note: * $p < 0.05$

The standard deviation is located in parentheses beneath the mean

Means with different subscripts within each row are significantly different at $p < 0.05$ base on Tukey post hoc comparisons

Table B.2. Comparison of the effects of Hazard Acceptance message frames on the amount of change between the pre- and post-tests (ANOVA and Tukey Post Hoc).