Factors Influencing Residential Risk Perception in Fire-Prone Landscapes

By

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Abstract

Since the 1990s the U.S. and especially the Western U.S. have experienced more intense and costly fires. To help address this problem government agencies are increasingly looking at homeowners in fire-prone landscapes to mitigate fire risk. Part of this effort involves communicating risk and understanding how residents perceive risk. This paper seeks to analyze and better understand how residents in a fire-prone ecosystem determine wildfire risk. It conducted a mail-based survey in six central Oregon counties and produced a response rate of 51 percent. The survey contained a descending scale of five risk targets ie region or neighborhood and asked respondent to choose how much risk they perceive for the given target. Drawing on the literature around risk perception and natural hazards, a number of potentially significant variables were included in the analysis. Then, models were created for the risk target and regressed through Ordinal Logit. This study found that respondents were more likely to perceive higher risk at broader targets while they perceived less risk at lower and more personal targets. It also found proximity to a wildland area, home or property exposure to wildfire, and management approval to significantly influence residential risk perception. These results were not all consistent with the research expectations, but still offer interesting insight into how people conceptualize risk.

Key Words: Risk Perception; Wildfire; Proximity; Management Approval; Risk Targets

Introduction

Wildfire severity and frequency have been increasing across the Western United States and they are projected to continue to intensify for the foreseeable future (National Wildfire Coordinating Group, 2009). There are two major explanations for this increase in fires. One is increasing temperature as a result of anthropogenic climate change and natural climatic variation (Westerling, Hidalgo, Cayan, and Swetnam, 2006). Moisture conditions also contribute through both overall decreased moisture content (dryer) and alternating wet-dry patterns. The wet-dry pattern increases fuel load in the wet period and then in the dry period increases burn chances (Westerling et al., 2006). The second explanation for increased wildfire stipulates that land management policy has created conditions that increase the probability of a fire event (Westerling et al., 2006). In support of the first explanation, Westerling et al. conducted a large time-series review of western U.S. wildfire records between 1970 and 2003 and compared the data with hydrological and land records. They found that earlier spring snow pack melting and higher spring and summer temperature is increasing fire risk (2006). The Quadrennial Fire Review is a newly instituted joint report issued by the U.S. Forest Service, Bureau of Indian Affairs, Bureau of Land Management, National Park Service and U.S. Fish and Wildlife Service along with their state, local, and tribal partners that collectively constitute the wildland fire community. It argues for an 'all of the above' approach, finding increased fire incidents are being driven by climate change, high fuel load due to historic fire suppression efforts, and by escalating rates of drought (National Wildfire Coordinating Group, 2009).

Additionally, residential development adjacent to public forestlands has been growing (Gude, Rasker and Van den Noort, 2008). This area is termed the Wildland-Urban Interface (WUI) and growth within the WUI has been particularly acute across the west with an average of 14 percent of interface land developed (Gude et al., 2008). For Oregon, future growth in the WUI poses particular problems due to

the large amount of developable interface land. Currently 10 percent of the WUI is developed, but Oregon has the largest potentially developable interface among western states at 5,960 square miles (Gude et al., 2008). WUI development creates a large problem for fire management with an increasing number of residents vulnerable to worsening fire conditions. Also, the WUI itself complicates firefighting efforts due to the different approaches required for structure vs. wildland fire. The encroachment of homes toward wildlands also increases the overall probability of fire, property damage and the cost of fire fighting (Spyratos, Bourgeron, and Ghil, 2007). Together, rising incidence of fire and growth in the WUI will strain the budget of the U.S. Forest Service and state fire prevention efforts (QFR, 2009).

The purpose of this paper is to analyze and understand how residents in a fire-prone ecosystem determine wildfire risk. It draws on literature around risk and risk perception as well as environmental values specifically the Values-Beliefs-Norm theory (Stern, 2000). Previous research on wildfire risk perception has focused on personal knowledge and experience (Martin, Martin, and Kent 2009). This paper expands on existing research into wildfire risk perception in a number of ways including: the effect of proximity to wildland, the role of land management approval, geographic scale and worldview. Most notably, it examines risk perception as a dependent variable instead of its typical use as an independent variable, which, helps understand where ideas on risk come from in the first place (Tierney, 1999).

This study is part of a larger National Science Foundation (NSF) grant (1013296) project titled Forests, People, Fire (FPF). Its goal is to use systems models, integrated research, and collaborative learning to improve our understanding of how humans adapt (or not) to living in fire-prone forests and to learn how policies could be made more effective. The paper will present background on federal fire policy and its changes over time. It will then move to a review of the literature on risk and risk perception as well as value theory and the New Environmental Paradigm. This paper then develops research expectations based on the literature. It relates the methods used in the study and how it was analyzed. It will report the results of the analysis and a discussion of the results. It will propose

policy implications based on the results and the literature. It concludes with a section containing limitations of the study, conclusions from the study and possible future extensions of the research.

Background

Federal Forest Fire Policy: One of the major factors in increasing fire risk is in the historical practice of fire suppression on federal lands, which increased the amount of fuel available to feed big fires. Before governmental intervention, fire was a vital part of many ecosystems. High frequency and low intensity fire would reduce the amount of undergrowth, return nutrients to the soil and promote the germination of pine seedlings. After its creation, the Forest Service began to promote "scientific management" of forests (C. Davis, 2006). This management included the suppression of wildfire in all cases, in opposition to the Native American and small landholders' practice of intentional use of fire. The policy of fire suppression was further entrenched in Forest Service policy following a massive wildfire in 1910 that resulted in the death of 79 firefighters and burned 5 million acres of forest (C. Davis, 2006). This model of fire suppression reached its apex in the "10 a.m. policy" which called for fires to be put out by the morning following a full day of firefighting (C. Davis, 2006). This policy was followed for most of the twentieth century until large wildfires again began to break out across federal lands. An example of the new wave of wild fires is the 2002 Biscuit Fire in southern Oregon. Sessions, Buckman, Newton, and Hamann, in an Oregon State University, College of Forestry report, describe the Biscuit fire (2003, 2):

> The Biscuit Fire began July 13, 2002. During the next 54 days, Biscuit burned approximately 400,000 acres within a perimeter surrounding 500,000 acres on the Siskiyou National Forest. Biscuit was the largest fire in recorded Oregon history and the nation's most expensive fire suppression effort of 2002, reportedly costing $150 million in federal and state funds.

President Bush utilized the Biscuit fire as a launch pad to build support for and demonstrate the necessity of his Healthy Forest Initiative (J. Davis, 2004).

The rise in wildfires in the 1990s and early 2000s, drove state, local and federal governments to focus on wildfire as a policy issue. Previously, fire policy had largely been left to the Forest Service. These efforts changed the focus of state and federal land managers from fire suppression to fire prevention (C. Davis, 2006). An important part of this shift in focus is the Firewise program. The program developed as a collaboration between the Forest Service, the U.S. Department of the Interior and the National Fire Protection Association (National Fire Protection Association, n.d.). It seeks to educate and encourage both homeowners and communities in fire prone areas to manage their homes and property in way that would make them more defensible. Researchers have found that even small changes in fire risk for individual homes can influence landscape wide fire spread risk (Spyratos et al., 2007). An important question for the Firewise program is what factors influence homeowners to engage or not engage in Firewise behavior. Answering this question will improve outreach efforts and hopefully reduce fire risk within the WUI.

Literature Review:

Risk: Risk can be broadly defined as "the chance within a time frame of an adverse event with specific consequences" (Burgman, 2005, p. 1). Humans have dealt with risk and uncertain futures for a long time. This can be seen in early forms of shipping insurance and grain futures from as early as 2000 BCE (Arnoldi, 2009, p. 24-25). The modern conception of risk differs from earlier forms is in the quantification of risk. Also, as our society has become industrialized risk has become a systematic byproduct of our technology (Beck, 1992). This new systematic nature of risk combined with the notion that risk is quantifiable has, over the last 50 years, led to a new conception of risk as a social problem to be managed by the state (Arnoldi, 2009, p. 5). This societal shift towards risk assessment and management

has led some researchers to declare a new "risk society" (Beck, 1992). However, reductions in risk often led to reduction in benefits produced from that risk (Fischhoff, Slovic, Lichtenstein, Read, and Combs, 1978). This prompts the question "how safe is safe enough" (Fischhoff et al., 1978)? To answer this question physical, social and biological scientists developed a new field, risk assessment, which is dedicated to determining and analyzing risk (Fischhoff, Watson, and Hope, 1984).

Not all risks are created equal. Some risk is more easily quantifiable such as traffic accidents, which occur frequently and consequently have a large amount of data for use in analysis. On the other hand, risk also covers low frequency events, such as nuclear meltdowns, for which risk analysts have little to no data (Tierney, 1999). In this case the gaps in the data are filled by modeling and expert opinion (Tierney, 1999). While modeling fills a useful role, Slovic, a longtime risk researcher, claims that their "structure is subjective and assumption laden, and whose inputs are dependent on judgment" (1999). The use of models is thus problematic, because risk assessments do not typically differentiate the quality of data used to make assessments (Burgman, 2005, p. 3). The result is that risk assessments for low frequency risk events gain a greater sheen of reliability than the underlying assessment actually merits.

Risk Perception: The concept of risk perception is multifaceted. A dominant theme of research into risk perception is driven by the gap between lay and expert assessments of risk (Tierney, 1999). Risk is commonly perceived in two ways either "risk as feeling" or "risk as analysis" (Slovic and Peters, 2006). Of interest in this paper is "risk as feeling," which Slovic and Peters define as "our instinctive and intuitive reactions to danger" (2006). This corresponds with research on bounded rationality, which makes a distinction between two different modes of decision making or judgments (Slimak and Dietz, 2006). The theory of bounded rationality is an alternative to the totally rational model of human decision making advanced in economics. Bounded rationally stipulates that people are rational to the extent that is compatible with the access to information and the computational capacities that are actually possessed by people and the environment in which they exist (Simon,

1955). These two modes of thought are labeled system one and system two. Kahneman describes the two systems as follows (2003, 698):

> The operations of System 1 are typically fast, automatic, effortless, associative, implicit (not available to introspection), and often emotionally charged; they are also governed by habit and are therefore difficult to control or modify. The operations of System 2 are slower, serial, effortful, more likely to be consciously monitored and deliberately controlled; they are also relatively flexible and potentially rule governed.

Surveys of risk perception are likely to trigger a System 1 response (Slimak and Dietz, 2006). Researchers have proposed multiple theories to explain this form of risk perception (Sjoberg, 2000).

One approach derived from psychology is the psychometric model or paradigm. Fischhoff et al. made the first attempt to quantify public risk perception through the use of a psychometric questionnaire (1978). They found that proposed characteristics of risk that influence risk perception could be collapsed into two major axes. These were new-old technology and certainty of death (Fischhoff et al., 1978). Subsequent work has found other major factors in risk perception including many exposed and Unnatural and Immoral risk (Sjoberg, 2000). Another major theory of risk perception is cultural theory, which comes from an Anthropological perspective. Douglas first proposed it in her book *Risk and Culture* (Douglas and Wildavsky, 1982). Proponents of this theory argue that risks are either highlighted or ignored based on cultural biases (Dake and Wildavsky, 1990). These biases are rooted in worldviews based on "ways of life," which are the foundation of human interpersonal relations. Cultural theory finds four major "ways of life": egalitarians, fatalists, hierarchists and individualists (Sjoberg, 2000). The cultural theory of risk was operationalized by Dake and Wildavsky (1990) with scales that attempt to measure these ways of life and correlate them with risk perception.

In a review of these theories, Sjoberg finds that the conventional models have low explanatory values (2000). The problem with most approaches is that the theory seeks to explain differences in how risks are perceived rather than differences in how individuals perceive risks (Slimak and Dietz, 2006). The Values-Beliefs-Norms (VBN) theory as explained by Stern (2000) is a general theory of environmental concern that can be applied to risk perceptions (Slimak and Dietz, 2006).

Another aspect of risk perception is the context of that risk. Specifically, the target of a given risk changes the amount of risk that people perceive (Hermand et al., 2003). Sjoberg claims (2000, 3):

> "The risk target is of paramount importance in risk studies. This fairly simple fact seems not to be generally known and many studies still work with non- specified risk targets. This means that they probably miss out on the need to understand perceived personal risk, and it introduces some uncertainty as to what target they actually do study."

Additionally, researchers have found that respondents generally perceive less risk for themselves than they do for broader targets in a phenomenon known as "unrealistic optimism" (Hermand, 2003; Klein and Weinstein, 1997; Sjoberg, 2000).

Tierney calls for a sociological critique of risk research (1999). She problematizes the denotation of risk assessment as an unbiased and objective field and instead illustrates the way that risk is a social construct (1999). Typically research into risk perception is used as a way to understand behavior, but Tierney proposes looking at risk perception as a dependent variable to understand where ideas on risk come from in the first place (1999).

Risk Perception and Wildfire: Increasing frequency of fire events and growing populations living in fire-prone area increases the importance of understanding how residents conceptualize fire risk. This has led to a greater focus on the social dimension of fire risk (McCaffrey, 2008). McCaffrey notes that the literature on natural hazards focuses on human-hazard interaction, which can be a useful lens of analysis for research on the interactions between humans and wildfire (2004).

Surprisingly, few studies have examined wildfire as a natural hazard with respect to public considerations (McCaffrey, 2004).

One important variable for consideration in risk perception is exposure to wildfire. It may seem reasonable that exposure to a hazard would increase an individual's perception of risk and mitigation activities. However, research finds inconsistent support for a positive relationship between exposure and risk perception (Arvai, 2006; McCafferty, 2004; McGee, 2009; Martin, 2009). In a survey of residents who had experienced a wildfire, Arvai et al. found two major types of response to the hazard event either, a "wake-up call" where perception of risk was increased, or a "letdown" where perception of risk decreases (2006). Arvai et al. also describes how wildfire affected the perception of risk they found that residents in areas nearby, but unexposed to fire, felt an increased risk. The directly exposed residents actually felt that they had already had their "bad luck" and were at a lower risk of wildfire.

Trust also plays an important role in the public's perception of risk (Slovic, 1999; Vaske, 2004). Siegrist and Cvetkovich define social trust as "the willingness to rely on those who have the responsibility for making decisions and taking actions related to the management of technology, the environment, medicine, or other realms of public health and safety" (2000). Social trust serves to mediate the attitude that residents have towards management activities (Vaske, Absher, and Bright, 2007). If residents believe that authorities are properly handling a risk they show less concern (Fessenden-Raden, Fitchen, and Heath, 1987). The relationship between trust in agencies and risk perception in the context of wildfire has not been directly addressed in the literature.

A final consideration is the effect of proximity to a hazard on a resident's risk perception. The literature on proximity and risk perception has divergent findings with some finding lower risk perception for residents closer to a given hazard, while others find higher risk perception at closer proximities (Maderthaner, 1978; Gregg, 2004; Peacock, 2004). There has not been much research about this relationship in

the case of wildfire risk perception. This paper will examine that connection to help fill the existing gap.

Theory of Human Values: People have been found to have a set of core values or worldview. It is these core values, which shape much of people's behavior and attitudes, and so has been a large topic in psychology and increasingly used in other social science fields. Schwartz and Bilsky made an attempt to synthesize much of the research in the field to devise a universal model of human values (1987). Schwartz and Bilsky define value as "concepts or beliefs, about desirable end states or behaviors, that transcend specific situations, guide selection or evaluation of behavior and events, and are ordered by relative importance" (1987). Since values are considered to have a goal orientation, they devise seven broad motivations that fuel the values people have. They are: enjoyment, security, achievement, self-direction, pro-social, conformity, social power and maturity. Schwartz and Bilsky then constructed a series of scales positioning motivations as opposite poles (1986). These scales are: self-direction versus conformity, achievement versus security, achievement versus prosocial, and enjoyment versus prosocial. Schwartz conducted cross-cultural surveys based on this theoretical construct to validate it, and found broad agreement for the general structure across the 20 nations surveyed including non-western countries such as Brazil, Zimbabwe, China, Estonia and Japan (1992).

Environmental Values and Attitudes: Building off the work of Schwartz, some scholars began to apply Value Theory to environmental topics. This began with Dunlap and Van Liere's proposal for the New Environmental Paradigm (NEP). In 1970, Dunlap studied the burgeoning environmental movement through the lens of a political sociologist. His first studies looked at the views of eco-activists in comparison to the Oregon student body. The results he found showed a "major new domain in which partisan and, in particular, ideological cleavages were apparent" (Dunlap, 2008). After further research he theorized that a new paradigm was emerging in the western world, which was challenging the Dominant Social Paradigm (DSP). He called this paradigm the New Environmental Paradigm (NEP).

Schultz, another scholar, looked at what value clusters (scales) relate to environmental attitude, with attitudes being defined as beliefs adapted from core values (Schultz and Zelezny, 1999). They then utilized Schwartz's value typology, which is broken down into four categories: Self-transcendence, Self-enhancement, Openness and Tradition. With this model they tested to see how values relate to attitudes in the NEP scale and the ecocentric-anthropocentic scale (Schultz and Zelezny, 1999). They found that self-transcendence and openness value clusters predicted more ecocentric attitudes while self-enhancement and tradition predicted more anthropocentric attitudes (Schultz and Zelezny, 1999). While this result may not be all that surprising, it is important to show that there is clear relation between values and attitudes.

Pro-environmental attitudes or beliefs are derived from core values to form environmental world-views or paradigms. One example already mentioned is the NEP. Not all pro-environmental attitudes come from the same value clusters; instead Schultz finds that there are three sources of concern for threats to the environment (2001). These are concern for self, concern for people in general, and concern for nature. These different values can sometimes fuel alliances between groups that have divergent world-views. A topical example is the protests surrounding the XL-Pipeline. It brought together property rights and farmer groups in Nebraska with environmentalists; these groups successfully delayed and possibly killed the pipeline (Mohammed and Gardner, 2011). Another example of alternative motives for pro-environmental behavior comes from (Theodori, Luloff, and Willits, 1998). They find that outdoors recreation increases environmental behavior for all activities including fishing, hunting and riding off-road vehicles.

To help understand some of the mediating variables between beliefs and behavior, Stern proposed two important ideas. The first concept is Environmentally Significant Behavior (ESB), which is the behavior that directly or indirectly impacts ecosystems and the biosphere in positive ways. He notes that some scholars utilize an intent-based definition but he uses the impact-based definition (2000). The second part is proposing the Value-Belief-Norm theory, which links value theory,

norm-activation theory, and the New Environmental Paradigm (NEP) to predict behavior (Stern, 2000). The model forms a causal chain starting with pro environmental values leading to an ecological worldview (with NEP as an example). The NEP informs, "Beliefs that environmental conditions threaten things the individual values and that the individual can act to reduce the threat (Stern, 2000)." These beliefs underlie an individual's personal norms and when their norms are violated that leads to ESB.

Research expectations

Given the literature review above, the study will examine public perceptions of risk associated with wildfire at five different geographic scales (targets). It will control for proximity to a wildland area, previous wildfire exposure, management approval, length of residency and environmental values. The study developed the indicators based on a Bogardus Social Distance format, with wildfire risk target instead of social acceptance of groups.

Methods

Study Area: The study area for the survey was located in central Oregon in an area covering all the land from the northern border of the Warm Springs Reservation to the southern border of the state and an area between the crest of the Cascade Range to the west and the edge of the sagebrush steppe to the east (see Fig. 1). This ecologically diverse region could be viewed as a 50- to 100-km wide

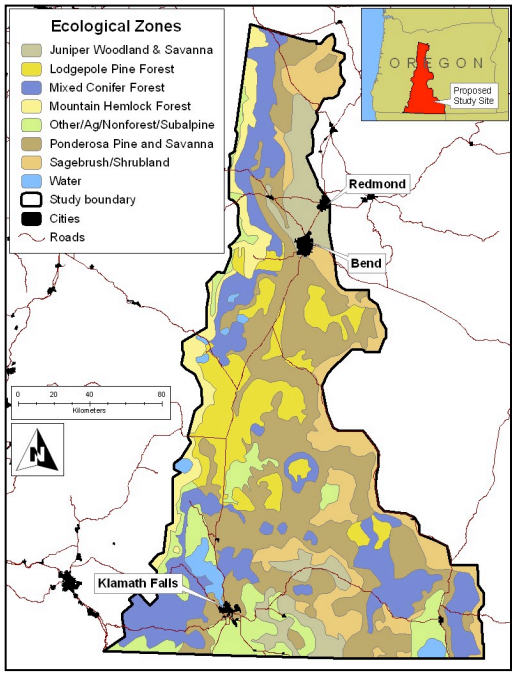

Figure 1. Map of study area with ecological zones

ecotone running from cold, wet subalpine forest types to very dry shrub-steppe (annual precipitation runs from >2000 mm to < 300 mm) (National Science Foundation Proposal 1013296). The sample population was drawn from a simple random sample of six Oregon counties, Crook, Deschutes, Jefferson, Klamath, Lake, and Wasco. These counties included the population centers of Bend, Klamath Falls, Redmond and Lakeview. Given its ecological and social diversity and recent history, central Oregon is one of the best places in the U.S. to study fire-prone landscapes (National Science Foundation Proposal 1013296).

Data Collection: Data were collected using a mail survey sent to a regionally representative random sample of 1506 residents within the survey area. The names and addresses for the survey sample were provided by a commercial research company. The survey was administered between March and May 2011 using a modified version of the Dillman (2007) design method. First, a preliminary postcard was sent to the selected respondents alerting them that a survey would be arriving in the upcoming weeks. Second, the survey was sent along with a cover letter explaining the research and a prepaid return envelope. Finally, a second survey, reminder cover letter and a prepaid postage return envelope were sent to those who had yet to respond. Of the initial 1506 surveys that were sent out, 720 completed surveys were returned by respondents and 92 were returned by the post office as bad addresses resulting in a 51% response rate.

Survey Design and Model Variables: The survey instrument was seven pages long and contained three sections. The first section was concerned with respondents' interests in, activities and knowledge of wildfire issues in Central Oregon. This included questions about risk perception, exposure to wildfire, the contributing causes of wildfire and thirteen questions about specific Firewise behaviors. The questions on risk perception were turned into a scale derived from Bougardus Social Distance Scale (Bougardus, 1933). The thirteen questions on Firewise behaviors were taken from a similar survey by Kyle, Theodori, Absher, and Jun (2010) that looked at the relationship between home and community attachment and Firewise behaviors.

The second section concerned respondent's attitudes towards the environment and contained a modified version of the shortened six-item New Ecological Paradigm (NEP) Scale that was created yet never published by Dunlap in 1982 (Dunlap, Van Liere, Mertig, and Jones, 2000). Similar to the original six-item scale, the modified version contained two questions from each of the three facets of the original scale: balance of nature, limits to growth, and anti- anthropocentrism. Three of the questions were worded biocentrically and three were worded anthropocentrically to maintain the balance of the original scale. These six items were put into an index that was used to measure value orientations. There were also two questions about climate change that were taken from a nationwide survey administered by the Pew Research Center for the People and the Press (2009).

The paper utilizes five models of risk perception with a decreasing scale from the regional level of fire risk down to household fire risk. The models contain the same independent variables, while the dependent variable changes. The dependent variable, risk perception, was operationalized through Q-5, which ask respondents to "indicate the level of risk you perceive for future fires in Central Oregon." It then offers responses on a four point Likert scale, which begins with no risk and increases through low, moderate and finally high risk. For exposure the survey asks over the previous five years their level of exposure at the same five scales as risk perception. It contains a Likert scale that starts with no exposure, one to two days of exposure, three to five days of exposure and six or more days of exposure. The only exposure question utilized in the models is home exposure. This allows for simpler analysis. Additionally, the home exposure variable was converted to a dummy due to the small number of cases that responded with high or moderate exposure. Agency approval was operationalized using Q-3 of the survey. It asks "Do you feel wildfire management is a problem in central Oregon" and offers three response choices: Yes, it is a problem, No, not a problem or Don't know. The question was converted to a dummy variable with the don't know responses recoded as missing data. Hazard proximity was operationalized using Q-24. It asks, "How close is your residence to a wildland area (either forest or rangeland)," and it contains six

responses: live within a wildland area, adjacent to a wildland area, between 100 and 300 yards, more than 300 yards but less than a mile, between 1 and 3 miles and more than 3 miles.

Analysis: This paper utilized the Stata 10 se statistical software package. To create the risk models this paper utilized Ordinal Logistic Regression. This form of regression is useful for categorical or ordinal dependent variables (O'Connell, 2006). The regression makes some unique assumptions primarily on the proportional or parallel odds assumption (O'Connell, 2006). This assumption is violated when the independent variables do not behave the same way across all the regressions of the dependent variable (O'Connell, 2006). A common test for violation of this assumption is the Brant test (Long and Freese, 2006, p. 199). This test, however, is frequently violated and results can be confirmed using alternative models such as stereotype logistic regression (Long and Freese, 2006, p. 277). Violating the Brant test leaves one unable to utilize odds ratios in interpreting the regression.

Results

This table shows the percent distribution of responses for the five risk perception targets. Region and county risk perception had a higher proportion of people choose high and moderate risk. Community risk perception had the most responses in low risk and moderate risk. For neighborhood and home risk most people choose low to no risk. Overall, there is a general trend of higher risk perceived at broader geographic scales and lower risk perceived at more local scales.

Table 1. Dependent variables

	Region risk *Percent (n)*	County risk *Percent (n)*	Community risk *Percent (n)*	Neighborhood risk *Percent (n)*	Home and property risk *Percent (n)*
No risk	4.58 (32)	4.30 (30)	16.88 (118)	32.66 (228)	38.77 (271)
Low risk	14.88 (72)	12.91 (90)	41.06 (287)	36.1 (252)	33.19 (232)
Moderate risk	41.20 (288)	43.90 (306)	24.61 (172)	17.34 (121)	16.02 (112)
High risk	43.92 (307)	38.88 (271)	17.45 (122)	13.9 (97)	12.02 (84)

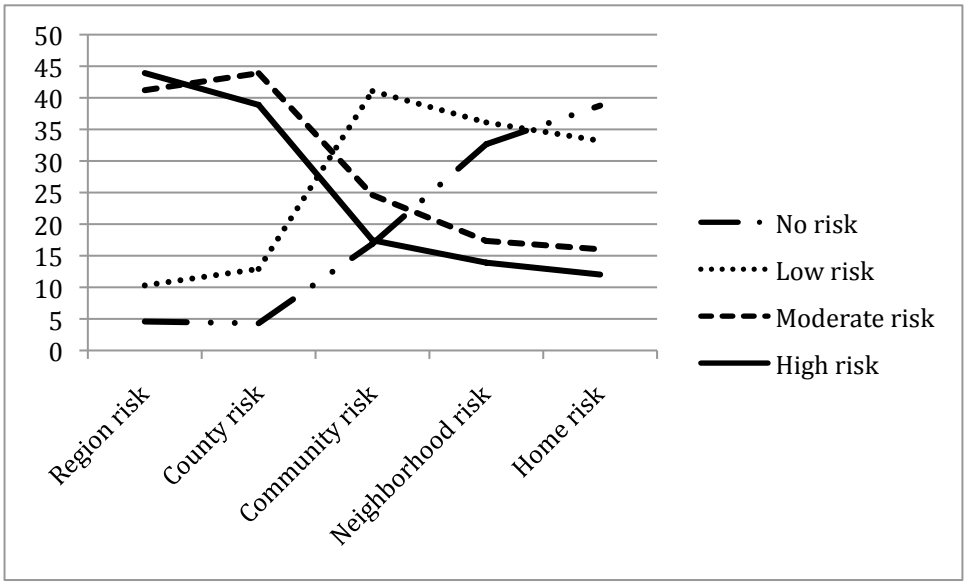

Figure 2. This shows the percent distribution of risk responses for the five risk scales.

The table below shows the means and confidence interval for each risk target. It demonstrates the same general trend as Table 1. The means for region and county risk are not significantly different, but they are both significantly different from community, neighborhood and home risk. Community risk is significantly different from region, county, neighborhood and home risk. Neighborhood and home risk are not significantly different from each other, but are significantly different from region, county and community risk. To test the first hypothesis we find significant differences between multiple risk targets, but not all of them. This lends partial support to rejecting the null hypothesis.

Table 2. Mean and 95 percent confidence intervals for five risk targets.

	Mean (SE)	Confidence Interval	
Region risk	3.24 (.031)	3.18	3.31
County risk	3.17 (.031)	3.11	3.23
Community risk	2.43 (.037)	2.35	2.5
Neighborhood risk	2.12 (.039)	2.04	2.2
Home or property risk	2.01 (.039)	1.93	2.08

Descriptive statistics for the independent variables are reported in Table 3. For the Management Approval variable, the mean of the responses is much closer to 1 than 0 and can also be represented as a percent (83.5). This shows that a large majority of the respondents believe that wildfire management in central Oregon is a problem. The mean of the Proximity wildland variable (4.26) represents a population that lies outside or just within the WUI. Home exposure, another dummy variable, has a mean of .198 showing that only 20 percent of respondents reported fire exposure. Resident central Oregon is a continuous variable with a high amount

of deviation. The average length of residency in central Oregon (24.2 years) corresponds with population trends in the area. The city of Bend and surrounding areas has grown with a large number of new residents, while the rest of the region contains life long residents. The NEP index shows a slight ecocentric majority for the respondents.

Table 3. Independent variables

Variable name	Variable description	Mean (SD)
Management approval	Dummy variable for wildfire management problem in central Oregon 1 = yes it is a problem 0 = not a problem	.835 (.371) n=594
Proximity wildland	Proximity of residence to a wildland area (forest or rangeland) 1 = within a wildland area, 2 = adjacent to a wildland area, 3 = between 100 and 300 yards, 4 = more than 300 yards but less than a mile, 5 = between 1 and 3 miles and 6 = more than 3 miles.	4.26 (1.64) n=706
Home exposure	Dummy variable for exposure of wildfire to residence or property over last five years 1 = fire exposure 0 = no exposure	.198 (.399) n=681
Resident central Oregon	How long the respondent has lived in central Oregon [Range: 1 to 84 years]	24.2 (18.7) n=717
NEP index	New Environmental Paradigm Index. 6 = Anthropocentric worldview 30 = Ecocentric worldview	20.9 (5.82) n=704

All models were checked against a stereotype logistic regression, which relaxes the proportional odds assumption. Most independent variables retained the level of significance from the OLR models. In the case of deviation between the stereotype and ordinal regressions, the lower level of significance was chosen. The log odds coefficient can be interpreted to mean an increase in x leads to a higher or lower (depending on the sign) probability of falling into a higher ordinal category.

Proximity to a wildland area was the only variable that was significant across all five models, however the level of significance decreased at larger risk targets. The log odds can be interpreted, as an increase in distance from wildlands will lower the likelihood of falling into a higher risk response category. This result allows us to test the second hypothesis and the data provide support to reject the null hypothesis in favor of the alternative. For management approval, responding yes (management is a problem) increases the likelihood of falling into a higher risk response category. For home exposure, responding yes (x=1) increases the likelihood of falling into a higher risk response category. For residency in central Oregon, increasing amount of years residing in central Oregon decreases the likelihood of falling into a higher risk response category. For the NEP index an increase towards a more ecocentric worldview increases the likelihood of falling into a higher response category.

Creating the five geographic scales of risk allows for an examination of saliency of the independent variables for different risk targets and their relative contribution to overall risk perception at the different levels. Risk targets can be thought of as contextual variables. Management approval was found to significantly effect residents' risk perception at the neighborhood, county and region level (see Table 4). While home exposure was found to be significant at the local level, it had a decreasing influence at larger levels. The same general pattern can be seen in wildland proximity (see Table 4). This implies that at more concrete targets like home or neighborhood the resident draws from personal experience to inform risk perception. At more abstract targets such as county and region their own experience is less important and residents look to experts to make their assessments.

Table 4. Ordinal Logistic Regression estimates for five risk perception models.

	Log odds home risk (SE)	Log odds neighborhood risk (SE)	Log odds community risk (SE)	Log odds county risk (SE)	Log odds region risk (SE)
Management approval	.195 (.219)	.497* (.222)	.389 (.215)	.576* (.222)	0.896*** (.23)
Proximity wildland	-0.539*** (.055)	-0.666*** (.058)	-0.423*** (.054)	-0.171* (.053)	-.143 * (.053)
Home exposure	1.64*** (.21)	1.62*** (.217)	1.38*** (.21)	0.381 (.211)	.296 (.222)
Resident central oregon	-.013** (.005)	-.003 (.005)	.002 (.004)	-0.007 (.005)	-0.004 (.005)
NEP index	.019 (.014)	.026 (.014)	.016 (.014)	-.008 (.014)	.016 (.014)
Log likelihood	-593.87	-585.79	-638.07	-565.34	-544.35
Pseudo R^2	0.148	0.175	0.098	0.024	0.027
N	538	537	539	540	538

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$;

For the home risk model, the residency variable violated the proportional odds assumption. To examine how this variable behaves over the four response categories, the paper utilized the prgen (generate probability) command. This command generates a set of fitted probabilities for the variable of interest for each possible response value of the dependent variable. It found that the probability of choosing the no risk response rose as the length of residency increased. The low risk response does not show a significant trend. The medium and high risk responses showed the same general trend; the probability of choosing these categories decrease over length of residency.

Figure 3. Starting from left to right, the probability of selecting a home risk category of no, low, moderate or high risk over number of years living in central oregon with upper and lower bound confidence intervals.

Discussion

Risk target and risk perception: The risk targets permit the testing of the "unrealistic optimism" theory. This theory, referenced in the literature, asserts that people tend to perceive less personal risk for a given hazard than they perceive risk for broader targets like country or world (Hermand et al., 2003). Another way of thinking about unrealistic optimism is the idea "it couldn't happen to me." The results show strong support for "unrealistic optimism" with respondents perceiving significantly higher risk for the central Oregon region in comparison with home and property risk (see Table 2). Additionally, the risk targets formed three clusters with region and county risk together, community risk alone and neighborhood and home risk together. This suggests that respondents are making mental breaks between

these targets.

Management Approval: The management approval variable was significantly positive for risk perception. Previous research has not looked into the exact relationship between management approval and risk perception. Instead, the literature has found a connection between trust and approval for management activities (Vaske et al., 2007). Trust in this case is specifically referring back to the definition provided by Siegrist and Cvetkovich "the willingness to rely on those who have the responsibility for making decisions"(2000). So, in this case trust more simply means, "trust in competency." This study also makes an extension from trust, which was not measured, to management approval and then to risk perception.

Proximity: Proximity proved to be an extremely important variable for resident's risk perception. The literature on proximity and risk perception has divergent findings with some finding lower risk perception for residents closer to a given hazard, while others find higher risk perception at closer proximities (Gregg, 2004; Maderthaner, 1978; Peacock, 2004). For this study there was a very clear positive relationship between increasing proximity to a wildland area and the likelihood of higher risk responses. There are a few possibilities for the disagreement with Maderhaner, Guttmann, Swaton, and Otway most notably the difference in character of hazards (1979). In Maderhaner et al.'s study they were examining technological hazards such as nuclear reactors or prisons. This study was looking at a natural hazard, wildfire (McCaffrey, 2004). Maderhaner proposed that greater familiarity with the surveyed hazards could reduce the amount of risk perceived. In both natural hazard studies (Gregg, 2004; Peacock, 2004), closer proximity to a given hazard increased risk perception. This reflects the results of this study and suggests that proximity may influence perception differently based on the type of hazard.

Hazard Exposure: Exposure to a fire event is another variable with an unclear relationship to risk perception. This study found that home exposure exerts a strongly significant *($p < .001$*, see table 4) positive effect on risk perception. There

are some possibilities to help explain this result. The first is time span, the survey instrument only inquired on fire exposure over the previous five years. Another possibility is that having any direct threat to one's home can break through the unrealistic optimism that a specific risk event will not happen to them. Also, this more significant result could be due to the nature of the survey. Arvai et al., for instance, drew results from workshops that contained less than 100 residents from only two communities (2006). On the other hand, this survey sampled from a broad geographic area with varying experience with fire and had a larger number of cases.

The original intent for analysis was to include the exposure variable that corresponded to the risk perception target in a given model. For instance, region fire exposure would be used as an independent variable when region risk perception was the dependent variable. This, however, proved to complicate analysis and so only one exposure response, home or property exposure was used as a variable. Additionally, the home exposure variable contained a limited number of 3-5 day and 6 or more days responses. This creates a "rare event" problem in logistic analysis. Having a small number of responses for certain option in the variable results in an underestimation of the probability of these options (King and Zeng, 2001). To correct for this problem the exposure variable was converted to a dummy and any affirmative exposure responses were collapsed into one category.

Other Variables: The new environmental paradigm scale did not show any significant effect on any of the risk models. Like other variables used in this study, there are mixed results concerning the relationship of the NEP and risk (Slimak, 2006; Sjoberg, 2000). In the specific case of wildfire, there is no clear environmental problem. It is a natural part of many ecosystems. The Slimak study, which found NEP to exert a significant influence on risk perception, focused on risk associated with environmental problems (acid rain, pesticides, global warming). Perhaps the nature of the risk could act as contextual variable like risk target and increase the saliency of NEP to risk perception.

The length of residence in central Oregon was only significant for home risk.

For the home risk model, the length of residence exerts only a weak effect. An interesting result for residency was the longer people have stayed, the less risk they perceived.

Along with the listed independent variables, a few socio-economic status questions were run in the models. These were education status, gender and age. They were not significant in the models and worsened the overall fit of the models. They were not included in the final analysis as a result.

Policy Implications

The findings of this study have a number of implications for policy. Broadly, this study offers insight into the way that people understand fire risk. The most pertinent finding for land managers is to reinforce the connections between agency approval, trust and risk perception. Residents are unlikely to accept risk information from agencies that they don't trust (Fessenden-Raden, 1987). The results extend the role of trust even further. People who don't approve of existing management are likely to perceive greater risk than those who feel that land managers are doing a good job. Also, the importance of home wildfire exposure to risk perception highlights the role of personal experience in residents' determination of risk. The lack of significance for the NEP in risk perception demonstrates that wildfire risk perception (at least currently) is not determined by cultural values. Wildfire risk perception does not represent a cultural cleavage like timber policy in the Northwestern U.S or climate change. This bodes well for outreach efforts, since

Conclusions and Future Research

This study sought to better understand the factors influencing resident's risk perception in the context of wildfire. Relatively little research has looked at this

specific topic. It tested a number of variables suggested in the literature. It found that proximity to a wildland area and home exposure were significant for more personal risk while management approval was significant at broader targets. It also confirmed the unrealistic optimism effect for wildfire risk perception. This study also utilized ordinal logistic regression in order to preserve more information in the data as compared with binary response variables.

There are some limitations to this study. The survey only covered one region, which makes the findings less robust than a larger study conducted across multiple fire-prone regions. There were a number of problems and assumptions that needed to be made for the analysis, since the survey instrument was not designed for this specific study. For the management approval variable this study made an assumption that perceiving a problem with wildfire management in central Oregon meant that respondents did not approve of current management and vice-versa for not perceiving a problem. Additionally, the exposure variable did not explain what constituted an exposure. Without an explicit definition, there are a number of possible interpretations for what home exposure means. Respondents could mean smoke from a nearby fire or fire that comes close enough to cause property damage.

There are a number of possible extensions to this paper. One is an expansion and clarification on agency trust. Another question is what types of information and media influence residents risk perception and the relative importance of information in comparison to other variables like proximity or management approval. Also, the role of risk perception in connection to risk mitigation behavior could be another area for future research. A final extension is utilizing spatial analysis to compare self-reported risk perception and fire exposure against state risk assessments and wildfire events.

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