AN ABSTRACT OF THE THESIS OF

Stacey Sargent Frederick for the degree of Master of Science in Forest Ecosystem and Society presented on December 9, 2013.
Title: Public Perceptions of Smoke from Wildfire, Prescribed Fire, and Fire Use

Abstract approved:

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Christine S. Olsen

Managers and policy-makers across broad disciplines and organizations are calling for a better understanding of public opinion on natural resource issues. One such issue is that of fire and its role in the management of our forests and rangelands. Public perceptions of fuel reduction techniques, with a particular emphasis on using prescribed fire as a management tool, have been under study for almost a decade. However, limited research on public opinions regarding smoke from these wildfires, fuel reduction fires, and private-use fires has been completed, even though the importance of smoke has been well-observed by managers through the frequent concerns expressed over smoke. This thesis begins to address two of the information gaps about smoke. First, a multi-location case study provides information on factors that may affect acceptance of smoke from various types of fire. Second, a longitudinal panel-study reviews how public perceptions of smoke and agencies change after an active fire season year.

Public Perceptions of Smoke from Wildfire, Prescribed Fire, and Fire Use

by
Stacey Sargent Frederick

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented December 9, 2013
Commencement June 2014

Master of Science thesis of Stacey Sargent Frederick presented on December 9, 2013.

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

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Stacey Sargent Frederick, Author

ACKNOWLEDGEMENTS

I would like to extend my deepest gratitude to a number of people who helped make my time and research here not only possible, but simply wonderful. First and foremost, my adviser, Dr. Christine Olsen who inspired me to attend graduate school, was instrumental in project design, funding, and overall academic support. Her availability as an advisor and her expertise as a mentor has been exceptional. Dr. Bruce Shindler not only acted as an integral part of my committee but also started me on this research path towards the social sciences. His belief in my abilities and guidance over the years has helped to shape the woman I have become. I would like to also thank Dr. Patricia Muir for her thorough and caring hand as a committee member and the unique perspective she has given this project. Dr. Chris Knowles acted as my GRC but went beyond his required role with his input and availability. Dr. Eric Toman of Ohio State University was also highly involved in this project and his support and kindness are greatly appreciated. Funding for this project is greatly appreciated from the Joint Fire Science Program and the Pacific Northwest Research Station.

My academic cohort exceeded all expectations. My sanity and happiness through these years can be attributed to them in many ways. For all the discussions, long hours in 215, happy hours, and memories made; I am so thankful to you all. A special thanks to Bess Perry (star survey stuffer volunteer and gym partner), Joanie Schmidgall, the adventure calendar group, and so many more for their love, support, and friendship. I would like to thank my family (especially my parents) who began my love of natural resources and all their support, love, and nurturing. And finally, my adored husband Eddie Harding-Frederick who not only provide support and feedback throughout these sometimes stressful times, but provides me with the best gift every day, happiness. Your love and support in all aspects of my life are beyond description.

CONTRIBUTION OF AUTHORS

Drs. Christine Olsen and Eric Toman were the lead PI's on this project and were involved in the overall concept and design from the initial research stage onwards. Dr. Christine Olsen was the lead PI for the longitudinal component and was the main feedback contributor to the research design, statistical analysis, and thesis writing stages of this project. Danielle Mazzotta, Devyani Singh, and Kate Roseburg are fellow graduate students who contributed to the prior stage of interviews and the post analysis of this research.

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CHAPTER 1 - INTRODUCTION

After over a decade of fire suppression, many forests and rangelands in the United State are under threat from catastrophic and more frequent wildfires due to un-characteristically high fuel accumulation and altered ecosystem functions (Agee and Skinner 2005; Hardy 2005). The return of fire on these landscapes through the use of managed or prescribed fire is commonly performed, with thousands of acres being treated each year (National Interagency Fire Center 2009). However social and legal restrictions present major barriers to the use of fire as a fuel reduction tool (Ryan et al. 2013). A major barrier is the public response to the smoke emissions from prescribed and other fire types. Positive public attitude influences the success of policy implementation (Vogt, Winter, and Fried 2005) and will be increasingly important given the increase in restrictions on air quality established by the Environmental Protection Agency in 2013 (EPA 2013). Unlike some other impacts of fire that remain fairly localized, smoke affects air quality regardless of fire boundaries and sometimes at great distances.

Public attitude regarding natural resource issues is determined through many factors but a key element is the social acceptance of practices. Social acceptability is not easily quantified, but rather a state of thought that is eventually reached through a multitude of interactions and opinions; it is ever changing based on incoming information and experiences (Shindler et. al. 2002). Extensive research has shown that social acceptance for prescribed fire use has increased across diverse geographic regions (Loomis et al. 2001; Winter et al. 2002; Shindler and Toman 2003; Brunson and Shindler 2004), but concerns over air quality and smoke remain (Winter et al. 2002; Abrams and Lowe 2005; Brunson and Evans 2005). Indeed, it was noted as a primary concern by residents in the vicinity of an escaped prescribed burn (Brunson and Evans 2005), and remains a concern surrounding wildfires as well (Weisshaupt et al. 2005). A more recent

study suggested that while a select few study participants believe smoke is too significant a concern to consider prescribed fire as a management option, most participants are willing to deal with some inconveniences caused by smoke (Shindler et al. 2009).

Studies that have included questions regarding smoke show that acceptance, much like prescribed fire acceptance, is highly conditional (Brunson and Evans 2005) with one major condition being the origin or source of the smoke (Weisshaupt et al. 2005). While descriptive statistics on the acceptance of smoke are important general information, they are only the first step into understanding smoke acceptance. There are usually numerous factors that calculate into acceptance of a practice and by knowing what these are and how they may change based on differing conditions, more informed decisions for air and forest management may be made.

Building upon the work of Weisshaupt et al. (2005) that showed smoke source or origin influenced public acceptance, this research explored other factors hypothesized to be important to smoke acceptance. As there is limited work on the public perceptions of smoke, I developed a list of potentially influential factors based on a review of the literature, onsite information gathering and interviews completed by a previous project team. These factors of acceptance included agency-public relationships, experience and knowledge of smoke, communication sources use, perceived benefits of prescribed fire, perceived risks from smoke, and relevant demographics. I then re-measured these factors in a panel-study to understand how they may have changed following an active wildfire season in one case-study location.

Thesis Purpose and Organization

The purpose of this project was to illuminate and fill the research gaps surrounding the public perceptions of smoke from fire. Information on this subject will add to the available literature regarding social acceptance theory and will also be a springboard for future research

into smoke acceptance and perhaps smoke support. This information will also help to inform forest managers and air quality managers about overall smoke perceptions and what factors may be influencing public opinion; this information may be useful for future management decisions.

Chapter 2 provides a cumulative analysis from four sites to determine which factors influence smoke acceptance. These sites are towns and cities near four national forests: the Fremont-Winema National Forest in southern central Oregon; the Shasta-Trinity National Forest in northern California; the Kootenai National Forest in northwestern Montana; and the Francis-Marion National Forest in central South Carolina. The four sources of smoke included wildfire, prescribed or controlled fires, naturally-ignited fires allowed to burn, and pile or debris burns. To determine acceptance, each type of smoke was rated on a 1-7 scale of agreement that smoke from that source was acceptable. These responses were then used as the independent factor in a regression analysis to predict smoke acceptance of certain sources. Dependent factors were based on previous interviews conducted on-site by a different research team and on literature that focused on prescribed fire acceptance.

Chapter 3 also focuses on the acceptance of smoke and associated factors but employs longitudinal methods to provide a measure of change in public opinion after an active fire year (Bauer 2004). Respondents from the initial northern Californian survey (Chapter 2) were resurveyed one year later. Between the two survey years, an active wildfire season with apparent smoke impacts occurred in and around the surveyed area. Changes in public opinions about smoke can be measured most accurately using a panel-study (Bauer 2004), as was done for this project.

The final chapter (4) provides a cumulative synthesis of both studies and outlines the overall management and scientific implications of the human dimensions of fire smoke. As this is only an initial step into understanding smoke perceptions and acceptance, future considerations and directions are also suggested.

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CHAPTER 2- WHAT INFLUENCES PUBLIC ACCEPTANCE OF SMOKE: AN IN-DEPTH ANALYSIS

Abstract

While the social implications of wildland and prescribed fire have been a topic of study for the last few decades, there is still much to be learned about the implications of smoke. This paper examines perceptions of smoke and possible factors that influence acceptance of smoke, as well as future directions for this emerging field of study. This exploratory study used survey data gathered in 2012 at four sites across the United States to determine what factors are associated with the acceptance of smoke. While perceived risks from smoke were a significant factor in determining smoke acceptance from all fire types examined (wild, prescribed, naturally-ignited allowed to burn, and pile), other influencing factors were highly dependent on the fire origin. These findings will allow managers to regulate fire and smoke with a better understanding of key social factors.

Introduction

Where there is fire, there is often smoke. This smoke causes concerns over health, safety, and even economic impairment for many communities. Such concerns can reduce people's tolerance of smoke and in turn, influence the use of prescribed fire as a management tool (Weisshaupt et al. 2005; McCaffrey 2006). Smoke from fires, whether prescribed or wild, affects air quality regardless of boundaries, sometimes at great distances. In 2011, 32 states were listed as affected by wildfire smoke conditions (Knowlton 2013). Smoke may play a further role in restricting the use of fire because of the legal regulations on air quality. Due to local issues of terrain, air circulation patterns, or nearby air pollution sources, many air quality districts are in a frequent battle to shed their "non-attainment" air quality status. When an area's status is designated as "non-attainment," serious restrictions can be imposed on all potential sources of air pollutants, including prescribed fire. In the spring of 2013, stricter regulations (lower levels of particulate matter allowed) were passed into law by the Environmental Protection Agency (EPA 2013).

Across the United States, forests and rangelands that once experienced frequent fires have been altered from fire suppression polices implemented over the previous decades (Agee and Skinner 2005). Suppression has led to vegetation fuel accumulation that has resulted in altered fire behavior uncharacteristic of the ecosystems' historic regimes (Hardy 2005). Reducing fuels in forests through various management actions (i.e. prescribed fire, thinning, etc.) has emerged as a favored solution in many forested areas. However, social barriers to implementation of these actions remain, especially on public lands (e.g. CAPA 2012; Hundley 2013). Research into the acceptability of prescribed fire and other fuel reduction activities has shown that while acceptance for prescribed fire use has increased across diverse geographic

regions (Loomis et al. 2001; Winter, Vogt, and Fried 2002; Shindler and Toman 2003; Brunson and Shindler 2004; McCaffrey and Olsen 2012) concerns remain about air quality and smoke (Winter, Vogt, and Fried 2002; Abrams and Lowe 2005; Brunson and Evans 2005).

Understanding factors that contribute to public perceptions of smoke may allow managers the opportunity to address major concerns and possibly influence smoke tolerance. The research on perceptions that is presented here will not only inform practical decisions of managers and policy makers, but will help to fill a research gap in fire social science literature. This work addresses the question: "what factors influence the acceptance of smoke from multiple types of fires?" Based on previous research by Weisshupt et al. (2005), it was hypothesized that smoke acceptance levels would differ depending on the smoke origin. Given the limited amount of information regarding public perceptions of smoke, a variety of factors were selected for analysis of their influence on smoke acceptance. These included experiences with smoke, smoke risk perception, beliefs about prescribed fire benefits, knowledge of smoke, the variety of communication methods used to gather smoke information, and demographics including education and age. This pool of factors was selected based on literature on fire acceptance and on information gathered on-site.

Conceptual Foundations

Perceptions of Smoke

Studies related to the human perceptions of fire smoke are limited, and results that do exist about such perceptions of smoke are typically represented by a few variables in a larger fuel reduction perceptions study. These results show a general acceptance for prescribed fire, and have uncovered the factors that may influence prescribed fire acceptance (Loomis et al. 2001; Winter, Vogt, and Fried 2002; Shindler and Toman 2003; Brunson and Shindler 2004), but also

show that air quality and smoke from prescribed fires remain major concerns (Winter, Vogt, and Fried 2002; Abrams and Lowe 2005; Brunson and Evans 2005). Smoke was noted as a primary concern by residents in the vicinity of an escaped prescribed fire (Brunson and Evans 2005), and remains a concern surrounding wildfires (Weisshaupt et al. 2005). Even small bursts of smoke have been shown to influence the perceptions and attitudes of citizens (Carroll et al. 2005). Results about smoke have found that a large minority (~30% of households) suffer respiratory issues that can cause health impacts from smoke (McCaffrey and Olsen 2012). While the impacts of fire smoke on health are still under review, one study provides evidence that prescribed fire smoke may cause less asthma related visits than wildfire smoke (Bowman and Johnston 2005).

Of the limited research into smoke acceptance (McCaffrey and Olsen 2012), the source or origin of the smoke has been shown to be important (Kneeshaw et al. 2004; Weisshaupt et al. 2005). In a rare look at what may influence perceptions of smoke from prescribed fire, one study determined that participants were more tolerant of smoke after receiving education materials (Loomis et al. 2001). Studies have also shown a link between smoke acceptance and knowledge of likely benefits associated with prescribed fire (Loomis et al. 2001; Winter, Vogt, and McCaffrey 2004; Weisshaupt et al. 2005; McCaffrey and Olsen 2012).This link is further enforced by a study that showed that approval of a management practice is connected to beliefs about likely outcomes (Winter, Vogt, and McCaffrey 2004). For example, if a positive outcome from prescribed burns is believed to be likely, then prescribed fire will be more positively received. Belief in prescribed fire benefits may indicate a better-informed audience who see fire on the landscape as an ecological process rather than a natural disaster. In some cases,

demographic variables significantly influence acceptance of fire management practices including fire smoke (McCaffrey and Olsen 2012). Such studies found more concern over smoke from women than men (Ryan and Wamsley 2008; Lim et al. 2009) and that those living in rural areas were more accepting of smoke because they saw smoke as part of the rural lifestyle (Weisshaupt et al. 2005; McCaffrey 2006).

Social Acceptability

Strides have been taken in recent years to ensure the public has opportunities to provide input into management decisions on public land, often in the form of public comment periods or governmental meetings. Beyond being a legal prerogative for some federal agencies to include a form of public input, it is the intrinsic duty of public agencies to practice publically beneficial and acceptable actions.

Determining social acceptability is by no means a simple process. Social acceptance is a state of thought reached through a multitude of interactions and opinions (Shindler and Toman 2003), and therefore is not easily quantified. It is ever-changing based on new information and experiences that people have, allowing them to weigh the positives and negatives of different options and choose a preferred alternative. Social acceptance is more complex than simply an evaluation judgment; it is a cognitive process that judges a set of alternatives based on both affective and cognitive factors.

Affective factors incorporate emotions, personal values, social norms, and even moods, that influence (directly or indirectly) judgments (Dunn and Schweitzer 2005; Kennedy and Pronin 2008; Pham and Avnet 2009). The ability to identify and compare factors that influence social acceptance hinges on the assumption that respondents have enough knowledge and understanding (or cognitive comprehension) of the topic to be able to weigh the pros and cons of

the various alternatives (Brunson and Shindler 2004). In the realm of fire and fuels management, previous research indicates that this assumption of some knowledge may be met in specific areas of knowledge. These specific areas of knowledge include: the ecological role of fire; the associated risks and benefits of fire; and the need for active management to reduce fire risk and improve forest health (Carroll et al. 2005; Burns and Cheng 2007; Vining and Merrick 2008; McCaffrey and Olsen 2012). While understanding social acceptance can be a complex process, possessing knowledge of the public's acceptance of a given management procedure opens numerous doors of possibility. General knowledge of this can help to craft management decisions that better reflect the public's opinions and a deeper understanding of what factors are playing into social acceptance can help target outreach efforts.

Knowledge

To further support at least a general familiarity with the natural resource issues in question, measures of knowledge were also used in this study. The term "knowledge" can refer to actual knowledge, such as a test score, and to self-assessed knowledge, typically a rating of personal knowledge. Self-assessed knowledge is often higher than actual knowledge and it plays a role in the public's trust of mangers and risk/benefit perceptions of the related topic (Wann and Branscombe 1995; Earle 2010). Knowledge of prescribed fire benefits has previously been used as a measure of cognitive factors, an important element in the social acceptance equation (Brunson and Shindler 2004). Self-assessed knowledge is an easier measure to obtain than actual knowledge and has been used when exploring the connections between social trust, acceptance of practices or programs, and risk perceptions (Siegrist and Cvetkovich 2000).

Risk

Application of risk perceptions studies vary from medical to environmental but the core components remain the same (Briggs 2008). Risk quantification often involves measurements of the likelihood of an impact occurring, multiplied by the severity of the impact (McCaffrey and Olsen 2012). For smoke risks, the impacts that may be experienced range from relatively benign (scenery impacts) to serious (personal health impacts). One study that surveyed respondents before and after an escaped prescribed burn showed evidence that risks and experience with smoke impacts may influence acceptance of prescribed fire (Brunson and Evans 2005).

Trust

Another factor that plays an important role in natural resource management is the trust the public holds in the natural resource management agencies (McCaffrey and Olsen 2012). Trust is "… the willingness to accept vulnerability based on positive expectations about another's behavior" (Dunn and Schweitzer 2005). Trust can be dissected into two major forms; confidence (or ability) and relational trust (Earle 2010) although many subdivisions of these two forms exist. Confidence is a more external measure of the relationship and is often measured by asking about the confidence level the public has in the agencies to achieve specific, tasks, or outcomes (Earle 2010; Toman et al. 2011). Relational trust, referred to simply as "trust" for the remainder of this paper refers to an overall feeling or judgment of character. For example, asking for a rating in the ability of an agency to manage for fire smoke would be a measure of confidence while asking for a rating of trust in the agency would be relational trust. Affective factors like values and emotions also contribute to trust judgments (Earle 2010).

Trust in agency managers is often a significant factor for prescribed fire acceptance (Shindler and Toman 2003; Winter, Vogt, and McCaffrey 2004; McCaffrey and Olsen 2012) and

it is expected to also be a significant positive variable for smoke acceptance. The amount and type of trust in a relationship can change overtime. For example, as new experiences occur, trust can fluctuate in response. Individual characteristics like trust propensity (a person's disposition to trust) will have greater influence at the beginning of a relationship until more information and experiences are available and confidence-based trust becomes more influential (Schoorman, Mayer, and Davis 2007). Trust and confidence are both important factors for determining prescribed fire acceptance with varying results for which is the more significant factor (Winter, Vogt, and McCaffrey 2004; Earle 2010; Toman et al. 2011; Shindler et al. 2011).

Overall objectives

All of these concepts are not mutually exclusive, but rather tend to interact with one another while also influencing social acceptance. For example, knowledge can influence both social trust and risk perceptions. When knowledge is lacking, reliance on experts to inform decisions may be substituted (Siegrist and Cvetkovich 2000). Thus, someone with lower knowledge may have a stronger reliance on social trust, which in turn accentuates the tradeoffs between alternatives, benefits, and risks for any social judgments (Siegrist and Cvetkovich 2000; Earle 2010). However, risk perceptions can be mediated by an understanding of the benefits of prescribed fire, or an understanding of risk mitigation strategies. By mitigating the risk through understanding or knowledge, acceptance can be increased (McCaffrey and Olsen 2012). The overall objectives of this study are to first establish a more general understanding of smoke acceptance from different types of fire and then to explore which factors may be influencing this acceptance.

Methods

Study sites

The sites selected were chosen to reflect diverse geographic regions and socio-economic conditions where smoke from wildfire and prescribed fire was a concern. In Southern Oregon near the Fremont-Winema National Forest, air quality standards and restrictions have limited development, especially that of potential industries. Many of these communities struggle to meet the minimum air quality standards (and are designated as having "non-attainment" air quality status) given the local valley topography that is highly prone to air stagnation and inversions. The use of woodstoves as a primary or secondary source of heat is common for many residents in this area and often creates conflicts with air quality management. Agency managers often state that they are blamed for smoke that they did not produce. If a resident believes this to be true, this is very harmful to the relationship as the residents then view them as being allowed to burn when they could not, even when they were burning wood as the main or only source of heat for their homes. Such misconceptions have added strain to the relationships between residents and local managers.

The Montana site (near the Kootenai National Forest) was highly rural, and only rural populations were sampled there. Similar to Oregon, woodstove use during non-attainment status and the struggle with the natural air circulation patterns and topography heightens the concerns of smoke in this area. The northern California site included metropolitan areas in and around Redding, with a major interstate passing through the area. Many of the communities rely strongly on forest tourism as a major source of income and this creates a strong potential for negative impacts from smoke. Land management and ownership is more diverse here than in the other sites, with a national park and state forests as well as a national forest. The Francis-Marion

National Forest in South Carolina is surrounded by large population centers like Charleston and North Charleston but also includes more suburban and rural areas. South Carolina, like many southern states, has a long history of fire use to manage vegetation, both by the government and by the private citizens. This tradition changes as more urban populations encroach on the remaining rural areas, especially with the ability of smoke to travel into these urban areas.

Sampling and Questionnaires

This study employed a quantitative design with random sampling, which was appropriate in order to examine perceptions about smoke across the four study areas. Specifically, we used a mail/internet survey that was developed based on interviews conducted at the study sites (Mazzotta, Olsen, and Toman 2012).

Samples were purchased from a professional sampling company that used pre-determined GPS coordinate and zip code boundaries that limited the sample to counties and towns near the study locations, and used U.S. Census definitions for urban and rural landscapes. Permanent residences were targeted and drawn from the US Postal Service's Computerized Delivery Sequence.

The questionnaire (Appendix B) included a variety of question topics and forms, including Linkert-type scales, inclusive multiple choice questions, open-ended responses, and dichotomous questions as well as an explanation of the survey and a section for written comments. Beyond the inclusion of two site-specific photos and appropriate substitutions for specific names (e.g., Oregon Department of Forestry and California Department of Forestry) the questionnaires were identical across all sites. Definitions for unfamiliar terms (e.g., naturally-ignited fire, pile/slash burns) were provided. The questionnaire asked respondents to indicate

their perceptions of fire management, understanding of forest conditions and fuel treatments, preference for treatments, and acceptance and experiences with smoke from different fire types. Surveying procedures were implemented using a modified "tailored design method" (Dillman 2007). First, a notification postcard was sent to all individuals in the sample, followed a few days later by a complete mail packet (cover letter, questionnaire, and a postage-paid return envelope). After two weeks, a reminder postcard was sent to all participants who had not yet replied. Complete packets were again sent to all non-respondents three weeks later. An online response option was provided through a survey link in the cover letter and was administered using a professional online survey service plan. There was limited response (9% of returned surveys) from the online option with the vast majority returning by mail.

From March-June 2012, survey packets were sent to randomly selected individuals in communities near the four study sites described above. Equal amounts of surveys were sent to each site. Of the 4,325 surveys that were successfully delivered, 992 were returned (Table 2.1). Response rates varied between the four sites with 30% in Montana (n=323), 25% in Oregon (n=270), 24% in California (n=252), and 13% in South Carolina (n=147). A non-response bias check was conducted via telephone where a subsample of the non-respondents were given an abbreviated version of the survey. This phone sample was compared to the original responders, and no significantly important differences were found for demographics or survey questions.

Table 2.1. Sample size and response rates from each site

Site	Mailed Questionnaires	Undeliverable Questionnaires	Completed Questionnaires (*n*)	Response Rate (%)
California	1200	128	252	24
Oregon	1200	130	270	25
Montana	1200	106	323	30
South Carolina	1200	111	147	13
Total	4800	475	992	23

Data Analysis

ANOVA and post-hoc tests determined that few significant differences existed between the selected sites in terms of public perceptions about smoke and the public-agency relationship. Thus, I combined the data across all four sites for further analysis. The next step was to assess the factors that influenced smoke. While the survey asked about various types of fire and how acceptable smoke was from each, further analysis focused on smoke from fire types that are performed by agency managers (wildfires, prescribed fires, naturally-ignited fires allowed to burn, and pile burns). To determine which factors were influential to acceptance of smoke from these sources, two-tail, bivariate correlations (Spearman's rho) were run between each smoke origin and a number of hypothesized independent variables (Table 2.2). For all analysis, the SPSS (Statistical Package for Social Scientists) program was used. These bivariate correlations employed non-parametric methods given the non-continuous variables like gender that were included. Following is an explanation of all variables used in the bivariate correlations.

Table 2.2. Bivariate Correlations (Spearman's rho) of Acceptability influences by smoke origin

	Wildfire	Prescribed Fire	Naturally-ignited	Pile burns
Smoke risk	-0.268**	-0.527***	-0.384***	-0.428***
Smoke impacts	-0.156**	-0.277***	-0.181***	-0.225***
Fire type	0.218***	0.131**	0.047	-0.017
Agency trust	0.160***	0.349***	0.221***	0.153**
Gender	-0.012	0.026	-0.049	0.07
Education	0.046	0.128**	0.138**	0.069
Age	-0.114*	-0.126**	-0.115*	-0.069
Rural/urban	-0.029	-0.055	-0.049	0.046
Knowledge	0.017	0.01	0.066	0.077
Comm exp	0.037	0.166***	0.115*	0.147**
Agency confidence	0.221***	0.462***	0.277***	0.254***
Rx fire benefits	0.188***	0.476***	0.267***	0.296***
Site	0.002	-0.013	-0.041	-0.001

***. Correlation is significant at the <0.001 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Smoke acceptance was assessed using a 7-point scale of 1" Strongly Disagree" to 7 "Strongly Agree" with 4 "Neutral" that smoke from a source was acceptable. "Don't know" responses were deleted from analysis. Smoke origin was also included as a variable in the regression through the *Fire type* variable, which was a degree of agreement that "the type of fire influences acceptance of smoke," quantified on the same 7-point scale defined above.

To measure *knowledge*, respondents rated their knowledge regarding smoke from 0 "knowing nothing about smoke" to 100 "knowing everything that could possibly be known about smoke". Given the limitations of this survey, self-assessed knowledge was used in place of actual knowledge. Fifteen possible communication methods ranging from web pages to government meetings were listed to measure respondents' experience level with a variety of communication methods. Respondents marked "Yes" or "No" for experience with each source.

"Yes" responses were tallied into an index ranging from 0-15 sources of communication (*Comm experience*).

Two types of trust were addressed in the survey. Relational trust, called *agency trust* here was measured on a 7 point scale of 1 "No Trust" to 7 "Full Trust" for local forest service and state forest agencies (Appendix A; Cronbach Alpha .87). "Don't know" responses were excluded from analysis. The *agency confidence* variable combined responses to "How would you generally rate the agencies for managing smoke?" for state and federal agencies (Cronbach alpha .87) on a 7 point scale of 1 "Poor" to 7 "Excellent." Collinearity issues existed with these two trust variables but agency confidence was found to be a more significant factor in smoke acceptance in all smoke origins from a preliminary regression and was used alone in further regressions.

Five prescribed fire benefits were proposed on a scale of agreement of 1 "Strongly Disagree", 4 "Neutral", 7 "Strongly agree." These were then combined into a *Prescribed fire benefits* index (Appendix A; Cronbach alpha .94) that included agreement with the multiple proposed benefits. Risk was thus quantified by multiplying the likelihood (1 being "Very Unlikely" and 7 "Very Likely") and severity (1 "No Impact" to 7 "Severe Impact" factors into *Smoke risk*. This variable is thus measured on a continuous scale of 1 "No Risk" to 49 "High Risk."

To measure actual experience with smoke impacts, respondents marked which of six types of impacts experienced in the past 5 years. Possible smoke impacts included unpleasant odors, discomfort, a road closure or delay, evacuation from home, personal property damage, and personal health effects from smoke. These responses were then added into a 6-point cumulative

scale of 1 (“one type of smoke impact experienced”) to 6 (“six types of smoke impacts experienced”) and called *Smoke impacts*.

Demographic factors included in this analysis were: *Gender* (coded as 1 “male” and 2 “female”), *education* (highest level completed from 1 “some high school” to 8 “graduate degree”), and *Age. Rural/urban* status was assigned using the census designation with urban residents coded as 0 and rural coded as 1.

Variables not significantly correlated ($p > 0.01$) with any of the smoke acceptance questions were dropped from further regression analysis. No statistically significant correlations were found between the dependent variables (acceptance of smoke from wildfire, prescribed fire, naturally-ignited fire that is managed, and pile burns) and gender, self-assessed knowledge, study site location, or living in a rural (versus urban) area. These independent variables were removed from further analysis.

Two dependent variables, agency trust and agency confidence, were collinearly related as shown by the strong correlations between them. Collinearity issues mean that the relationship between two variables is strong enough for potential interference with the regression results if both are included. To determine which variable should be used, preliminary regressions with the two variables were run. These preliminary regressions showed that agency confidence was a more significant predictor and thus was selected for inclusion in the final regressions.

The remaining variables were all continuous in nature and so a parametric analysis using a multiple linear regression was used (Ordinary Least Squares regression using the “enter” method that enters all variables at the same time). Even though not all independent variables

were significantly correlated with each type of smoke, the same list was entered into each regression to allow for comparison

Results

Respondents were typical of household members who respond to mail-back questionnaires (Blanchard and Ryan 2007). They tended to be older (61 years old average), Caucasian (88%), well-educated (73% attended at least some college), and male (58%). The vast majority of respondents were permanent residents (97%) with roughly half (52%) indicating they were retired. Most (82%) were not reliant on forests as a source of income or employment, though over 80% stated that they had heard or read about various natural resources issues including the potential impacts of smoke from wildfires, managing or using naturally-ignited fire to improve forest health, and the need to reduce forest fuels near their community. Finally, almost 40% stated they use fire on their property to either manage vegetation or to burn trash and unwanted debris.

Respondents were asked to indicate their acceptance of smoke from different sources. Wildfire suppression was the most acceptable source of smoke (μ=5.45), followed by prescribed fire (μ= 4.71), naturally-ignited fires that were allowed to burn (μ=4.50), and pile burns (μ=4.38) (Figure 2.1). Only 11% disagreed that wildfire smoke was acceptable while 25% disagreed that prescribed fire smoke was acceptable (Figure 2.1). Respondents were also asked whether they agreed (7) or disagreed (1) that the source of the smoke changed their willingness to accept the smoke. The average response was between neutral and slightly agree (μ=4.74). Perceptions of risk (likelihood multiplied by severity) were fairly low (μ=16.60 out of 49) and multiple smoke impacts had been personally experienced by the average respondent (μ= 2.51). The results also showed a significant difference ($p < 0.01$) between respondents' trust and confidence in state and

federal agencies with higher ratings for trust (μ=4.54) than confidence (μ=4.17). While respondents were asked about a variety of communication sources, most people had experience using around a third of them to gather smoke information (μ=5.12 out of 17). On, average, respondents agreed with the benefits of prescribed fire (μ=5.59).

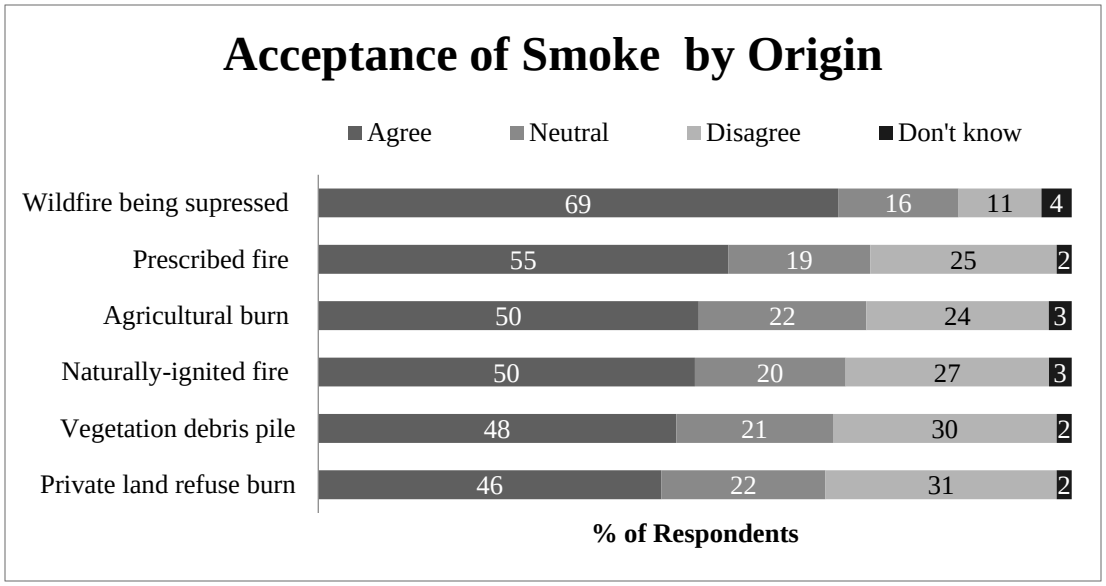

Figure 2.1. Percent agreement that smoke is acceptable by origin of smoke.
Responses to "Smoke from a _____ (wildfire managers are attempting to suppress, prescribed fire, etc.) is acceptable" from 1 "strongly disagree" to 7 "Strongly agree". Plotted are the summed percentages of respondents who agreed (1-3), were "neutral" (4), and who disagree (5-7).

Table 2.2. Means of Analysis variables

Independent variables	Mean	SD	Dependent Variables- smoke acceptance	Mean	SD
Smoke Risk[1]	16.60	12.96	Wildfire[11]	5.45	1.69
Smoke Impacts[2]	2.51	1.16			
Fire Type[3]	4.74	1.84	Prescribed fire[11]	4.71	1.87
Knowledge[4]	58.78	23.34			
Agency Trust[5]	4.54	1.49			
Agency Confidence[6]	4.17	1.51	Naturally-ignited[11]	4.50	1.92
Communication Experience[7]	5.12	3.60			
Prescribed fire benefits[8]	5.59	1.46			
Education[9]	4.54	1.98	Pile burn[11]	4.38	1.90
Age	60.82	14.14			
Gender	0.58	0.49			
Rural/Urban[10]	0.70	0.46			

[1] Responses measured on a continuous scale of 1 = No Risk to 49 = High
[2] Responses measured on a 6-point cumulative scale where 1 = 1 type of smoke impact experienced to 6 = types of smoke impacts experienced
[3] Responses measured on a scale of 1 “strongly disagree” to 7 “Strongly agree”
[4]Responses measured on a scale of 0 “knowing nothing about smoke” to 100 “knowing everything”
[5] Responses measured on a scale of 1 “no trust” to 7 “full trust”
[6] Responses measured on a scale of 1 “Poor” to 7 “Excellent”
[7] Responses measured on a scale of 0 to 15 communication sources experienced
[8] Responses measured on a 7-point scale of 1 “strongly disagree” to 7 “Strongly agree”
[9]Education level from 1 “some high school” to 8 “graduate degree”
[10]Responses measured as 2 categories of 0 “urban” and 1 “rural”
[11] Responses measured on a scale of 1 “strongly disagree” to 7 “Strongly agree”

Factors that influence smoke acceptance

The regression model of acceptance for smoke from a wildfire under suppression explained 13% of the variance of responses (Table 2.4). Respondents' agreement that fire type influenced their willingness to accept smoke plays a strong role in increasing their acceptance of wildfire smoke. Higher confidence in state and federal agency managers and lower risk perceptions of smoke are also significantly related to increased wildfire smoke acceptance, although to a lesser degree. The prescribed fire smoke acceptance model was the most successful at predicting responses, with 42% of the variance explained. This model also included the most significant variables in the regression model. As seen before, positive agency confidence and negative smoke risk were both associated with increased acceptance, along with the demographics of age (greater in age tended to be less accepting of smoke) and education (greater levels of education were associated with acceptance of prescribed fire smoke). Agreement with prescribed fire benefits was a significant factor unique to this model only.

The naturally-ignited fire smoke acceptance model predictsed18% of the variance in smoke acceptance and shared most significant factors with the prescribed fire model. More agency confidence, less smoke risk, more education and younger age are again significant factors for increasing smoke acceptance. Education and smoke risk had more influence on smoke acceptance than confidence and age. Acceptance of pile or vegetation debris pile smoke, the least acceptable source of smoke (Table 2.4), was predicted only by two significant factors, with 20% of the variance explained. Smoke risk was the most significant factor but the unique predictor of communication experience was also significant, where the more communication sources used, the higher the acceptance.

Table 2.4. Regression results for smoke acceptance from multiple fire origins

Independent analysis variables	Regression models for each smoke source			
	Wildfire	Prescribed	Let burn	Pile
Agency confidence[a]	0.133**	0.206***	0.104*	0.077
Smoke risk[a]	-0.168***	-0.306***	-0.265***	-0.318***
Smoke impacts[a]	-0.04	-0.009	-0.014	-0.052
Fire type[a]	0.207***	0.058	0.027	-0.04
Education[a]	0.038	0.083*	0.134***	0.049
Age[a]	-0.038	-0.066*	-0.093*	-0.035
Comm experience[a]	0.026	0.056	0.031	0.11*
Prescribed fire benefits[a]	-0.015	0.268***	0.076	0.075
R^2	0.131	0.417	0.182	0.204
Adjusted R^2	0.118	0.408	0.170	0.193
F	10.29	49.49	15.26	17.83
SE	1.577	1.418	1.730	1.665

[a] Standardized beta are shown with significance levels indicated by asterisks
***Relationship is significant at the <0.001 level (2-tailed)
** Relationship is significant at the 0.01 level (2-tailed)
*Relationship is significant at the 0.05 level (2-tailed)

Discussion

Beyond forming a general understanding of public smoke perceptions, identifying specific factors that influence smoke acceptance can be a great benefit to the management community about how to best collaborate with the public for a successful fuel reduction program. This study has revealed a number of key findings that can help inform the future of smoke research and management.

First, our findings about the acceptance of smoke add to the overall theory of acceptance through our exploration of the associated cognitive aspects. Cognitive and affective aspects play a role in social acceptability as they contribute to perceptions of what is a “good” or “bad” alternative (Brunson and Shindler 2004). When respondents have a better understanding, specifically of fire’s ecological role and benefits, they have been found to be more accepting of

fuel reduction practices (McCaffrey and Olsen 2012). Similarly, respondents who believed in positive outcomes from fuel reduction treatments were more accepting of those treatments (Shindler, Toman, and McCaffrey 2009). Belief and understanding of the benefits of prescribed fire also contributed to the acceptance of prescribed fire smoke in this study. This suggests that the final outcomes of a prescribed fire, when viewed as beneficial, outweigh the costs of dealing with the smoke, just as prescribed fire acceptance was linked to belief in prescribed fire benefits in Shindler, Toman, and McCaffrey (2009). However, understanding of the ecological benefits of prescribed fire did not influence acceptance of smoke from naturally-ignited fire or vegetation debris piles, two commonly used forms of fuel reduction closely related to prescribed fire. This further suggests that the tradeoffs of smoke from prescribed fire and the benefits of prescribed fire are specific to that particular fire type, and do not necessary extend to other forms of fire-use.

Most respondents agreed with the benefits of prescribed fire suggesting an understanding and belief that fire was beneficial for environmental protection and fire prevention. Concepts associated with prescribed fire have become increasingly familiar to the public (Loomis et al. 2001; Shindler and Toman 2003; Blanchard and Ryan 2007; Shindler, Toman, and McCaffrey 2009). Not only the process of prescribed fire, but the reasoning behind it, has been a major focal point in the information campaigns of agencies throughout the US (Blanchard and Ryan 2007). This strong dialogue specifically about prescribed fire has created an understanding and knowledge, which factored into acceptance of fuel reduction practices and now of smoke acceptance (Weisshaupt et al. 2005; Shindler, Toman, and McCaffrey 2009) with a direct

connection between increased acceptance and the participant's learning of prescribed fire practices, as illustrated in McCaffrey (2009).

Managers often put prescribed fire into a general category that can include naturally-ignited fires allowed to burn but previous research shows that smoke acceptance is influenced by fire type (Weisshaupt et al. 2005). Given that acceptance decisions take into account so many different factors, the more specific the question, the more accurate the results may be. For example, by dividing prescribed fire into subcategories, such as by proximity to nearby communities, the levels of acceptance have been shown to change (McCaffrey 2009). Acceptance as a highly conditional judgment is further supported here where each fire type had a unique mix of factors that influenced smoke acceptance. The importance of fire type suggests that smoke planning should take into account the specific source of smoke. Furthermore, when studying the acceptability of smoke, including specific benefits that are directly related to each fire type (i.e. benefits that are specific to pile burn fire in order to relate them to acceptance of smoke coming from a pile burn) may be insightful.

Understanding the benefits of prescribed fire may have also alluded to a deeper understanding of fire's role in the ecosystem. Establishing an understanding of ecological benefits has also been linked to the outreach efforts, through the ability to increase knowledge from a trusted source (Kasperson et al. 1988; McCaffrey and Olsen 2012). The importance of affective factors on acceptance of fuel management options has recently been revealed and could be considered for smoke acceptance as well (Ascher, Wilson, and Toman 2013). Affective aspects were not a focus of this study but indubitably played a role in influencing how respondents answered acceptance and risk questions. Some social norms may be extrapolated

from some of the demographics, such as age and education. Age was a significant factor for predicting the acceptability of prescribed and naturally-ignited fire smoke. This could be related to the health issues of older people or could be an indication of differing values between generations. Older generations in many of these areas grew up with much higher level of federal timber harvesting and may prefer fuel reduction methods that include more utilization including harvests. Higher education led to more acceptance of prescribed fire and naturally-ignited fire smoke and this may be associated with a greater understanding of the role of fire in the landscape and perhaps more knowledge of the precautionary practices that forest agencies use.

A second significant finding was the prominent role that risk perception played in predicting acceptance, even with relatively low mean risk scores (μ=16.6 out of 49). Lower perceptions of risk from smoke were associated with greater levels of acceptance of smoke from all four fire types. This is consistent with other fire-related work and was as I expected. Risk perceptions are also closely linked with trust and confidence, where more trust means less perceived risks (Winter, Vogt, and Fried 2002). One potential explanation for the strong importance of risk in my study could be that general knowledge about smoke and management activities that produce smoke was not high for a self-assessment (μ< 60 out of 100). Prior literature indicates that perceptions about the risks and benefits of a practice are of greater importance in predicting acceptance when knowledge levels about the issues are low (Siegrist and Cvetkovich 2000; Blanchard and Ryan 2004). Some studies have postulated that prior experience with the risk event would influence acceptance (Loomis et al. 2001; Brunson and Evans 2005; McCool et al. 2006; Toman et al. 2011) yet this hypothesis was not supported here where most respondents had experience smoke impacts recently. This is surprising given the

serious impacts that smoke may cause (e.g., health, property damage) but may be partially explained by the way I measured impacts – various types of impacts were simply summed and no weighing was used to indicate differences in impact severity. An examination the severity of impacts in relation to acceptance may produce a different result. In a similar study looking at fuel reduction acceptance, previous experience did not play a significant role after beliefs and personal importance were controlled for (Vogt, Winter, and Fried 2005). For my prescribed fire smoke model, the balance between the risks and benefits demonstrates the evaluative process of weighing the alternatives before making judgments about acceptance (Brunson and Shindler 2004).

A third noteworthy finding emerged in the results about trust. Trust and confidence were highly correlated and so confidence was used in place of trust in the regression models. Different studies have found differing results as to which of the two, trust or confidence, is more significant for determining acceptance. In some fuel reduction acceptance studies, relational trust was found more significant than confidence (Winter, Vogt, and McCaffrey 2004; Earle 2010) while others found confidence in an agency to take specific actions was more significant (Toman et al. 2011; Shindler et al. 2011). Here, agency confidence was a significant predictor of acceptance of smoke from wildfire, prescribed fire, and naturally-ignited fire smoke. This suggests the importance of strong public-agency relations. The need for a stronger relationship between the public and agencies is a common finding in natural resource social science studies and has been noted in numerous conclusions as a means to achieve many goals including: increased acceptance of fuel reduction (Blanchard and Ryan 2004; Winter, Vogt, and McCaffrey 2004; McCaffrey 2006; Toman et al. 2011) improved citizen understanding and knowledge of

fire in the ecosystem (Brunson and Shindler 2004; McCaffrey and Olsen 2012), and even improved overall fire management effectiveness (Rodriguez-Mendez et al. 2003; Liljeblad and Borrie 2006). These findings suggest that this relationship may be improved as public confidence in agency's abilities to complete specific actions increases.

Fourth, it is noteworthy that the models differed in their effectiveness at predicting smoke acceptability. That there were distinct differences among smoke sources in terms of predictor variables reinforces previous findings that the source of smoke matters (Kneeshaw et al. 2004; Weisshaupt et al. 2005). Prescribed fire smoke was best predicted with the given factors, followed by pile burns, naturally-ignited fire, and finally wildfire smoke. The source may be of particular importance for wildfire smoke acceptance, as agreement with the statement "the type of fire influences willingness to accept smoke" was a significant predictor of wildfire smoke acceptance. As the wildfire model had the lowest predictive power, additional factors of influence are likely at play. A major factor may be that wildfire smoke is seen as inevitable, as an act of god or nature (Kumagai, Bliss, et al. 2004). It is acceptable because there is no alternative. Since social acceptability requires options or alternatives to choose from, the lack of alternatives is being translated as acceptance (Brunson and Shindler 2004).

Finally, there are some limitations of this study to note, and future directions to consider. Additional space to include more in-depth questions could have been beneficial, especially when looking specifically at respondent's experiences with smoke, or testing their actual knowledge, or including tradeoff scenarios for acceptance. Furthermore, research in this area could apply the principle of the Belief-Attitude-Behavior model to better understand acceptance (Brunson and Shindler 2004). For example, understanding a person's beliefs about the benefits of smoke and

comparing these to the actual behavior (such as accepting smoke or not) could fill a vital gap in understanding not only what the public thinks about smoke, but how they react to it based on those beliefs. Moderating effects and the indirect relationships between variables could be explored in future studies as the knowledge base of smoke acceptance is added to.

Management Implications and Conclusions

Concerns over smoke often seem to dominate the reservations expressed by managers about the use of fire as a management tool. A major focus of this study was to discover what factors increase tolerance and acceptance of smoke. This study lays the groundwork for future understanding of what may be done to increase the ability of managers to use fire on public lands. The risks and benefits associated with prescribed fire smoke shows an important relation between less perceived risks/more agreement with the benefits of prescribed fire and how this combination translates into increased prescribed fire smoke acceptance. How citizens come to a low risk/high benefit perception of prescribed fire is the next question to be addressed. Previous literature shows that low risk/high benefit is related to the communication process (which is also influenced by trust) (McCaffrey and Olsen 2012). Major efforts into the promotion and use of prescribed fire have been taken on by agencies and even environmental groups across the country. Whether it was these efforts, or any number of other factors, the respondents seemed to be viewing prescribed fire differently than respondents in other previous studies. Further efforts into these campaigns, as well as targeting them to include other types of fire use (i.e. naturally-ignited fire) could be beneficial for the future management of forests and fuels.

Another consideration in changing the perceptions regarding fire and fire smoke includes not just what the message is, but also who the message is coming from. Messages that originate from trusted sources of information with a positive pre-existing relationship are more likely to be

received and acted upon (Earle 2010). Furthermore, creating an information exchange that is not just one-direction but rather provides opportunities for input from the public can help establish said relationship and increase the viability of the message received (McCaffrey 2004; Toman et al. 2011). Results from this study (the significance of agency confidence in most models) reiterates the need for stronger relationships between agencies and the public. Further catering the message to the audience includes adjusting tone. Studies into behavior-changing communication methods show that positive, "good-news' messaging is effective (Montague, Borland, and Sinclair 2001). Scare tactics or focusing on the worst case scenarios should be put aside for positive messages of action. An example would be presenting evidence that shows the benefits of fire on the landscape rather than the foreboding impacts of a severe wildfire. While ignoring the risks of prescribed fires is also impractical, presenting the benefits allows for an informed, cognitive process of weighing the benefits versus the risks.

Public acceptance for prescribed fires has been increasing and this study also reveals the smoke associated with the use of fire is fairly acceptable to most people. Even though most respondents rated smoke as acceptable, further studies and management considerations should focus on the perceptions of those who are not accepting, with special emphasis on issues of personal or family health. In some cases, majority decisions can be made but in others, careful consideration of the minority and their needs should be pursued for the sake of environmental justice (Hartley 2008). With roughly a third of US households dealing with health issues from smoke (McCaffrey and Olsen 2012), making decisions that produce smoke because the majority of the population is accepting of it still places those most vulnerable citizens at risk. With the increase in wildfire intensity and frequency, and thus an increase in fire season smoke, showing

that smoke produced during a prescribed burn is often less severe than that of a wildfire could be one approach. There is evidence that smoke from smaller prescribed fires is less harmful to human health (asthma) than the surge of smoke that comes from a large wildfire (Bowman and Johnston 2005). Alternatives other than fire as a fuel management tool could also be used, when possible, as roughly a third of households suffer from respiratory ailments.

While there is still a long road of research ahead, knowing how these respondents view smoke and what might be contributing to those views offers a path forward. This research suggests that while smoke is a major concern to some citizens, this is indeed the minority (< 30% agreed that smoke was of significant concern). For managers wanting to use fire on the landscape, this suggests that many of the concerns heard over fire smoke come from a concerned and vocal minority. While not to be dismissed, this minority should be especially targeted in communication plans while having a forum for their concerns to be voiced and diligently attended to. Increasing the public's knowledge of smoke with a special emphasis on the trade-offs between wildfire and prescribed fire (including that smoke from prescribed fires may be less harmful to populations than wildfire smoke) might be one crucial way to increase acceptance. As this field continues to evolve, additional knowledge should continue to be incorporated into the solutions of this complex problem.

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CHAPTER 3- LONGITUDINAL PANEL RESULTS: HOW THE 2012 FIRE SEASON IMPACTED PUBLIC PERCEPTIONS OF SMOKE AND AGENCY RELATIONSHIPS IN NORTHERN CALIFORNIA

Abstract

A longitudinal panel study design was used to survey residents in northern California near the Shasta-Trinity National Forest to improve our understanding of how people view smoke and how these views may change overtime. A random sample of residents was surveyed in 2012. Several socially important fires affected the area the following summer. The same individuals were then resurveyed in 2013 with predominantly identical survey format and questions. By comparing the responses between the two years, significant changes (or lack thereof) can be revealed. While smoke acceptance did not change significantly between years, some smoke risk perceptions and the confidence in agencies to complete specific tasks did change. Other changes between years included respondent's extent of experience with smoke, the usefulness of different communication sources, and knowledge of smoke.

Introduction

Wildfires and the smoke they produce often come at the peak of the recreation and field seasons. This can result in the displacement of tourists, the inability of locals to enjoy the warm seasonal days, and postponed work schedules. Poor air quality from smoke can also have serious implications for some vulnerable populations; children, the elderly, pregnant women, and those with respiratory ailments (Knowlton 2013). For these reasons and more, smoke from wildland and prescribed fire is a major concern for people across the country and in many parts of the world (Record Searchlight Staff 2012a; Brown 2013).

Smoke can affect communities far removed from a fire, as it travels with no regard to air quality jurisdictional boundaries. For some communities that already struggle with maintaining air quality standards, smoke from wildland or prescribed fires may result in further restriction on other activities (e.g. woodstove use, yard debris burning, industrial smoke). Low air quality can also reduce the ability of managers to use fire on public lands (Haines, Busby, and Cleaves 2001). Understanding public perceptions of smoke and how they may change after an active fire season can assist with future management strategies and goal setting. Such knowledge can provide guidance regarding how people may react to smoke and how to deal with the conflicts that could arise from fire and smoke management (Bengston 1994).

Significant impacts from smoke will continue and are predicted to increase in the future with the projected increase in wildland fires due to decades of fire suppression policy and climate change (Hardy 2005; Running 2006; Westerling et al. 2006; Pechony and Shindell 2010). To reduce wildfire risk and to restore ecosystem function to fire dependent forests, prescribed fire is used to treat fuels on millions of acres per year across the United States (Hardy 2005; National Interagency Fire Center 2009). Previous research has shown that acceptance for

prescribed fire has increased across diverse geographic regions (Loomis et al. 2001; Winter, Vogt, and Fried 2002; Shindler and Toman 2003) but controversy still surrounds its use (Ryan, Knapp, and Varner 2013). Concerns over issues of air quality and fire smoke have not been as extensively studied, nor have possible changes in public attitudes about smoke consequent to experiencing fire been assessed (Winter, Vogt, and Fried 2002; Abrams and Lowe 2005; Brunson and Evans 2005).

One of the existing studies regarding attitudes towards smoke indicated that exposure to even a minor smoke event can influence the perceptions and attitudes of citizens regarding fuel reduction strategies including prescribed fire (Carroll et al. 2005). This same study also determined that smoke origin (e.g. prescribed fire versus wildfire) influenced smoke acceptability. In a rare look at what may influence perceptions of smoke from prescribed fire, one study determined that participants were more tolerant after receiving education materials (Loomis et al. 2001).

One step in understanding public perceptions of smoke is assessing the social acceptability of fire smoke. Social acceptability grants tolerance of an activity without outright support and is the initial stage of approval. It is a complex process of ever-evolving judgments, selecting which alternatives are the most appropriate given the cognitive beliefs and values of an individual (Brunson and Shindler 2004). If a practice is determined to be socially acceptable, actions and planning to increase support can be taken. Or, if acceptance is the desired goal, stating that a practice is accepted by the public can be used to help justify further use of the practice.

The next step is to understand the many aspects of public opinion that are associated with social acceptance. There is limited literature on which factors may influence smoke acceptance, but some information can be extrapolated from previous prescribed fire acceptance research. For example, the relationship respondents have with the local agencies who manage fire has been shown to be an indicator of acceptance for prescribed fire and fuel reduction treatments (Winter, Vogt, and McCaffrey 2004; Earle 2010). One manifestation of this relationship is trust in management agencies. Trust is "… the willingness to accept vulnerability based on positive expectations about another's behavior" (Dunn and Schweitzer 2005, pg. 736). For this article, trust is further broken down into confidence (the ability to complete specific, quantifiable tasks or to achieve specific outcomes) and relational trust (an overall feeling or emotional judgment of character) often referred to simply as "trust" (Earle 2010). Federal and state forestry agencies are commonly perceived differently, the more local agencies having higher trust ratings than their further-removed counterparts in federal agencies (Shindler and Cramer 1999; McCaffrey and Olsen 2012).

Observing changes overtime in the factors that influence social acceptance can also be informative, as social context is rarely, if ever, constant. Again, studies in related areas may illuminate some of the manners in which variables associated with smoke acceptance could change. For example, some events may not impact relational trust of government agencies but may influence confidence-based trust (Earle 2010; Toman, Shindler, and McCaffrey 2010). With knowledge, there is evidence that an understanding of fuel reduction methods is related to support of those actions and receiving educational materials can lead to an increase in support of fuel reduction methods (Loomis et al. 2001; Toman, Shindler, and Brunson 2006). Interactive

sources of communication materials can be more effective than passive sources at increasing knowledge and support, even if the interaction is as simple as an actual person handing out non-interactive materials (McCaffrey 2004; Toman, Shindler, and Brunson 2006). Experiencing an event, such as a wildfire can sometimes also change the perceptions of risk and hence the acceptability of smoke (Kasperson et al. 1988).

Hypotheses

I explored the changes in agency relationships, acceptance and knowledge of smoke, perceptions of smoke risk, and communication source usefulness following the experiences of a fire season. I describe the 2012 fire events and respondent's experiences to provide context for observed changes. Changes in smoke acceptance were expected, including a decrease in acceptance of smoke from naturally-ignited fires given the events of the fire year and the potential emotional response to the events (Burchfield 2007). I also expected that a change public confidence in land management agency was more likely than a change in trust of that agency; confidence can easily be altered based on specific events while relational trust is more resilient to change (Earle 2010). Even if the impacts of the fire season were minor, such far-removed fire events may cause changes in confidence (Winter, Vogt, and Fried 2002; Winter, Vogt, and McCaffrey 2004). I also hypothesized that perceptions of risk would change after exposure to fire events (Kasperson et al. 1988). As more internet resources are integrated into the fire and smoke communication network, people may change their behaviors of information gathering and I predicted that websites would be seen as more useful than before.

Methods

In spring of 2012, 1200 mail-back questionnaires focused on the public perceptions of smoke from fires were sent to each of four sites in the United States. Some results of this survey

can be found in Chapter 2. Sites were initially chosen to reflect multiple geographic regions and diverse smoke situations. As this survey was attempting to establish a baseline of information (not the emotional response after a major event), selected sites had not experienced any massive fires in the previous three years. Survey questions and site context information were informed by on-site interviews from a previous research team with a variety of stakeholders at each site (Mazzotta, Olsen, and Toman 2012). Random samples of residents near each site were obtained through a private sampling company. Sampling used pre-determined GPS coordinate and zipcode boundaries that limited the sample to permanent residents near the four chosen national forest sites. The site in northern California near the Shasta-Trinity National Forest was selected for a follow-up study because of the active fire season that followed the initial survey administration in that area. Respondents at this site lived in various towns including Redding and Shasta Lake, as well as in more rural areas such as Weed, Palo Cedro, Mount Shasta, and Cottonwood.

The 2012 fire season in the Shasta-Trinity national forest area included several wildland and prescribed fires. Information on the fire season was obtained through local and national news websites as well as from communication with agency or community members that participated in the initial on-site interviews. Considerable media attention was given to some high profile fire events during the fire season. For example, the Ponderosa fire (26,676 acres; lightning-ignited) threatened 940 homes, caused widespread evacuations, and destroyed 52 residences and 81 outbuildings, including one residence and five outbuildings damaged in counties included in my survey (Espino, Longoria, and Szydlowski 2012). Another high-profile fire was the Bagely fire (46,040 acres; lightning-ignited) that had major recreation impacts through road, trail, and

campground closures, as well as by sending smoke to surveyed counties (Benda and Longoria 2012). Governor Brown declared two surveyed counties, Shasta and Tehama, in a state of emergency due to fires (Record Searchlight Staff 2012a).

The Reading fire was a lightning-ignited fire that was allowed to burn (also known as a naturally-ignited fire) within the confines of Lassen National Park. This fire burned further than the intended boundaries and escaped containment onto non-National Park land. It threatened the nearby residents of Shingletown (a surveyed community) and burned far longer than anticipated, creating closures and cancelations of events both within and beyond the park boundary.

Many small wildfires (<5,000 acres) also occurred during the 2012 fire season. While small and often quickly contained, several of these fires caused serious impacts to nearby populations. The Coal fire (only 241 acres) burned approximately 20 miles from Redding, impacting interstate traffic and threatening the homes of individuals that had been evacuated just two months prior from the small (980 acre) Salt Creek fire (USFS 2012; Record Searchlight Staff 2012). The Stafford fire near the small town of Hayfork, CA resulted in an air quality advisory for Trinity County (Record Searchlight Staff 2012). Even smoke from far away, like the 42,000 acre North Pass fire that was over 70 miles from the study area, was linked to the poor air quality in Redding (Benda and Longoria 2012).

Survey methods

Surveying procedures were implemented in spring of 2012 using a modified "tailored design method" (Dillman 2007). Mailings occurred in two waves. First, a notification postcard was sent to all individuals in the sample, followed a few days later by a complete packet (cover letter, questionnaire, and a postage-paid return envelope). After two weeks, a reminder postcard was sent to all participants who had not yet replied. Complete packets were again sent to all non-

respondents three weeks later. There were over 250 responses to this initial survey for a response rate of 23%. Non-response bias checks were conducted using a reduced version of the survey administered over the phone. The non-response bias check showed no important significant differences between respondents and non-respondents.

In the spring of 2013, respondents of the initial survey from northern California were sent a follow-up, mail-back questionnaire. Most of the questions were the same as in the previous year to provide the opportunity to study change between the two years. Other questions that asked specifically about experiences with the fire and smoke events from the past year were also included. The mailings occurred in the same fashion as described previously. The response rate from the follow-up survey was 61% (n=146 out of 252).

Analysis

To compare responses of the same individuals overtime, paired t-tests using SPSS (Statistical Package for Social Scientists) were used along with effect size to compliment the interpretations. For paired t-test analysis, responses that were missing or marked “Don’t know” were excluded from analysis. To calculate effect sizes, the University of Colorado, Colorado Springs effect size calculator was used, as SPSS does not have this capability (Becker 2000). Effect size adds to the interpretation of the results by showing the strength of the differences between the two years with less influence coming from a sample size than a standard p-value analysis. To interpret the effect sizes, Cohen (1988) and Vaske (2008) provided numerical guidelines to compare results across studies and scales with “small” or “minimal” effect sizes supporting the results of a p-value analysis. To measure the effect size, the difference between means is divided by the standard deviation.

To measure risk perceptions I created a risk index by multiplying the two components of risk: likelihood and severity. Likelihood refers to the chance of occurrence while severity refers to how drastic the impacts would be if they were to occur (Merkhoher 1993). By breaking smoke risk down into individual impacts from minor to serious, a fuller understanding of which specific risk perceptions changed and how respondents reacted to fire and smoke experiences can be generated. Six possible impacts of varying degrees were tallied into a smoke experience index. "Yes" responses to having experienced each impact were added into an index of 0 impacts experienced in the past 5 years up to 6 impacts experienced. These experiences included unpleasant odors, discomfort, a road closure or delay, evacuation from home, personal property damage, and personal health effects from smoke.

Results

Respondents were typical of those who reply to mail-back surveys (Blanchard and Ryan 2007) with 64% of respondents indicating they were male and an average age of 66 years old. Thirty percent of respondents indicated that someone in their household suffered from a respiratory ailment. Thirty percent lived in a community with a Community Wildfire Protection Plan but the majority of respondents (61%) were unsure if a CWPP existed in their neighborhood. Eighty-four percent of respondents rated the chance of a wildfire occurring near their homes in the next five years as "somewhat" to "very likely".

A series of questions was asked in 2013 to provide some context for results of the longitudinal comparison. A variety of fire types were experienced, heard of, or read about during the 2012 fire season in northern California. Most respondents had experienced, heard, or read about wildfires (87%) and prescribed fires (65%) with less experiencing pile burns (30%) and agricultural burns (14%). A few respondents (10%) marked that they also experienced some fires

whose source wasn't identifiable. Overall, 95% said that they had experienced, heard, or read about a fire in northern California during 2012.

Only a few of the respondents experienced direct impacts from the fires of 2012 with 13% stating that their homes or property were threatened, 8% were evacuated, and 2% had property damage However, a higher percent (26%) had family or friends that experienced one or more of the above impacts of the 2012 fire season. 52% of respondents said they experienced a prescribed fire that got out of control during the 2012 fire season. A majority of respondents, 79%, experienced smoke during the 2012 fire season. This number is less than the 95% who had heard of/read/experienced a fire, showing that some of the respondents were aware of the fires but had experienced no direct impacts, even with the far-reaching capabilities of smoke. Of households who experienced smoke from the fires, the average smoke severity rating was 4.2 on a 7-point scale (1=not severe to 7=very severe).

Respondents were asked how acceptable smoke was (on a 7-point scale (1=not severe to 7=very severe)) from multiple different types of fires, with the definition of "acceptable" left to the respondent. When looking at the results for the two years cumulatively (as there were no significant differences between the two years), the majority of respondents agreed that smoke from a wildfire was acceptable (68%), with less acceptance of smoke from other fire types; prescribed fire (52%), naturally-ignited fire (46%), pile burns (46%), agricultural (45%), and finally private landowner-produced smoke (40%) (Figure 3.1). Attitudes toward smoke also showed no significant changes between years. Relevant questions about attitudes included: "smoke from prescribed burns is a necessary inconvenience," "smoke is acceptable if it results in healthier forests'" and "I do not worry about smoke."

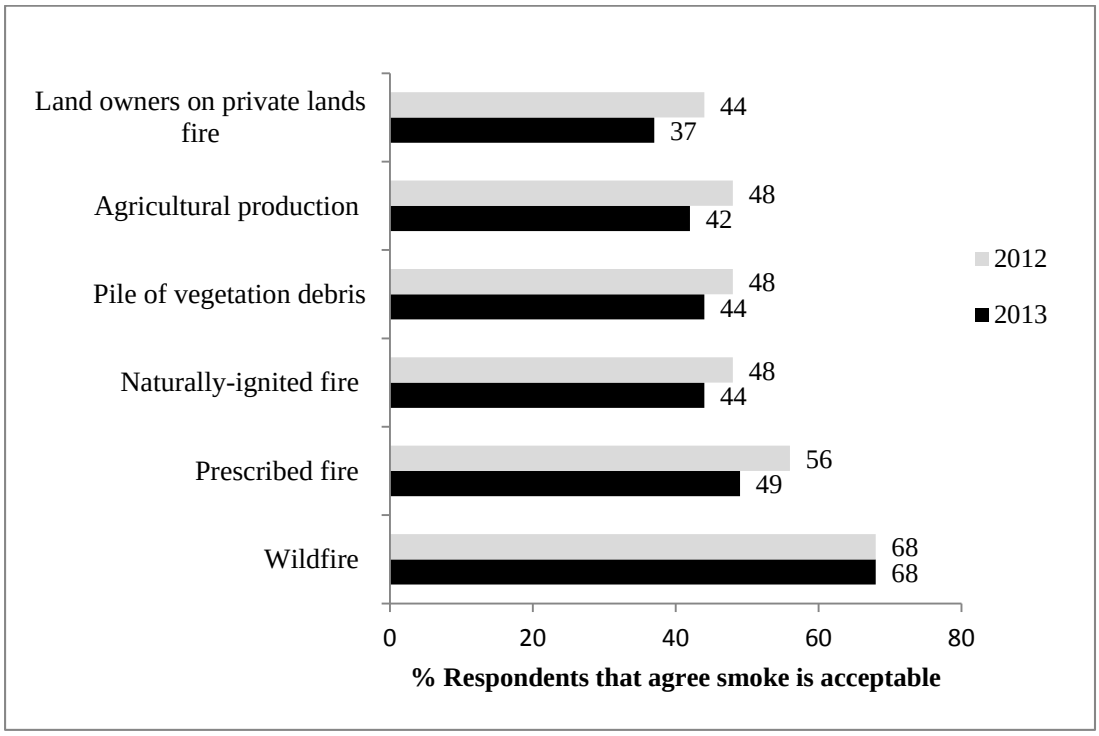

Figure 3.1. Smoke acceptance by smoke origin. Plotted are the summed percentages of respondents who agreed to strongly agreed.

Perceptions about some specific risks did significantly increase between the two years (Table 3.1). Negative impacts to scenery, reduced tourism, reduced opportunities for personal recreation, and reduced ability to accomplish personal property activities all significantly increased with medium or typical effect sizes. Risk for family and personal health impacts, negative travel impacts, and negative impacts on their ability to work were not significantly different with small to minimal effect sizes (Cohen 1988; Vaske 2008). There was, however, a significant decrease in number of impacts experienced from an average of 2.9 impacts to 2.62 (Cohen's *d* was medium or typical).

Table 3.1. Changes in the perceptions of risk from smoke impacts

Variable	2012 mean	2013 mean	Paired-sample *t*-test value	*p*-value	Cohen's *d* effect size
Negative impacts to the scenery[1]	18.69	21.74	1.99	0.049	0.21
Reduced tourism and recreation visits[1]	18.48	23.79	3.39	0.001	0.35
Reduced opportunities for me to participate in recreation activities[1]	15.95	19.56	2.29	0.024	0.24
Reduced ability to accomplish activities on my property[1]	13.33	16.96	2.39	0.019	0.24
Negative impact to my family's health[1]	15.15	15.97	0.60	0.551	0.07
Negative impact to my health[1]	20.70	20.90	0.12	0.902	0.01
Negative impacts to my ability to work[1]	10.73	12.31	1.14	0.257	0.11
Number of impacts experienced from smoke[2]	2.90	2.62	-2.39	0.018	0.27

[1] Responses measured on a continuous scale of 1 = No Risk to 49 = High Risk as a combined index of likelihood and severity from eight potential impacts of smoke
[2] Number of "Yes" responses to having experienced 0-6 smoke impacts.

The relationship between the public and the management agencies was also explored. The confidence ratings of federal agencies' ability to manage local public forests, to reduce fire risk, and for managing smoke ($p < 0.01$) were lower in 2013 than in 2012 with medium/typical effect sizes (Cohen 1988; Vaske 2008). For state agencies, there are significantly lower confidence ratings for the agency's ability to manage public forests and reduce fire risk, but no significant change in confidence about managing smoke.

When asked about the level of trust they had in various management agencies, local entities were more trusted, with local forest service ($\mu=4.21$), local air quality district ($\mu=4.24$), and state forests ($\mu=4.34$) achieving the highest trust , while further removed entities like the EPA ($\mu=3.29$) and the Federal agencies in Washington D.C. ($\mu=3.04$) having the lowest of these

scores on a scale of 1 “no trust” to 7 “full trust.” These relational trust measures showed no significant change between the two years and had small/minimal effect sizes. Specific abilities of the agencies to provide the best information available, in a timely manner, showed no significant differences between years and are supported by small/typical effect sizes.

Table 3.2. Changes in respondents ratings of agency confidence between 2012 and 2013

Variable	2012 mean	2013 mean	Paired-sample *t*-test value	*p*-value	Cohen’s *d* effect size
Federal agency rating for[1]					
managing local public forests	4.15	3.65	-3.26	0.001	0.268
specifically reducing fire risk	4.02	3.51	-3.39	0.001	0.271
managing smoke	4.04	3.62	-2.92	0.004	0.243
State agency rating for[1]					
managing local public forests	4.34	4.02	-2.36	0.020	0.194
specifically reducing fire risk	4.20	3.89	-2.03	0.044	0.179
managing smoke	4.11	3.89	-1.51	0.135	0.137

[1]Rating of agencies (Forest Service and state forestry) a 7 point scale of 1 “Poor” to 7 “Excellent”

Many forms and avenues of communication and information gathering are available to the public. Respondents were asked to rate sixteen of these possible sources for usefulness (Figure 3.2). While respondent’s perception of usefulness for most sources did not change between 2012 and 2013, the perceived usefulness of TV and radio public service messages increased while that of informational brochures and flyers or door-hangers decreased. In year

two, social media was also added to the questionnaire, with 14% having used this source for smoke information and an average usefulness rating of 2.3.

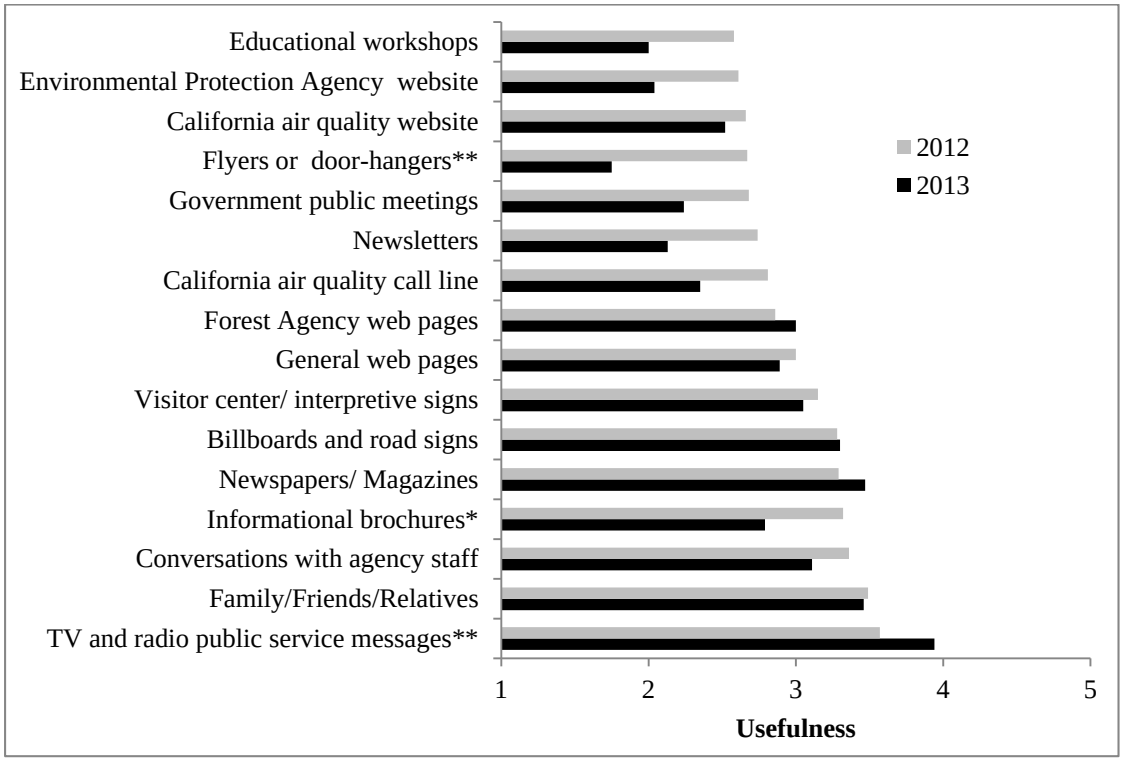

Figure 3.2. Respondent perceptions of utility of various sources of information on smoke

Responses measured on a 5-point scale of 1 "not useful" to 5 "very useful." Means for each year reported. * significant at $p < 0.05$; ** significant at $p < 0.001$

Respondents were asked about their levels of knowledge regarding smoke on a scale of 0-100 where 0 meant "know nothing" and 100 meant "know everything that could possibly be known about smoke." The average response was 60/100 in the initial survey. This was significantly lower the following year (53/100) (Table 3.3). However, there was not a significant change for the level of knowledge respondents felt they needed in order to feel comfortable understanding smoke. The drop between years in current level of knowledge but maintenance of

self-assessed knowledge necessary to make decisions created a larger gap in the information sufficiency for 2013, also known as the difference between what respondents knew and what they wanted to know.

Table 3.3. Self-assessed knowledge about smoke.

Variable	2012 mean	2013 mean	Paired-sample *t*-test value	*p*-value	Cohen's *d* effect size
Needed smoke knowledge to feel comfortable	66.76	66.19	-0.21	0.835	0.023
Self-assessed knowledge	59.52	53.41	-3.27	0.001	0.261

Discussion

2012 Experiences and Smoke Acceptance

There is still much to be learned about the human dimensions of smoke. This study begins to increase our understanding of how public perceptions, agency-relations, and acceptance of fire smoke differ before and after an active wildfire season. Results show that even though the majority of respondents experienced smoke and were aware of fires, these events did not produce significant changes in smoke acceptance. This finding is different than results from another study which reported that even a minor event can influence perceptions about smoke (Carroll et al. 2005).

Given the site context, the 2012 fire and smoke experiences were nothing new to these respondents. Indeed, the majority of respondents believed that a wildfire would likely burn near their homes sometime in the next five years. Believing fire likely to occur could reflect an overall change in perceptions about smoke and fire, in which these events are becoming

recognized as part of the respondent's environment, rather than as a rare, natural disaster that elicits an intense emotional response (Burchfield 2007). Some participants in a previous study held the belief that living in rural areas meant dealing with issues such as smoke and that smoke is simply a part of the chosen lifestyle (Weisshaupt et al. 2005); this may be the case in northern California as well.

While there were no changes overtime in acceptance of smoke from different sources, agreement that smoke is acceptable is not universal, even for the most acceptable sources like wildland and prescribed fire. This suggests that there is still headway to make in increasing smoke acceptance. The least acceptable sources of smoke were those from fires conducted by private citizens or agriculturalists. This reinforces the previous finding that smoke production benefiting the whole society is preferable to smoke production that benefits onlyone private landowner or farmer (Weisshaupt et al. 2005).

Risks

While some risks showed no significant changes, recreation and tourism impacts from smoke did significantly increase. Considering the far-reaching effects of smoke, even residents who may not have been directly affected by smoke where they live could have experienced recreational restrictions or a decline in tourism due to smoke. As the respondents rated smoke severity as moderate, this increase could mean that the fire smoke of 2012 was especially influential on recreation.

Another explanation might be that events do not directly change the risks, but rather that these risks were amplified due to social mechanisms (Kasperson et al. 1988). Northern California's economy is highly dependent on recreation and many residents partake in outdoor activities. Even if the residents didn't perceive the smoke as being severe, when it impacted

something they deeply valued (such as recreation or livelihoods) these individuals perceived these impacts as severe due to their own personal filters. The increase in risk perceptions could also be based not on personal experience, but outside influences such as the strong media attention given to some of these fires and their recreation impacts (Record Searchlight Staff 2012b) or informal communication networks (friends or family talking about the impacts they experienced on their recreation and how this increased their risk) (Kasperson et al. 1988).

Agency Relationships

Although the confidence in the agencies' ability to complete specific actions (manage for smoke, manage forests, and reduce fire risk) decreased between the two years, the overall trust rating for all types of air and forest management agencies did not significantly change, as predicted by the literature (Winter, Vogt, and McCaffrey 2004; Earle 2010). Given the Reading fire event, acceptance of smoke from a naturally-ignited fire was expected to decrease. While this was not the case, there were significant changes in the confidence respondents had in the state and federal agencies to both manage forests and to reduce the risk from fire. For federal agencies, this decrease was also seen in the confidence for that agency to manage smoke. Thus, the impacts of a mistake may have a direct effect on the confidence in an agency to complete a specific action, but this effect does not extend to the overall trust between the public and the agencies.

Communication

Changes in how information about smoke is disseminated, including through websites and even social media, were expected to have an influence on which sources were perceived as useful. For most sources, there was no significant change in perceived usefulness between 2012 and 2013. This included no change in the perceived usefulness of the web-based sources,

contrary to our hypothesis. This may reflect a generational error (Schaie 1965) given the advanced age of many respondents who may not be utilizing these online sources. Or this could be an effect of the short time period between surveys (Earle 2010). Interview participants in a prior study noted that new informational campaigns utilizing mass media including billboards/road signs and TV/radio were put into play around the time of the surveys in this area. While the billboards did remain a highly rated source, there was no significant increase in their perceived usefulness overtime. TV and radio did show signs of a successful communication campaign with the significant increase in usefulness of these sources. Informational brochures and flyers significantly decreased in usefulness, showing a movement away from the more passive, hard-copy based communication sources. There may also be an issue here with timeliness of information; TV and radio are able to disseminate more up-to-date information than flyers and brochures.

Additional confirmation that there could be better communication about smoke comes from the significant decrease in self-assessed knowledge between 2012 and 2013. This, coupled with no significant change in what respondents desired to know about smoke, shows that the knowledge deficit actually increased between the two years. As this was self-assessed knowledge, the relatively high rating was probably inflated to begin with (Wann and Branscombe 1995). Exposure to knowledge and deliberation can influence change in environmental values (Rodriguez-Mendez et al. 2003), so addressing this need for more knowledge about smoke could have multiple benefits. When knowledge is lacking, people tend to rely on experts to inform decisions (Earle 2010), resulting in an indirect relationship between trust and knowledge. More reliance on experts to inform decisions can lead to the tradeoff

between alternatives, benefits, and risks being more important in the acceptance judgment (Siegrist and Cvetkovich 2000; Earle 2010). Given the moderate levels of trust for forest and air quality agencies, acceptance of smoke may be strongly linked to these risks and benefits of fires.

Limitations and potential errors

Case studies have inherent restrictions on the ability to generalize results beyond the confines of the sampled population but understanding the specifics of one population provides useful insight and background for future research. Managers can also use the information reported here to develop smoke management and communication plans.

While socially significant fires did occur between the two surveys, this does not confirm a causal relationship, as changes in the variables tested could be attributed to other causes (Bauer 2004). Given that the majority of respondents did report similar experiences and that conclusions were drawn from a conglomeration of many respondents, a relationship is likely. Thus, while the conclusions drawn from this study should be further tested in different populations, there is evidence to support the interpretations discussed.

Potential errors of longitudinal methods include test-retest and age-effects. These should be minimized given that the time period between surveys was approximately one year; long-enough to avoid test-rest and short enough to avoid age-effects (Bauer 2004). Generational errors (Schaie 1965) may be an issue affecting some findings given the older age of the study population.

Management and Policy Implications

The 2012 fire season was expected to be highly influential on the perceptions of smoke and management, but there were few substantial changes between pre and post fire exposure. Smoke acceptance, even given the Reading fire that caused some controversy, did not

significantly decrease as might have been expected. With a few exceptions, most of the smoke and agency-perception variables were fairly resilient to change even after such a fire season.

The areas where changes did occur indicate that increasing the public's confidence in agencies to implement specific actions should be focused on, rather than relational trust. As confidence is more susceptible to quick changes based on new information and events, this presents greater opportunities but also greater challenges. On one hand, a more flexible and open judgment that is based on specific actions can mean that any positive efforts to improve confidence could be rapidly beneficial. On the other hand, even small mistakes could bring about immediate negative associations that must be overcome in the future.

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CHAPTER 4-CONCLUSION

Given climate change and the accumulation of fuels in many forests across the United States, there is not a foreseeable end to the risk of catastrophic and frequent wildfire (Hardy 2005; Running 2006; Westerling et al. 2006; Pechony and Shindell 2010). The presence of fire, and the associated smoke, can however be partially mitigated through prescribed fire and fuel reduction programs (Ryan, et al. 2013). The impacts of smoke will often be lessened when comparing a prescribed and wildfire, as air quality coordination, air flow, direction, and atmospheric barriers to smoke dispersal are considered before a controlled burn (Hardy et al. 2001) while such considerations are not possible with a wildfire. Similar to the general difference between prescribed and wildfire severity, the impacts of smoke can be less harmful following a successful implementation of a prescribed fire (Ryan, et al. 2013). Smoke is however, a "wicked" problem, one with many facets of interrelated obstacles including conflicting social values competing, with no clear way to determine which value should be favored (Shindler and Cramer 1999).

Tackling wicked problems is difficult but solutions typically come from an open, responsive dialogue and understanding between the different groups (Shindler and Cramer 1999; Toman, Shindler, and Brunson 2006). The first steps in establishing such a dialogue could be including and informing the local communities about fuel reduction activities throughout the process. This could increase the understanding of why managers are making the decision to burn. If the practices are seen as environmentally beneficial there may be more acceptance (McCaffrey and Olsen 2012) and this is already being done in many areas. To draft such communication plans, it is important to be able to prioritize the messages and utilize the resources that best

address the concerns of citizens, but it is also important to have adaptive messages that can keep up with changing social values (Shindler and Cramer 1999). This research lends itself to helping draft such plans by both establishing overall factors of smoke acceptance and by elucidating which aspects changed after a severe fire season. Strategies to deal with the social backlash that can come from wildfire, escaped controlled burns, or smoke impacts from any form of fire (Weisshaupt et al. 2005) can include a forum for groups to voice their opinion and be heard.

While much work has been done regarding social acceptability theory around prescribed fire and other fuel management procedures, less work has addressed smoke. The second chapter addressed the social acceptability of smoke from many fire types and explored what factors may influence that acceptance. As previously found, the origin or source of the smoke was an important consideration for respondents' acceptance levels (Weisshaupt et al. 2005). Not only were acceptance levels different for these varying sources of smoke, but the factors that contribute to their acceptance are unique in most cases. Sometimes demographics played a role in acceptance (e.g. for smoke from prescribed and naturally-ignited fires) while for others (wildfires), a combination of agency confidence and fire type significantly influenced acceptance. Understanding and agreeing with the benefits of the fire was also highly influential for acceptance of smoke from prescribed fire, again suggesting that acceptance is strongly conditional upon fire type but also that specific knowledge and beliefs can increase acceptance.

There were also some factors that transcended the specificity of fire type and were found in all or most of the acceptance models. Regardless of beliefs about benefits, demographics or informational gathering skills, the most universal determinate of smoke acceptance was

perceptions of risk for direct or indirect smoke impacts. The perceptions of risk from smoke impacts influenced acceptance regardless of smoke origin. For most cases, the agency relationship was also a highly-critical component to smoke acceptance. Confidence in agencies' ability to manage smoke was also a significant influence on smoke acceptance in three out of four of the models.

The third chapter explored smoke and agency perceptions from a different angle. It used a longitudinal approach to evaluate the perceptions before and after an active fire season in order to identify changes. For risks, a relationship between the events of the fire season and changes in perceptions of specific impacts was shown. During the 2012 fire season there were numerous direct impacts on recreation, scenery, and outdoor workability. These were reflected in the study with a significant post-fire increase in the risk perceptions for these types of impacts. These risk perceptions increased despite the fact that respondents reported experiencing significantly fewer types of smoke impacts post-fire than pre-fire.

Agency confidence affected smoke acceptance from most smoke sources and generally decreased after an active fire season. Even though most of the smoke during 2012 was from wildfires with generally unmanageable smoke, there were enough impacts from the smoke, or possibly enough association between the smoke and the fires, that respondents perceived poor management by federal agencies. The decision to let the naturally-ignited fire burn when this fire then became the Reading wildfire could also be playing a role in the significant decreased in agency confidence to reduce fire risk or to manage smoke. Confidence in both federal and state agencies' management of forests and ability to reduce fire risk also significantly decreased after the 2012 fire season, showing an overall trend of decreasing confidence after the active fire

season. However, general trust government agencies did not decrease. This relationship is supported by previous literature, which reported the confidence or ability of agencies to complete specific tasks was brought into question after events, but the overall general measures of trust remained fairly constant overtime (McCaffrey and Olsen 2012).

Additional agency-public relationship factors were examined. One component of this relationship is strong communication between these two groups (Kumagai, Daniels, et al. 2004). While interactive communication tactics have been shown to be more useful when they occur (Toman, Shindler, and Brunson 2006), increasing awareness and knowledge through multiple methods is still important. Self-assessed knowledge about smoke decreased over the year period causing a larger deficit of knowledge between what respondents felt they knew about smoke and what they wanted to know to feel comfortable. This change showcases an opportunity for improved communication. It could also point to the need for an improved relationship, if this lack of knowledge doesn't come from a lack of available information, but rather a lack of available trusted information (Earle 2010). And even though self-assessed knowledge was not a direct influencer of smoke acceptance from any of the fire types, it could still be related to acceptance indirectly with its role in the formation of personal perceptions such as risk or agency trust.

Findings from this study also suggest that the preferred methods or sources of communicating information may be shifting. Increases overtime in the perceived usefulness of TV and radio may suggest preference for sources that can give up-to-date information over sources that become quickly outdated. For example, flyers are a source that quickly become obsolete. In this study, their usefulness rating significantly decreased from 2012 to 2013. A

productive way of dealing with smoke could be founded in part on better communication before a prescribed fire so that people are able to prepare for it if they have health problems, as suggested by the findings in Weisshaupt et al. (2005). While information is widely disseminated for wildfires through multiple methods of media coverage, this could also be done for prescribed fires. This may also be one of the few available methods to address the concerns over some smoke impacts that are related to health.

While a significant change was not seen in the risk perceptions over health impacts, health is still an important component of the decision to implement prescribed fires. Individual perceptions of risk concerning health impacts were one of the highest perceived risks in both years. Even though there are many benefits to using prescribed fire and many mitigation procedures, it unavoidably produces smoke. One study even suggests that while wildfire smoke causes a higher concentration of particulate matter (and thus more health effects) than prescribed fires, prescribed fires do not often emit smoke and particulates at levels that impact asthma (Bowman and Johnston 2005). As health is a human need that can be negatively impacted by prescribed fire, and because almost a third of the US population have respiratory ailments, the normal methods of compromise and understanding-building may be of lesser use here than for other wicked problems. Health is not something many people are willing to sacrifice even if they understand and agree with the benefits of prescribed fire, partially because there are alternatives (i.e. thinning, biofuel) that do not negatively impact health to such a high degree.

This also brings up issues previously raised in the field of the human dimensions of fire; those of economic burden and impact. Many of the people who suffer from respiratory ailments are older (American Lung Association 2013). Smoke mitigation protocols may be less available

to this vulnerable group of individuals, either due to mobility (in the case of evacuation) or monetary constraints (installation of air filtration systems or healthcare costs). This is an area in need of further study, specifically the ability for this smoke sensitive group to mitigate smoke impacts. On a similar note of economic burden, areas that rely on tourism as a major source of community income are often negatively impacted by smoke. While both of these concerns may be addressed under the justification that smoke from a prescribed burn is usually less severe than smoke from a major wildfire, other options should still be considered for fuel reduction as there are alternatives to wildland and prescribed fire. And even though smoke from a prescribed fire is acceptable to the majority of these respondents, this does not mean the concerns of the minority should be discounted.

Future work into smoke science should include more complex modeling with more factors to determine smoke acceptance. Additional studies along the lines of pre/post surveys and interviews will continue to add knowledge regarding changes in perceptions given fire events and can add rigor to the potential relationship between an active fire season and changes in smoke perceptions. As this body of work develops, an acceptable strategy to fire, fuel, and smoke management will one day emerge.

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APPENDICES

Appendix A- Reliability Analysis Table for Chapter 2

Table A.1 Reliability analysis of variables used in determining smoke acceptance from different sources

	Mean	Standard Deviation	Item Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Smoke risk[1]					0.94
Negative impacts to the scenery	17.74	14.82	0.75	0.94	
Reduced tourism and recreation visits	16.70	14.82	0.76	0.94	
Reduced opportunities for me to participate in recreation activities	15.96	15.62	0.84	0.93	
Negative impact to my family's health	21.05	16.32	0.84	0.93	
Negative impact to my health	19.81	16.44	0.85	0.93	
Reduced ability to accomplish activities on my property	14.39	15.40	0.83	0.93	
Negative impacts to my ability to work	11.06	14.04	0.75	0.94	
Negative impacts to my travel - road closures and/or car accidents	13.92	14.12	0.75	0.94	
Agency Trust[2]					0.87
Local forest service staff	4.44	1.64	0.77	NA	
State department of forestry	4.64	1.55	0.77	NA	
Agency Confidence[3]					0.87
Federal agencies	4.12	1.60	0.80	NA	
State agencies	4.21	1.59	0.80	NA	

	Mean	Standard Deviation	Item Total Correlation	Alpha If Item Deleted	Cronbach Alpha
Prescribed fire benefits[4]					.92
Prescribed fire reduces the amount of excess forest fuels	5.94	1.53	0.77	0.91	
Prescribed fire restores the forest to a more natural condition	5.49	1.68	0.84	0.90	
Prescribed fire improves wildlife habitat	5.40	1.78	0.79	0.91	
Prescribed fire reduces the risk of large wildfires near my community in the future	5.82	1.60	0.84	0.90	
Prescribed fire saves money by reducing the cost of fighting a wildfire	5.52	1.76	0.79	0.91	

[1] Items coded on 49-point continuous scales from 1 "no risk" to 49 "Extreme risk"
[2] Items coded on 7-point continuous scales from 1 "no trust" to 7 "full trust"
[3] Items coded on 7-point continuous scale from 1 "poor" to 7 "excellent" (How would you generally rate the agencies for managing smoke?)
[4]Items coded on 7-point continuous scales from 1 "Strongly disagree" with benefit to 7 "strongly agree" with 4 "neutral"

Appendix B- Initial Survey Instrument for Chapter 2 *

*This is one of four survey instruments. While almost identical, the state names, cover photos, and state agencies names were changed to reflect the site of each survey area.

Public Opinions about Smoke from Wildfire and Land Management Activities

A Survey of Citizens in Northern California

This questionnaire was developed by researchers at The Ohio State University and Oregon State University. The findings will be summarized to help forest managers and scientists better understand citizens' opinions of smoke management from fires. We are asking for your help because you live near public and private lands where management practices may result in smoke.

The first set of questions is about general land and smoke management. These are followed by questions about your trust in and communication with land and air management agencies. Finally, we ask a few questions about you so that we can better understand who our respondents are. All responses are confidential.

Oregon State University
College of Forestry

JOINT FIRE SCIENCE PROGRAM

THE OHIO STATE UNIVERSITY

Section 1: General Perspectives on Land Management, Fire, and Smoke

We are interested in your opinions about forest planning and management. For each of the following questions, please select the answer that most closely reflects your beliefs. **Answers and comments are strictly confidential.**

1) How likely do you think it is that a wildfire might occur in the forests near your home in the NEXT 5 YEARS? Please circle the number corresponding to your response or mark (⊗) "DON'T KNOW."

1----------2----------3----------4 ○ DON'T KNOW

/	/	\	\
VERY UNLIKELY	SOMEWHAT UNLIKELY	SOMEWHAT LIKELY	VERY LIKELY

DEFINTIONS – In this questionnaire, the following terms are defined as:

Forest Fuels: Any living or dead vegetation that can be ignited and burned.

Prescribed fire: Also called controlled burning, this practice involves intentionally setting fires by managers to produce desired conditions and protect against undesired results.

2) We are interested to know if you have heard or read about any of the following topics. Please circle YES or NO for each of the following:

Have you heard or read about…

…the use of prescribed fire?	YES	NO
…the potential impacts of smoke from wildfires?	YES	NO
…managing or using naturally-ignited fire to improve forest health?	YES	NO
…the need to reduce forest fuels near your community?	YES	NO

3) Forest managers can use prescribed fire in different locations and on different types of land. How acceptable are the following? Circle one number for each.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
Using prescribed fire ON PUBLIC LANDS is acceptable:							
-- around neighborhoods	1	2	3	4	5	6	7
-- in remote forest areas	1	2	3	4	5	6	7
Using prescribed fire ON PRIVATE LANDS is acceptable:							
-- around neighborhoods	1	2	3	4	5	6	7
-- in remote forest areas	1	2	3	4	5	6	7

4) Prescribed fires may result in a number of different outcomes. Please indicate your level of agreement with each of the following statements. Circle the number corresponding to your response in each row or mark (⊗) "DON'T KNOW."

Prescribed fire…	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE	DON'T KNOW
…reduces the amount of excess forest fuels	1	2	3	4	5	6	7	◯
…restores the forest to a more natural condition	1	2	3	4	5	6	7	◯
…improves wildlife habitat	1	2	3	4	5	6	7	◯
…reduces the risk of large wildfires near my community in the future	1	2	3	4	5	6	7	◯
…saves money by reducing the cost of fighting a wildfire	1	2	3	4	5	6	7	◯
…reduces scenic quality	1	2	3	4	5	6	7	◯
…creates more smoke in the short-term, but less smoke over time	1	2	3	4	5	6	7	◯

5) For the following question, please consider impacts that may be associated with the use of <u>prescribed fire</u> near your community. For each item please indicate both how LIKELY and how SEVERE you believe this impact would be. Please restrict your answers to impacts specifically from prescribed fire, but not smoke. The next question (#6) will ask about impacts from smoke.

<u>Prescribed fire</u> near my community would result in...	**How LIKELY is this impact?**							**How SEVERE will the impact be?**						
	VERY UNLIKELY			NEUTRAL			VERY LIKELY	NO IMPACT			MODERATE			VERY SEVERE
Negative impacts to the scenery	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced tourism and recreation visits	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced opportunities for me to participate in recreation activities	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Loss of wildlife habitat	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Damage to private property	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Risk of fire going out of control	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Increased soil erosion	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Economic loss of useable timber	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Contamination of drinking water	1	2	3	4	5	6	7	1	2	3	4	5	6	7

6) The previous question asked about impacts from prescribed fires. Now we are interested in your thoughts about potential impacts from smoke. For the following question, please consider potential impacts that may be associated with <u>smoke</u> from a prescribed fire near your community. For each item please indicate both how LIKELY and how SEVERE the impact could be.

<u>Smoke</u> in my community could result in...	**How LIKELY is this impact?**							**How SEVERE will the impact be?**						
	VERY UNLIKELY			NEUTRAL			VERY LIKELY	NO IMPACT			MODERATE			VERY SEVERE
Negative impacts to the scenery	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced tourism and recreation visits	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced opportunities for me to participate in recreation activities	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impact to my family's health	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impact to my health	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced ability to accomplish activities on my property	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impacts to my ability to work	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impacts to my travel - road closures and/or car accidents	1	2	3	4	5	6	7	1	2	3	4	5	6	7

7) Smoke may come from different types of fires and impact people in different ways. Please let us know about your experience with smoke from different sources in the LAST 5 YEARS. Mark the appropriate circle(s) to indicate the source of the smoke for each potential effect. If you have not experienced this effect, mark (⊗) "No" and move on to the next item. You may select more than one response for each item.

Have you or anyone in your household experienced...	NO	DIDN'T KNOW THE SOURCE	FROM PRESCRIBED FIRES	FROM WILDFIRE	FROM AGRICULTURAL BURNS	PILE/ DEBRIS BURNS	FROM WOOD STOVES
… unpleasant odors from smoke?	○	○	○	○	○	○	○
… discomfort from smoke?	○	○	○	○	○	○	○
… a road closure or delay due to smoke?	○	○	○	○	○	○	○
…evacuation from your home or office due to smoke?	○	○	○	○	○	○	○
… personal property damage due to smoke?	○	○	○	○	○	○	○
… personal health effects from smoke?	○	○	○	○	○	○	○

8) Please indicate your level of acceptance of smoke resulting from the following types of fires:

	STRONGLY DISAGREE			NEUTRAL		STRONGLY AGREE		DON'T KNOW
Smoke from a wildfire that managers are attempting to suppress is acceptable	1	2	3	4	5	6	7	○
Smoke from a prescribed fire that is ignited by managers on public lands is acceptable	1	2	3	4	5	6	7	○
Smoke from a naturally-ignited fire (such as lightning) on public lands that is allowed to burn is acceptable	1	2	3	4	5	6	7	○
Smoke from burning a pile of vegetation debris is acceptable	1	2	3	4	5	6	7	○
Smoke from a fire that is ignited by land owners on private lands (e.g., refuse pile) is acceptable	1	2	3	4	5	6	7	○
Smoke from a fire used to prepare fields for agricultural production is acceptable	1	2	3	4	5	6	7	○

9) Please indicate your agreement with the following statements about smoke.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
Smoke is not important to me	1	2	3	4	5	6	7
When I notice smoke, I can usually figure out its source	1	2	3	4	5	6	7
The type of fire (i.e. wildfire, prescribed, agricultural) influences my willingness to accept smoke	1	2	3	4	5	6	7
Private landowners don't do enough to manage their smoke	1	2	3	4	5	6	7
Smoke from prescribed burns is a necessary inconvenience	1	2	3	4	5	6	7
Smoke is acceptable if it results in healthier forests	1	2	3	4	5	6	7
I do not worry about smoke	1	2	3	4	5	6	7

10) How much do you feel you know about smoke? Using a scale from zero (0) to 100, where zero means knowing nothing and 100 means knowing everything that could possibly be known about smoke, please indicate how much you feel you know about smoke.

_____ (write number here)

11) How much do you feel you would need to know to have a comfortable understanding of smoke in your area? You might feel you need the same, more, or possibly even less information about this topic than you indicated in the previous question. Using the scale of zero (knowing nothing) to 100 (knowing everything possible), how much information would be sufficient for you?

_____ (write number here)

12) We want to know which values you feel are most important to protect when difficult decisions about natural resources must be made. Please circle the number that relates to the importance of the factor in your opinion.

	NOT IMPORTANT			MODERATELY IMPORTANT			EXTREMELY IMPORTANT
Environmental consequences are given top priority	1	2	3	4	5	6	7
Economic consequences are given top priority	1	2	3	4	5	6	7
Actions help support the local economy	1	2	3	4	5	6	7
The decision results in management activities that maintain or restore ecological conditions	1	2	3	4	5	6	7
The decision maintains forest access for recreation	1	2	3	4	5	6	7
When scientists play a role by reviewing management objectives	1	2	3	4	5	6	7
How the decision affects my personal property	1	2	3	4	5	6	7

Section 2: Trust in and Communication with Forest Agencies

We are interested in your opinions about the public agencies that manage land where fire occurs. For each of the following questions, please select the answer that most closely reflects your beliefs.

Forest Agencies: This refers to agencies that manage public lands, such as the U.S. Forest Service, Bureau of Land Management (BLM), National Park Service, and the California Department of Forestry. Please respond to the following questions by thinking about the agency or agencies you have had the most experience with.

13) We would like to understand how well you think forest agencies are doing managing land in your area. Please circle the number that most closely reflects your opinion.

How would you generally *rate the agencies…*	Federal Forest Agencies (U.S. Forest Service, BLM)							State or Local Forest Agencies (California Dept. of Forestry)						
	POOR		MODERATE			EXCELLENT		POOR		MODERATE			EXCELLENT	
For how well they manage public forests in your area?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
For specifically reducing fire risk?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
For managing smoke?	1	2	3	4	5	6	7	1	2	3	4	5	6	7

14) Trust in natural resource organizations is essential to the success of forest management programs. Please indicate your level of trust in the following agencies to make good decisions about <u>smoke management</u>. Circle one number for each or mark (⊗) "Don't know."

	NO TRUST			MODERATE TRUST			FULL TRUST	DON'T KNOW
Your local Forest Service staff in California	1	2	3	4	5	6	7	◯
Your local county air quality district	1	2	3	4	5	6	7	◯
California Department of Forestry	1	2	3	4	5	6	7	◯
Private landowners	1	2	3	4	5	6	7	◯
Forestry consultants who work with private landowners to conduct burns on private lands	1	2	3	4	5	6	7	◯
California Environmental Protection Agency, Air Resources Board	1	2	3	4	5	6	7	◯
U.S. Environmental Protection Agency (EPA)	1	2	3	4	5	6	7	◯
U.S. Federal Agencies (Forest Service, BLM) in Washington, D.C.	1	2	3	4	5	6	7	◯

15) The following questions ask for your opinion about agency managers. Please indicate your level of agreement or disagreement with each of the following statements.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
FEDERAL agency fire managers provide:							
…the best available information about smoke issues	1	2	3	4	5	6	7
…enough information about smoke so I can decide which actions I should take	1	2	3	4	5	6	7
…timely information regarding smoke	1	2	3	4	5	6	7
STATE agency fire managers provide:							
…the best available information about smoke issues	1	2	3	4	5	6	7
…enough information about smoke so I can decide which actions I should take	1	2	3	4	5	6	7
…timely information regarding smoke	1	2	3	4	5	6	7

16) Please indicate your agreement with the following statements about the information available regarding smoke.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
If I wanted to, I could easily locate information about smoke emissions	1	2	3	4	5	6	7
It is hard for me to find useful information about smoke emissions	1	2	3	4	5	6	7
I intend to find out more about smoke	1	2	3	4	5	6	7
I don't need to look for any more information about smoke	1	2	3	4	5	6	7
Seeking additional information about smoke would be a productive use of my time	1	2	3	4	5	6	7
People whose opinions I value expect me to be knowledgeable about smoke	1	2	3	4	5	6	7
My friends and family think it is important to learn more about smoke emissions	1	2	3	4	5	6	7

17) Has your trust in Forest Agencies changed over time because of smoke management issues?

My trust in forest management agencies has: ○ DECREASED ○ NOT CHANGED ○ INCREASED

If your trust has **decreased** or **increased** because of smoke management, what is the primary reason?

_____

18) Has your acceptance of the use of prescribed fire changed because of smoke management issues?

My acceptance of prescribed fire has: ○ DECREASED ○ NOT CHANGED ○ INCREASED

If your acceptance has **decreased** or **increased** because of smoke management, what is the primary reason?

_____

19) There are many sources of information about smoke and we would like to know which sources you feel are most useful. You may encounter these sources when gathering general information about fire and smoke, or when seeking information about specific planned or ongoing smoke events. Please circle "Yes" to all information sources you have used to receive fire or smoke-related information, and then indicate how useful that source was. If you've had no experience with that source, please circle "No" and move on to the next question.

	Experience?		Useful?				
			NO	SOMEWHAT			VERY
Informational brochures	NO	YES	1	2	3	4	5
TV and radio public service messages	NO	YES	1	2	3	4	5
Newspapers/ Magazines	NO	YES	1	2	3	4	5
Newsletters	NO	YES	1	2	3	4	5
Flyers or door-hangers	NO	YES	1	2	3	4	5
Government public meetings	NO	YES	1	2	3	4	5
Conversations with agency staff	NO	YES	1	2	3	4	5
Billboards and road signs	NO	YES	1	2	3	4	5
Visitor center/ interpretive signs	NO	YES	1	2	3	4	5
Educational workshops	NO	YES	1	2	3	4	5
General web pages	NO	YES	1	2	3	4	5
Forest Agency web pages	NO	YES	1	2	3	4	5
Environmental Protection Agency website	NO	YES	1	2	3	4	5
California air quality website	NO	YES	1	2	3	4	5
California air quality call line	NO	YES	1	2	3	4	5
Family/Friends/Relatives	NO	YES	1	2	3	4	5

Section 3: Information About You

These questions help us more fully understand people's views and opinions. **All responses are strictly confidential.**

20) Are you? ○ MALE ○ FEMALE

21) In what year were you born? _____

22) Please indicate your race/ethnicity below (you may select more than one).

- ○ BLACK / AFRICAN-AMERICAN
- ○ HISPANIC, LATINO, OR SPANISH ORIGIN
- ○ ASIAN
- ○ OTHER OR UNKNOWN
- ○ WHITE / CAUCASIAN
- ○ AMERICAN INDIAN OR ALASKA NATIVE
- ○ NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER

23) Please indicate the level of your current household income before taxes.

- ○ LESS THAN $20,000 PER YEAR
- ○ $20,001 TO $40,000 PER YEAR
- ○ $40,001 TO $60,000 PER YEAR
- ○ $60,001 TO $80,000 PER YEAR
- ○ $80,001 TO $100,000 PER YEAR
- ○ $100,001 TO $120,000 PER YEAR
- ○ MORE THAN $120,000 PER YEAR

24) What is the highest level of education you have completed (mark one)?

- ○ SOME HIGH SCHOOL
- ○ HIGH SCHOOL GRADUATE / GED
- ○ VOCATIONAL SCHOOL
- ○ SOME COLLEGE
- ○ ASSOCIATE'S DEGREE
- ○ BACHELOR'S DEGREE
- ○ SOME GRADUATE SCHOOL
- ○ GRADUATE DEGREE

25) What is your zip code? _____

26) How long have you lived in this community? _____ Years

27) Are you a permanent (year round) or part-time resident in this home?

○ PERMANENT ○ PART-TIME OR SEASONAL

28) Is your employment or any source of income related to forests? ○ YES ○ NO

29) Are you retired? ○ YES ○ NO

30) Does the community where you live have a Community Wildfire Protection Plan?

○ YES ○ NO ○ DON'T KNOW

31) Are you a member of any forest or natural resource community or interest group?

○ YES ○ NO ○ DON'T KNOW

32) About how far is it from your home to a natural area where a wildfire might burn?

Around _____ miles…. or mark here if it's right next door ○

33) Do you or a member of your household use fire on your own property to manage vegetation?

○ YES ○ NO ○ DON'T KNOW

34) Do you or a member of your household use fire to burn trash or unwanted debris?

○ YES ○ NO ○ DON'T KNOW

35) Does your household use a woodstove (not including pellet stoves)?

○ YES ○ NO → Skip to the next page

If yes: in an average week, how often does your household use the woodstove during the cold weather season? Please provide your best estimate.

_____ Days per week

36) Has your household participated in a woodstove replacement program?

○ YES ○ NO ○ DON'T KNOW

37) Have you ever been unable to use your woodstove or fireplace due to smoke or air quality?

○ YES ○ NO ○ DON'T KNOW

If yes: in an average month, how frequently were you <u>unable</u> to use your woodstove or fireplace for smoke or air quality reasons?

_____ Number of days in a typical month during the cold weather season

38) If you have additional comments, please use the space below to share them.

Thank you for completing this questionnaire. We value your time and appreciate your response. Please return your completed survey in the postpaid envelope provided.

Appendix C-Longitudinal Survey Instrument for Chapter 3

Public Opinions and Experiences with Wildfire and Smoke

Follow-up in Northern California after the 2012 fire year

This survey is a follow-up to one you completed last year, and we would greatly appreciate your continued input. A number of fire-related events occurred in Northern California in 2012. This brief survey should only take about 15 minutes of your time. The first section asks you about your experiences with wildfire and smoke in the last year. The next sections are about your opinions of forest agencies and some brief information about yourself. All responses are confidential. Your opinions provide valuable information for future planning purposes. Thank you for your cooperation.

Oregon State
UNIVERSITY

College of Forestry

JOINT FIRE SCIENCE PROGRAM

Section 1: Fire and Smoke Experiences in 2012

We are interested in your fire and smoke experiences since we last contacted you in the spring of 2012. Please circle the answer that most closely reflects your experience. **Answers and comments are strictly confidential.**

Prescribed fire: Also called controlled burning, this practice involves forest managers intentionally setting fires to produce desired conditions and protect against undesired results.

1) Did you experience, hear about, or read about any fires in Northern California in 2012? Please circle your answer. YES NO → Skip to Section 2

2) What kinds of fires were they? Check all that apply.

- ○ WILDFIRE
- ○ PRESCRIBED FIRE
- ○ AGRICULTURAL BURN
- ○ PILE/DEBRIS BURN
- ○ DIDN'T KNOW THE SOURCE

To your knowledge, were any of these fires prescribed or controlled burns that got out of control? YES NO

3) Did any of these fires….

…threaten your home or property? YES NO

…cause you to be evacuated? YES NO

…damage your property? YES NO

…cause friends or family to experience any of the above? YES NO

4) Did you or a member of your household experience smoke from the 2012 fires? YES NO → Skip to Section 2

5) How severe was the smoke from the 2012 fires? Circle the number corresponding to your response.

NOT SEVERE, BARELY NOTICEABLE						VERY SEVERE
1	2	3	4	5	6	7

Section 2: General Perspectives on Land Management, Fire, and Smoke

We are interested in your opinions about forest planning and management. For each of the following questions, please select the answer that most closely reflects your beliefs. **Answers and comments are strictly confidential.**

1) How likely do you think it is that a wildfire might occur in the forests near your home in the NEXT 5 YEARS? Please circle the number corresponding to your response or mark (⊗) "DON'T KNOW."

1----------2----------3----------4 ○ DON'T KNOW

/ / \ \

VERY UNLIKELY | SOMEWHAT UNLIKELY | SOMEWHAT LIKELY | VERY LIKELY

2) Please indicate your level of acceptance of smoke resulting from the following types of fires:

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE	DON'T KNOW
Smoke from a wildfire that managers are attempting to suppress is acceptable	1	2	3	4	5	6	7	○
Smoke from a prescribed fire that is ignited by managers on public lands is acceptable	1	2	3	4	5	6	7	○
Smoke from a naturally-ignited fire (such as lightning) on public lands that is allowed to burn is acceptable	1	2	3	4	5	6	7	○
Smoke from burning a pile of vegetation debris is acceptable	1	2	3	4	5	6	7	○
Smoke from a fire that is ignited by land owners on private lands (e.g., refuse pile) is acceptable	1	2	3	4	5	6	7	○
Smoke from a fire used to prepare fields for agricultural production is acceptable	1	2	3	4	5	6	7	○

3) Smoke may come from different types of fires and impact people in different ways. Please let us know about your experience with smoke from different sources in the LAST 5 YEARS. Mark the appropriate circle(s) to indicate the source of the smoke for each potential effect. If you have not experienced this effect, mark (⊗) "No" and move on to the next item. You may select more than one response for each item.

Have you or anyone in your household experienced…	NO	DIDN'T KNOW THE SOURCE	FROM PRESCRIBED FIRES	FROM WILDFIRE	FROM AGRICULTURAL BURNS	PILE/ DEBRIS BURNS	FROM WOOD STOVES
… unpleasant odors from smoke?	○	○	○	○	○	○	○
… discomfort from smoke?	○	○	○	○	○	○	○
… a road closure or delay due to smoke?	○	○	○	○	○	○	○
…evacuation from your home or office due to smoke?	○	○	○	○	○	○	○
… personal property damage due to smoke?	○	○	○	○	○	○	○
… personal health effects from smoke?	○	○	○	○	○	○	○

4) For the following question, please consider impacts that may be associated with smoke from a prescribed fire near your community. For each item please indicate both how LIKELY and how SEVERE you believe this impact would be by circling the appropriate response.

	How LIKELY is this impact?							How SEVERE will the impact be?						
Smoke in my community could result in...	VERY UNLIKELY			NEUTRAL			VERY LIKELY	NO IMPACT			MODERATE			VERY SEVERE
Negative impacts to the scenery	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced tourism and recreation visits	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced opportunities for me to participate in recreation activities	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impact to my family's health	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impact to my health	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Reduced ability to accomplish activities on my property	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impacts to my ability to work	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Negative impacts to my travel - road closures and/or car accidents	1	2	3	4	5	6	7	1	2	3	4	5	6	7

5) Please indicate your agreement with the following statements about smoke.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
Smoke is not important to me	1	2	3	4	5	6	7
When I notice smoke, I can usually figure out its source	1	2	3	4	5	6	7
The type of fire (i.e. wildfire, prescribed, agricultural) influences my willingness to accept smoke	1	2	3	4	5	6	7
Private landowners don't do enough to manage their smoke	1	2	3	4	5	6	7
Smoke from prescribed burns is a necessary inconvenience	1	2	3	4	5	6	7
Smoke is acceptable if it results in healthier forests	1	2	3	4	5	6	7
I do not worry about smoke	1	2	3	4	5	6	7
It is hard for me to find useful information about smoke	1	2	3	4	5	6	7

6) How much do you feel you know about smoke? Using a scale from zero (0) to 100, where zero means knowing nothing and 100 means knowing everything that could possibly be known about smoke, please indicate how much you feel you know about smoke.

_____ (write number here)

7) How much do you feel you would need to know to have a comfortable understanding of smoke in your area? You might feel you need the same, more, or possibly even less information about this topic than you indicated in the previous question. Using the scale of zero (knowing nothing) to 100 (knowing everything possible), how much information would be sufficient for you?

_____ (write number here)

Section 3: Trust in and Communication with Forest Agencies

We are interested in your opinions about the public agencies that manage land where fire occurs. For each of the following questions, please select the answer that most closely reflects your beliefs.

Forest Agencies: This refers to agencies that manage public lands, such as the U.S. Forest Service, Bureau of Land Management (BLM), National Park Service, and the California Department of Forestry. Please respond to the following questions by thinking about the agency or agencies you have had the most experience with.

1) We would like to understand how well you think forest agencies are doing managing land in your area. Please circle the number that most closely reflects your opinion.

How would you generally rate the agencies…	Federal Forest Agencies (U.S. Forest Service, BLM)							State or Local Forest Agencies (California Dept. of Forestry)						
	POOR		MODERATE			EXCELLENT		POOR		MODERATE			EXCELLENT	
For how well they manage public forests in your area?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
For specifically reducing fire risk?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
For managing smoke?	1	2	3	4	5	6	7	1	2	3	4	5	6	7

2) The following questions ask for your opinion about agency managers. Please indicate your level of agreement or disagreement with each of the following statements.

	STRONGLY DISAGREE			NEUTRAL			STRONGLY AGREE
FEDERAL *agency fire managers provide:*							
…the best available information about smoke issues	1	2	3	4	5	6	7
…enough information about smoke so I can decide which actions I should take	1	2	3	4	5	6	7
…timely information regarding smoke	1	2	3	4	5	6	7
STATE *agency fire managers provide:*							
…the best available information about smoke issues	1	2	3	4	5	6	7
…enough information about smoke so I can decide which actions I should take	1	2	3	4	5	6	7

…timely information regarding smoke	1	2	3	4	5	6	7

3) Trust in natural resource organizations is essential to the success of forest management programs. Please indicate your level of trust in the following agencies to make good decisions about smoke management. Circle one number for each or mark (⊗) "Don't know."

	NO TRUST			MODERATE TRUST			FULL TRUST	DON'T KNOW
Your local Forest Service staff in California	1	2	3	4	5	6	7	○
Your local county air quality district	1	2	3	4	5	6	7	○
California Department of Forestry	1	2	3	4	5	6	7	○
California Environmental Protection Agency, Air Resources Board	1	2	3	4	5	6	7	○
Nearby National Park Service (e.g., Lassen NPS)	1	2	3	4	5	6	7	○
U.S. Environmental Protection Agency (EPA)	1	2	3	4	5	6	7	○
U.S. Federal Agencies (Forest Service, BLM) in Washington, D.C.	1	2	3	4	5	6	7	○

4) Has your acceptance of the use of prescribed fire changed because of smoke management issues?

My acceptance of prescribed fire has: ○ DECREASED ○ NOT CHANGED ○ INCREASED

If your acceptance has **decreased** or **increased** because of smoke management, what is the primary reason?

_____

If your acceptance has **decreased** or **increased** because of smoke management, was this change in the past year?

○ YES ○ NO

5) Has your trust in the Forest Agencies changed over time because of smoke management issues?

My trust in the agencies has: ○ DECREASED ○ NOT CHANGED ○ INCREASED

If your trust has **increased** or **decreased** because of smoke management, what is the primary reason?

_____

If your trust has **decreased** or **increased** because of smoke management, was this change in the past year?

○ YES ○ NO

6) There are many sources of information about smoke and we would like to know which sources you feel are most useful. You may encounter these sources when gathering general information about fire and smoke, or when seeking information about specific planned or ongoing smoke events. Please circle "Yes" to all information sources you have used to receive fire or smoke-related information, and then indicate how useful that source was. If you've had no experience with that source, please circle "No" and move on to the next question.

	Experience?		Useful?				
			NO	SOMEWHAT			VERY
Informational brochures	NO	YES	1	2	3	4	5
TV and radio public service messages	NO	YES	1	2	3	4	5
Newspapers/ Magazines	NO	YES	1	2	3	4	5
Newsletters	NO	YES	1	2	3	4	5
Flyers or door-hangers	NO	YES	1	2	3	4	5
Government public meetings	NO	YES	1	2	3	4	5
Conversations with agency staff	NO	YES	1	2	3	4	5
Billboards and road signs	NO	YES	1	2	3	4	5
Visitor center/ interpretive signs	NO	YES	1	2	3	4	5
Educational workshops	NO	YES	1	2	3	4	5
General web pages	NO	YES	1	2	3	4	5
Forest Agency web pages	NO	YES	1	2	3	4	5
Environmental Protection Agency website	NO	YES	1	2	3	4	5
California air quality website	NO	YES	1	2	3	4	5
California air quality call line	NO	YES	1	2	3	4	5
Family/Friends/Relatives	NO	YES	1	2	3	4	5
Social Media (i.e. facebook, twitter, etc.)	NO	YES	1	2	3	4	5

Over the last year, did you have an experience with a source of information that was particularly noteworthy? If yes, please explain :_____

Section 4: Information About You

These questions help us more fully understand people's views and opinions. **All responses are strictly confidential.**

19) Are you? ○ MALE ○ FEMALE

20) In what year were you born? _____

21) What is your zip code? _____

22) Does the community where you live have a Community Wildfire Protection Plan?

○ YES ○ NO ○ DON'T KNOW

23) About how far is it from your home to a natural area where a wildfire might burn?

Around _____ miles…. or mark here if it's right next door ○

24) Do you or a member of your household use fire on your own property to manage vegetation?

○ YES ○ NO ○ DON'T KNOW

25) Do you or a member of your household use fire to burn trash or unwanted debris?

○ YES ○ NO ○ DON'T KNOW

26) Does anyone in your household suffer from a respiratory ailment?

○ YES ○ NO ○ DON'T KNOW

27) If you have additional comments, please use the space below to share them.

Thank you for completing this questionnaire. We value your time and appreciate your response. Please return your completed survey in the postpaid envelope provided.