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Determinants of residential Firewise behaviors in Central Oregon

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ABSTRACT

As a result of climate change and past management practices, wildfires are becoming larger and occurring more frequently than ever before in the Western U.S. In order to mitigate the effects of this growing threat, fire management agencies such as the U.S. Forest Service have encouraged residents in at-risk communities to protect their homes, property and communities by adopting Firewise recommendations. Using annual random sample household surveys conducted in fire-prone central Oregon from 2011 to 2013, this study examines the impact of wildfire events (i.e., wildfire exposure and evacuation), risk perception, wildfire plan informedness, proximity to wildlands, and various demographic factors on resident Firewise behavior participation. Findings indicate that residents who have experienced a wildfire event, who are familiar with their county's Community Wildfire Protection Plan, who perceive wildfire risk to their community, and who live in proximity or within a wildland area, were significantly more likely to engage in Firewise behaviors than those residents without these experiences, orientations or household locations.

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1. Introduction

Over the last several decades, a confluence of events has necessitated the creation of a coordinated and comprehensive strategy concerning wildfires. Years of complete fire suppression that allowed for the buildup of fuels combined with hotter and dryer conditions caused by climate change have led to growing concerns about the potential for more frequent and severe wildfires. At the same time, more people are migrating into wildfire-prone areas

where urban development meets public wildlands known as the wildland–urban interface (WUI). Often, these new residents have not been exposed to wildfires and will not understand the threats associated with living near a wildland area (Brenkert-Smith, Champ, & Flores, 2006). In contrast, some people who have lived in these fire-prone areas for an extended period of time have grown accustomed to being protected from wildfires by the government and may no longer perceive any personal responsibilities in regards to wildfire mitigation. The costs associated with fighting wildfires in the WUI have also increased substantially in recent years and are predicted to double or even quadruple by the year 2025 (Gude, Cookson, Greenwood, & Haggerty, 2009).

A potential solution to this problem is the Firewise Communities program developed by the National Fire

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Protection Association with the purpose of encouraging the public to take responsibility for protecting their homes and communities. This educational program “teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses” (Firewise Communities, 2011a, para. 3). This program has been successful in encouraging residents in hundreds of communities to think about and participate in a number of wildfire mitigation strategies designed to save lives and property (Firewise Communities, 2011b). However, many people are either unaware of the threats posed by wildfire or do not know that there are individual behaviors that can help to reduce the threats (Kyle, Theodori, Asher, & Jun, 2010). There are a number of reasons why a person may not participate in wildfire mitigation, or Firewise, behaviors, and a better understanding of those reasons could be valuable for natural resource managers and policy makers trying to increase public participation in these activities.

The purpose of this study was to look at the wildfire mitigation behaviors of Central Oregon residents and determine the influence that wildfire risk assessment, household proximity to forests, wildfire information source and reliance, and previous exposure to wildfire has on residents’ decisions to participate in those activities. This study uses three years of random household surveys in fire-prone central Oregon to examine the determinants of Firewise behaviors. We will first discuss the study area and recent wildfire history and then will provide a literature review of the Firewise program, followed by our research methods and analyses.

1.1. Wildfire in the West and Central Oregon

In the last several decades wildfires annually burn millions of acres of forests across the United States. For example, in 2014 there were 63,612 wildfires in the U.S. burning an estimated 3,595,613 acres (U.S. Forest Service, 2014). According to many scientists and natural resource managers these fires have been increasing in size and intensity (Tullis, 2013). Some of the reasons given for the increase in frequency and intensity of these uncontrolled fires include, but are not limited to, increasing drought conditions in some areas including climate change, the movement of people and homes into the “wildland–urban interface” (WUI) areas, and prior management decisions that preferred fire suppression over allowing historically fire prone ecosystems to burn naturally (Moritz et al., 2014).

The question of how to approach the management of these larger, more intense, and more frequent wildfires in the U.S. has been fraught with much controversy. With the increasing movement of humans and their new physical structures into wildland forest and grassland areas—especially in the Western U.S.—there is a need to protect and preserve homes and human inhabitants. At the same time, suppression of fire keeps fire-prone ecosystems at greater risk, leading Ken Pimlott, Director of the California Department of Forestry and Fire Protection to observe (Tullis, 2013, p. 29): “The movement of people into the WUI, the fires they start there and infrastructure that needs protection, plus drought, climate, suppression—you combine

Table 1
Recent number of wildland fires in Oregon and acres burned.

Year	Number of wildland fires	Acres burned
2013	2,848	350,786
2012	963	1,256,049
2011	1,151	285,712
2010	1,315	93,731

Source: U.S. Forest Service (2014) *National Report of Wildland Fires and Acres Burned*. https://www.nifc.gov/fireInfo/fireInfo_statistics.html.

all of these things, and its creating more intense fires. It just becomes a larger problem.”

In central Oregon, fire is an important and natural part of the ecosystem with many plant and animal species dependent on wildfire for increased habitat and seed dispersal (Project Wildfire, 2007). Currently central Oregon is experiencing a rapid population increase. For example, in 2014, Deschutes County gained roughly 4,000 new residents, making it “the seventh fastest-growing metro area in the country” (Moore, 2015) and creating more opportunity for life and property loss due to more people living in the WUI. In addition, many newer residents may be less aware of wildfire risk if they have not previously lived in the WUI or been previously exposed to wildfire further exacerbating risk to themselves and their community.

It is estimated that fighting wildfires in Oregon costs on average \$110 million a year (Climate Central, 2013). With climate change increasing the risk of wildfire, central Oregon is particularly susceptible (see Table 1). Aside from the direct costs of protecting homes, property and lives in the WUI, there is also an “increased exposure to dangerous levels of air pollution, even in communities hundreds of miles from the fires themselves” (Climate Central, 2013, p. 1). Therefore, getting people to engage in fire prevention in the WUI in central Oregon would potentially decrease cost and severity of wildfires and protect against damage to homes, lives, and public health.

1.2. Firewise Communities

The Firewise Communities program was developed by the National Fire Protection Association (NFPA) as a way to encourage homeowners, property planners and developers, community leaders, and firefighters to develop local solutions to the problems caused by wildfire. The program is managed by the NFPA under the direction of the National Wildfire Coordinating Group’s Wildland Urban Interface Working Team (WUIWT), which is comprised of state and federal agencies including the Forest Service, U.S. Department of the Interior, U.S. Fire Administration as well as several others. The goal of this program is to save lives and property by educating people about how to live with and adapt to wildfires. This is accomplished using a number of methods including Firewise Communities Workshops, public education and an interactive website. The workshops are a series of seminars carried about by professionals from various backgrounds to educate individuals about the different Firewise behaviors and how they can best be implemented in the local community. There is no universal plan for protecting communities from wildfire as each community has unique characteristics that require

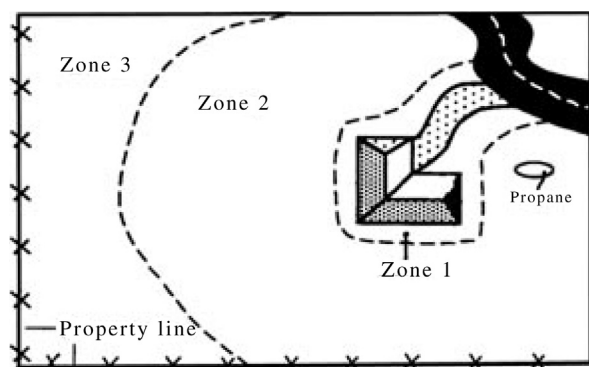


Fig. 1. Three defensible space zones around a house.

Source: U.S. Forest Service (2015) living with wildfire: homeowners' firewise guide for Arizona https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5339207.pdf.

individual attention. Each community develops its own protection plan in collaboration with community leaders, agency personnel and professionals and is responsible for implementing it. To date, more than 700 communities in 40 states have been recognized as Firewise Communities/USA sites (Firewise Communities, 2011a, 2011b).

1.3. Firewise behaviors

In addition to participating in community efforts to protect their homes, the Firewise Communities program encourages homeowners to participate in a number of individual behaviors that are also designed to protect homes from wildfires. The primary behaviors focus on landscaping and construction with emergency and evacuation planning recommended for worst-case scenarios. Firewise landscape designs stress fuel reduction in the area immediately surrounding the home. The ultimate goal for any Firewise landscaping project is creating a defensible space. Defensible space is defined as “the area around a building that has been significantly modified to reduce a wildfire’s intensity just enough to prevent the fire from igniting the house. It can also help prevent a house fire from spreading to surrounding vegetation” (Slack, 2000, p. 12). Within a 200-foot perimeter of the home called the home ignition zone are three separate zones (Fig. 1), each with its own specific recommendations for reducing or eliminating ignition hazards. The zones nearest the home require the most landscaping and maintenance. Recommendations include thinning and spacing bushes and trees, removing dead leaves, needles and branches, using rock and brick near the home’s foundation rather than mulch, creating fuel breaks such as driveways or paths, as well as many others.

When constructing or renovating a home using Firewise techniques, homeowners are encouraged to plan their construction in consideration of the home’s immediate surroundings. Homes that are exposed to more fuels and combustible materials are going to be more vulnerable to wildfires and will have a greater need for nonflammable and fire resistant building materials. The most important places to use fire resistant materials are on the roof, exterior

walls, and attachments such as decks and porches (Slack, 2000). The Firewise Communities program offers guides and videos instructing homeowners about which materials, plants, and landscape designs will make their homes safest from wildfires.

1.4. Wildfire mitigation decisions

Many residents in wildfire vulnerable areas are both aware of their general risk of wildfire and engage in some mitigation activities around their home and property (Brenkert-Smith et al., 2006; Kyle et al., 2010; Ryan, 2010). However, despite the risks posed by wildfires, some homeowners do not participate fully in Firewise behaviors or any other recommended wildfire mitigation behaviors (Brenkert-Smith et al., 2006) to the extent necessary to protect their homes and land. Generally, mitigation activities are most common when implementation incurs low cost and/or is associated with routine home and property maintenance (e.g. raking, clearing brush and weeds, mowing, cleaning gutters, etc.) (Brenkert-Smith et al., 2006; Brenkert-Smith, Champ, & Flores, 2011).

However, as more people from urban areas move into rural areas known as the wildland–urban interface (WUI) wildfire mitigation activities are increasingly important in the protection of personal property and homes. The WUI is the area of transition between urban development and undeveloped wildlands (Theobald & Romme, 2007). It is also the area where wildfires are most likely to threaten homes and where protecting structures is the most difficult (Radeloff et al., 2005). The WUI grew rapidly between 1952 and 1997 and is expected to grow by an additional 3.1%–8.1% by 2050 (Nowak & Walton, 2005) with much of the expansion taking place in the intermountain west (Theobald & Romme, 2007). However, the WUI is not a continuous stretch of land, but rather pockets of residential areas on the borders of wilderness areas. Thus addressing the mitigation needs of homeowners in the WUI is not a one-size-fits-all approach, but instead requires a deeper understanding of the barriers to action.

As more people choose to live in the WUI, individual wildfire mitigation efforts will become an increasingly important and necessary component of wildfire management. In order to develop effective wildfire mitigation policies, it is necessary to understand the reasons why homeowners decide whether or not to participate in these behaviors independently. Brenkert-Smith et al. (2006) asked residents of five Colorado WUI communities what they thought the most important issues were regarding wildfire, wildfire risk, and wildfire mitigation.

They found that the decision-making process was complex and involved several considerations including social context, perceptions of the environment and perceptions of risk reduction options. At the social level, some residents would make decisions based on community expectations. The community would have a particular focus and that discourse would be reflected in the individuals’ actions. Others would make their decisions based on informal social interactions with their friends and neighbors and others would negotiate outcomes within the household. Another factor residents’ considered was the biophysical

environment surrounding their homes. A common sentiment was that the proximity of other private and public unmitigated lands would render any personal efforts fruitless in the face of a severe wildfire. Finally, respondents reported a variety of opinions about which mitigation strategy would be the most effective for their particular landscape. Some preferred to be proactive and focused on fuel treatments and fire resistant building materials while others thought emergency preparedness strategies would work best. Cost and time were often cited as reasons why one option was preferred over another, and low-cost and low-effort options were the most common behaviors carried out by respondents.

Other studies have attempted to determine support for mitigation practices by using a combination of underlying factors (Absher & Vaske, 2006, 2007; Absher, Vaske, & Shelby, 2009; Kneeshaw, Vaske, Bright, & Absher, 2004). Their results showed that a combination of influences including sociodemographics, situational variables and psychological variables affected support for a specific policy although not each variable had an equal effect. Sociodemographics generally had a weak relationship with mitigation behaviors while situation and psychological variables had strong relationships, particularly with actions related to defensible space.

Research has also been conducted on a number of specific influences and barriers to participation. Kyle et al. (2010) looked at the influence of home and community attachment on Firewise behavior. They found that people who had the strongest attachment to their homes were most likely to engage in activities around their homes and those with the strongest attachment to their communities were mostly likely to participate in community-based activities. These findings were consistent with other research showing that attachment to a place or object is likely to translate into a desire to protect that resource (Payton, Fulton, & Anderson, 2005; Theodori, 2004). Bright and Burtz (2006) looked at the differences between full-time and seasonal residents in the WUI and found that while both groups generally supported Firewise activities, the level of support was consistently higher among full-time residents. These findings reinforce the argument that wildfire mitigation policies will need to be multifaceted and allow for specific alterations depending on the individuals and their communities.

One area of research that has received considerable attention is the effect of risk perception on mitigation behaviors. The literature has found that risk perception generally contributes to mitigation behavior but it is usually not the primary reason why a person chooses to participate. Typically, risk perception along with a combination of factors including land use values, place attachment, expected efficacy of mitigation options, and several other components will contribute to the decision-making process (Champ, Donovan, & Barth, 2013; Cortner & Gale, 1990; Gordon, Matarrita-Cascante, Stedman, & Luloff, 2010; Lindell & Prater, 2000; Schulte & Miller, 2010). One of the common characteristics of WUI residents is the high value placed on nature, wildlife and privacy. These homeowners may understand the risks posed by wildfires near their homes but choose not to participate in

mitigation behaviors because of their environmental values and land use preferences (Absher et al., 2009; Bright & Burtz, 2006; Nelson, Monroe, & Johnson, 2005). Other studies have found that residents might lack accurate information and the knowledge about how to effectively perform certain mitigation behaviors (Bright & Burtz, 2006; Nelson, Monroe, Johnson, & Brower, 2004) or they underestimate how effective their efforts might be so they choose not to try (Kumagai, Bliss, Daniels, & Carroll, 2004; Lewis & Nickerson, 1989; Winter & Fried, 2000).

Finally, a recurring theme in the risk perception literature is the idea of a risk perception gap (Cohn, Williams, & Carroll, 2008). This is said to occur when a person demonstrates concern about their level of risk and an understanding of what they should do but chooses not to participate in mitigation behaviors anyway (Cortner & Gale, 1990; Mileti, Nathe, Gori, Green, & Lemersal, 2003; Nelson et al., 2005). One explanation for this is that perceptions of risk often do not match actual risk. People tend to overestimate risks that are small and rare and underestimate risks that are large and more likely to happen (Simmons & Kruse, 2000; Slovic, Fischhoff, & Lichtenstein, 1979; U.S. EPA Science Advisory Board, 1990). People who have never experienced a devastating wildfire are also likely to underestimate their level of risk (Bradshaw, 1987). In contrast, some studies have found that the most significant determinant for a person's risk perception and mitigation behavior is previous exposure to a wildfire (Tierney, Lindell, & Perry, 2001), more specifically if an individual has experienced a previous evacuation due to wildfire (Brenkert-Smith et al., 2011). Although conflicting studies have shown that some people believe that because a wildfire has recently occurred, it is unlikely that one will happen again (Cohn et al., 2008; McCaffrey 2004).

1.5. Hypotheses

Based on the literature review, this study will test the following hypotheses:

- H1: The higher the level of familiarity with the county's Community Wildfire Protection Plans (CWPP), the more likely respondents will engage in Firewise behaviors.
- H2: The higher the level of perceived risk of wildfire to respondents' own neighborhood, the more likely respondents will engage in Firewise behaviors.
- H3: Those respondents living in, or in close proximity to wildland areas will significantly in more Firewise activities than those living at greater distance from wildland areas.
- H4: Those respondents who have been exposed to wildfire and/or who have been evacuated due to wildfire threat, are more likely to engage in Firewise behaviors than those with no exposure.

2. Methods

As discussed previously, the study area for the survey was located in Central Oregon in an area covering the entire state from the northern border on the Columbia River to the southern border of California in an area between the

crest of the Cascade Range to the west and the edge of the sagebrush steppe to the east. The sample population was drawn from a simple random household sample of six Oregon counties, Crook, Deschutes, Jefferson, Klamath, Lake, and Wasco, each fall for 2011, 2012, and 2013. These counties included the population centers of Bend, Klamath Falls, Redmond and The Dalles. The study area was chosen because of its fire-prone history as well as its diverse ecological and social characteristics. Notably, Oregon had two significant fire years in 2012 and 2013. In 2012, although there were fewer overall fires in Oregon that season, the southeast part of the state experienced its largest fire since 1865 (the Long Draw Fire) and was, overall, the worst fire season in 100 years (Templeton, 2012). In 2013, Oregon wildfires burned more state and federal land since the 1930s, costing the state \$122 million on fire suppression (Associated Press, 2013). Thus, it would be expected that people surveyed at this time would have some knowledge of wildfire threats in particularly fire-prone areas.

Data were collected using a mailed survey sent to separate random samples of approximately 1,400 households in central Oregon during the fall and winter of 2011, 2012, and 2013 in order to attain sufficient numbers of residents who have been exposed to wildfire as previously discussed. The random household samples were provided by a commercial marketing research company that builds household lists using a variety of data sources including USPS address data bases, telephone directories, property ownership lists, driver license information, etc. A modified version of Dillman's *Tailored Design Method* (2007) was used in questionnaire format with multi-wave survey implementation. Each contacted household was issued the following request for participation: "If available, we would prefer the person, 18 years old or older, who most recently celebrated a birthday to complete the survey." Three waves of first class mailings of survey materials were distributed beginning with a postcard announcing the project. Each mailing contained a copy of the survey, a hand-signed letter encouraging participation in the study, and a business postage prepaid envelope. We received response rates ranging from 47.5% to 51% (see Table 2). Response rates are calculated following the American Association for Public Opinion Research guidelines (2011). The rate of response for each year is above or slightly close to 50%, which "... is considered adequate for analysis and reporting" (Groves, 2006, p. 647). And while participation rates match or slightly exceed voter participation rates for the 2012 statewide election, there is always the concern of response bias. Some suggest that response rate may or may not be related to non-response bias depending on the context and other complexities involved in survey implementation (Groves, 2006).

For this study we compare survey respondents for each year with 2010 U.S. Census data to determine demographic representativeness. According to Groves, "The strengths of this method are that estimates independent of the survey in question are compared" (e.g., demographic characteristics) (2006: 655). However, "... the weaknesses are that the key survey variables of the study do not usually exist in the external source" (e.g., specific Firewise questions) (2006: 655). After eliminating those under the age of 18 in the 2010

Census data because only potential respondents 18 years of age and older were allowed to participate in the survey, we find that survey respondents are slightly older for three survey years, more highly educated, and more likely to be male than the 2010 Census would suggest.

3. Analyses

3.1. Dependent variables

The surveys contained thirteen questions on Firewise behaviors, which were replicated from a study by Kyle et al. (2010) that looked at the relationship between home and community attachment and Firewise behaviors in southern California. The Firewise activities cover four broad categories of activities. The categories include general planning activities that residents would do in preparation of a wildfire; activities that residents would participate in with other members of the community; activities that residents would perform to protect their entire property; and finally activities that are meant to protect the residents' homes. The responses to each of the thirteen items were then coded with 1 = "participate annually" and 0 = "not participating" to construct an additive index of behavior for all 13 activities. Table 3 reports results for all four survey years, and the findings suggest that although there were differences in the number and size of fires over the study period, Firewise participation by respondents looks very similar from year to year.

The Firewise activity most participated in is not surprising—"clean roof surfaces/gutters and surrounding vegetation. . ." (79.8%–80.2% rates of participation). While this is a suggested Firewise activity, it is also an activity that many to most residents would do anyway as part of normal residence maintenance. The second most engaged in activity involves general planning using National Weather Service reports for recreational activities that involve fire (e.g., camping, fireworks). This activity would be salient whether a resident lives in the WUI or outside a regional city such as Bend, and over 60% of respondents each year indicated that they engaged in such an activity. Not surprisingly, the activities most engaged in by residents for each survey year were the three home protection and the four property protection activities. Over 40% of all respondents indicated that they had engaged in these seven behaviors over the three-year period.

The average number of the thirteen Firewise activities engaged in by respondents from year to year ranges from 5.58 in 2012 to 5.66 in 2011. There were no statistically significant differences between survey year for all activities regardless of the number and severity of wildfires in the region, therefore in the forthcoming multivariate analyses will be using a combined set of data.

3.2. Independent variables

As discussed above, participation in Firewise behaviors can be affected by various factors including, but not limited to, demographic factors, familiarity with the issue, risk perception, proximity to wildland areas, and exposure to previous events. We utilized a multivariate analysis

Table 2
 Survey response rates.

Survey year	2011	2012	2013
Sample size	1,414	1,406	1,401
Returned surveys	720	688	666
Response rate	50.9%	48.9%	47.5%
Regional participation rate for 2012 general elections ^a		47.8%	
2010 U.S. Census Data for study region ^b			
% Female 18 and older = 50.2%	46.1%	45.5%	45.1%
% College degree = 25.1%	37.2%	36.8%	36.0%
% Population 65+ years = 19.9%	23.9%	19.9%	25.2%

^a Oregon Secretary of State: <http://sos.oregon.gov/elections/Pages/electionhistory.aspx>.

^b U.S. Census Bureau: <http://quickfacts.census.gov/qfd/states/41000.html>.

Table 3
 Firewise behaviors by survey year.

We are interested in your personal participation in the following activities to mitigate wildfire risk. Please indicate if you have participated in any of these activities or not by circling the responses “yes” or “no.”

	Percentage participating			
	2011	2012	2013	Combined years
General planning				
Prepare an evacuation plan in case of wildfire	33.3%	36.5%	34.6%	34.7%
Plan recreational activities that involve fire (e.g., campfires, fireworks) around weather service reports	62.1%	66.0%	61.9%	63.5%
Community activities				
Attend community-based meetings related to wildfire	19.3%	20.0%	19.1%	19.5%
Obtain information from a land management, community group or firefighting agency on how to prepare for wildfire	40.7%	42.9%	41.8%	42.0%
Volunteer within the community to help clear and remove combustible material (e.g., brush, litter)	24.6%	24.5%	24.3%	24.6%
Help organize community education programs related to wildfire	9.1%	8.9%	8.0%	9.0%
Property protection activities				
Plant fire-resistant plants	46.8%	47.1%	46.0%	46.7%
Plant trees and shrubs at least 15 feet apart	47.6%	47.8%	46.8%	47.6%
Prune the branches of all trees within 85 feet of your house to a height of 10 feet above the ground	49.0%	49.6%	48.2%	49.1%
Reduce the density of trees within 100 feet of your home	41.4%	41.5%	41.0%	41.3%
Home protection activities				
Clean roof surfaces/gutters and surrounding vegetation to avoid accumulation of needles, leaves and dead plants	80.2%	79.9%	79.8%	79.9%
Stack firewood/lumber at least 30 feet from house	52.4%	52.7%	52.3%	52.5%
Use nonflammable building materials such as tile, slate, stone, etc.	49.9%	50.1%	48.7%	49.8%
N range				
Mean number of activities	696–705	666–675	643–654	2,666–2,701
s.d.	5.66	5.58	5.59	5.65
	3.54	3.51	3.52	3.53

that controlled for all of the possible determinants for the additive index of 13 Firewise behaviors (see Table 4). The demographic control variables included in the multivariate analyses are age, gender, formal educational attainment, and employment status (unfortunately household income was not included in the survey). We also include two additional control variables for their possible impact on Firewise behaviors, namely if their central Oregon home is seasonal/vacation home or a permanent residence, and if they rent or own their home. It may be the case that seasonal/vacation home owners spend less time in central Oregon and maybe less familiar with wildfire exposure or have less time to engage in Firewise behaviors. Similarly, renters may not have the resources or motivation to pro-

vide Firewise upgrades to potentially temporary housing when compared to owners who have financial commitment to the property.

Summary measures for each independent variable are provided in Table 4. For the combined years of survey data, the average respondent had “some college,” 46% are women, the average age is 54.10 years, and 44% of respondents are fully employed. Only 3% of respondents indicated that their home was a seasonal/vacation home, and 83% said they owned their homes.

The wildfire issue familiarity measure used asked respondents if they were familiar with the county’s Community Wildfire Protection Plan (all counties in the study area have CWPPs), with a scale of 1 = not informed to

Table 4
 Independent variables.

Variable name	Variable description	Mean (s.d.)
Age	Respondent age in years. [Range: 18–91 years]	54.10 (15.38) n = 2,045
Gender	Dummy variable for respondent gender. 1 = female, 0 = male	.46 n = 2,051
Education	Formal educational attainment. 1 = Grade School to 7 = Graduate School	4.91 (1.25) n = 2,054
Employ	Dummy variable for current employment situation? 1 = full employment, 0 = else	.44 n = 2,044
Seasonal	Dummy variable for seasonal/vacation home. 1 = seasonal/vacation home, 0 = permanent home	.03 n = 2,044
Owner	Dummy variable for own or rent residence. 1 = own home, 0 = rent home	.83 n = 2,041
Familiar	How familiar with county's Community Wildfire Protection Plan? 1 = not informed to 4 = very well informed	1.87 (.91) n = 2,062
Risk	Perception of risk of wildfire to neighborhood? 1 = no risk to 4 = high risk	2.11 (1.01) n = 2,008
Proximity	Proximity to wildland area (either forest or rangeland)? 1 = live within a wildland area to 6 = more than 3 miles away	4.26 (1.64) n = 2,034
Exposure	Exposure to wildfire event in your community? 1 = Yes to 0 = No	1.40 (.78) n = 1,966
Evacuate	Ever evacuated as a result of a wildfire? 1 = Yes, 0 = No	.05 n = 2,071

4 = very well informed. The mean score was 1.87, which can be interpreted as slightly below “somewhat informed” for the average respondent. For the perception of risk variable, we asked respondents “how much risk do you feel about a future wildfire...in your community.” Response categories ranged from 1 = no risk to 4 = high risk. The mean score for this question was 2.11, which can be interpreted as “low risk.” For proximity of residences to wildland areas, we asked respondents “how close is your residence to a wildland area (either forest or rangeland)?” Response categories ranged from 1 = live within a wildland area to 6 = more than 3 miles. The mean response to this question was 4.26, which is equivalent to “more than 300 yards but less than a mile.”

The final two independent variables included in the multivariate analyses concern previous experience with wildfire. We asked respondents about their “exposure to wildfires over the last five years...in your community?” The response categories provided ranged from 1 = no exposure to 4 = 6 days or more. We did not ask the nature of the exposure, for example if it was smoke or actual fire threatening their communities. The mean score for the combined samples was 1.40, which is between “no exposure” and “1 to 2 days.” We also asked respondents a follow up question if they “were ever evacuated as a result of wildfire?” We coded this variable as 1 = yes and 0 = no. We did not ask if it was a mandatory or voluntary evacuation. The results indicate that 5% responded that they had been evacuated because of wildfire in the last 5 years.

3.3. Multivariate analyses

For the final set of analyses conducted we use ordinary least squares (OLS) estimates to examine the impact of the independent variables on the additive Firewise index (see Table 5). F-test results indicate that the model is statistically significant, and the adjusted R² is .342, which

Table 5
 Regression estimates for Firewise behaviors.

Variable	Coefficient	(SE)
Age	-.015**	(.005)
Gender	-.055	(.143)
Education	.403***	(.058)
Employ	-.023	(.153)
Seasonal	-1.006**	(.203)
Own	.771***	(.379)
Familiar	1.103***	(.076)
Risk	.801***	(.082)
Proximity	-.296***	(.051)
Exposure	.994***	(.145)
Evacuate	.535	(.335)
F-test	85.553***	
Adjusted R ²	.342	
N	1,743	

* p ≤ .05.
 ** p ≤ .01.
 *** p ≤ .001.

means the model explains over a third of the variation in Firewise activity participation. While the R² for the model is somewhat low, this is typically the pattern when analyzing public opinion data (Lewis-Beck, 1990).

When examining the coefficients in the model, we find that only three variables were not found to be statistically significant—gender, employment, and experience of an evacuation. There were no statistically significant differences between males and females in terms of participation in Firewise activities. While gender did not produce significant results, the other two demographic control variables did. Younger and more highly educated respondents were significantly more likely to engage in more Firewise activities than older respondents and those with less formal education. The finding for the impact of formal education is not surprising since the more highly educated have been found to be significantly more likely to be informed on a variety scientific and natural resource issues, and are sig-

nificantly more likely to participate in community activities (e.g., Galston, 2004; Larson & Lach, 2008; Steel, 1996). As for younger respondents engaging in more Firewise activities when compared to older respondents, this finding is consistent with recent research by political scientists that find while political participation is significantly lower for younger cohorts when compared to older cohorts, younger cohorts are significantly more likely to engage in their communities in a whole host of activities (Dalton 2009; Galston, 2004). Many of the 13 Firewise activities included in the dependent variable involve general planning and community participation activities (e.g., “volunteer within the community to help clear and remove combustible material).

For the two variables assessing the nature of the household sent the survey—seasonal/vacation homes versus permanent homes and owned versus rentals—both variables were found to be statistically significant in the direction one might expect. Owners of seasonal/vacation homes were significantly less likely to engage in Firewise behaviors when compared to permanent homeowners. As suggested above, this could be the result of the amount of time spent at the residence leading to less familiarity with wildfire conditions and potentially less time to engage in such behaviors during potentially shorter times on site. In addition, owners were significantly more likely to engage in Firewise behaviors when compared to renters. Renters may not have the same incentive to engage in Firewise upgrades to a residence owned by someone else.

Additional results from the model indicated that familiarity with the County’s Wildfire Protection Plan (CWPP) had a positive effect on the number of Firewise activities a respondent engaged in. The more familiar a respondent was with the CWPP, the more likely they were to engage in higher numbers of Firewise activities. This is not surprising given the purpose of CWPPs at the county level. For example, the East and West Deschutes County’s CWPP states the CWPP ‘is intended to serve as a planning tool for fire and land managers and residents to assess risks associated with wildland fire and identify strategies and make recommendations for reducing those risks’ (East and West Deschutes County CWPP, 2012). These results suggest that for those respondents who are familiar with their CWPPs in central Oregon, it has had a positive impact on engagement with Firewise behaviors.

Additional variables that had an impact on Firewise behavior were risk perception and resident proximity to wildland areas. As hypothesized, higher levels of wildfire risk perception to one’s community was positively and significantly associated with higher levels of participation in Firewise activities. Similarly, and as hypothesized, the closer respondents’ residences were to wildland areas—either forest or rangeland—the more Firewise activities they report participating in. When the relationship between these two independent variables was examined as part of multicollinearity tests, the correlation (Kendall’s tau b) between the variables was $-.436$ ($p < .01$). We would expect these two variables to be correlated with those respondent living closer to wildland areas perceiving more risk, however the strength of this relationship is not as high as one may suspect. Of

course, other factors could also come into play as the risk perception literature suggests (e.g., biophysical characteristics of nearby wildlands, community context, respondent values, etc.).

The final variables of interest and a major focus of this study are wildfire exposure and evacuation due to wildfire. We expected those respondents who have been exposed to wildfire and/or who have been evacuated due to wildfire threat, to engage in a greater number of Firewise activities than those respondents with no exposure. As hypothesized, we find that the greater the duration of wildfire exposure, the more likely someone is to participate in Firewise activities. However, those respondents that were evacuated from their homes either voluntarily or involuntarily were not significantly different than those who have not had this experience. While the relationship between evacuation and Firewise activity participation was close to the .05 significance level, it still did not produce significant results. These results suggest that exposure (e.g. evacuation) itself is not enough to encourage higher levels of Firewise activities.

4. Discussion and policy implications

Over the past several decades the frequency of wildfires has increased significantly, with larger fires, a longer fire season, and an extended duration of forest fires themselves (Tompkins & DeConcini, 2014). It is important that “more than half of the U.S. Western states have experienced their largest wildfire on record since 2000” (Tompkins & DeConcini, 2014, p. 1) indicating a clear shift toward larger, stronger wildfires. For people living in or around the WUI, fire prevention is key to minimizing wildfire damage, protecting lives and health, and reducing the costs of fire fighting.

This study examined wildfire mitigation behaviors of central Oregon residents to determine how risk assessment, household proximity to forests, prior exposure to wildfires, and access to relevant wildfire information and resources impacted residents’ decisions to participate in mitigation activities. Based on our hypotheses, we anticipated that residents that have been exposed to wildfire (and/or evacuated), are familiar with their county’s Community Wildfire Protection Plans (CWPP), perceive a higher risk of wildfire in their communities, and those living in close proximity to wildland areas will engage more in Firewise activities. In general, each of these hypotheses proved accurate, with the exception that we did not find a significant relationship between prior evacuation due to a wildfire and participation in Firewise activities. This suggests that other factors play a role in mitigation activities, and that individuals may feel somewhat insulated from another wildfire since they had already experienced one (see Cohn et al., 2008; McCaffrey 2004).

The majority of the survey respondents lived less than a mile from wildland areas (but more than 300 yards), indicated that they had little direct exposure to wildfires, were only somewhat informed about the Community Wildfire Protection Plan, and felt there was generally low risk of future wildfire. When examining the Firewise behaviors of survey participants, we find participation is generally

less than 50% for all respondents (with the exception of planning recreational activities around weather, cleaning roof surfaces, and stacking firewood at least 30 feet from house). Since central Oregon has a history of wildfire, we would expect that residents would perceive a higher risk of future wildfire, and consequently take action to reduce risk. However, as prior research has shown that risk alone is not sufficient to encourage wildfire mitigation (McCaffrey, Toman, Stidham, & Shindler, 2012) and that “although it is important to continually communicate risk information, outreach efforts with too singular a focus on...risk as a means to engage the public are unlikely to be effective” (McCaffrey, 2008, p. 21). Thus, future research should explore the multifaceted aspects of participation in wildfire mitigation behaviors by examining factors like part-time versus full-time residency, amenity migration, and general awareness of wildfire potential in individual communities and specific households.

The results of this study indicate that there is a clear need for residents to participate more in wildfire mitigation. The expected increased intensity and frequency of wildfire in central Oregon necessitates participation by residents in the WUI to minimize damage to personal property and protection of lives. Those living in the WUI are often not as accessible by firefighters, have limited water access and have greater potential for wildfire and exposure to smoke. Thus, engaging residents in wildfire protection behaviors can help reduce the demand on firefighters, the costs involved in fighting fires in the WUI and minimize the size, scope and damage of wildfires.

Many survey respondents did not have much familiarity with their county's Community Wildfire Protection Plan. Prior research has found that “outreach activities can positively influence citizen understanding and support” of fire mitigation (Toman & Shindler, 2006, pp. 726–727). By utilizing both broad based education campaigns and focused opportunities to engage individually or as a community, individuals are likely to have greater acceptance of community wildfire plans (Toman & Shindler, 2006). Therefore, one potential way to encourage individuals to engage in Firewise behaviors is to build capacity for mitigation through directed and detailed information about wildfire protection plans in the WUI.

However, it may be necessary to go beyond simply providing general information about wildfire mitigation activities and instead focus on identifying the barriers to program participation and recognizing where the community is vulnerable to wildfire in order to create strategies that are unique to each community (Smith et al., 2016). Specifically, property evaluations have demonstrated a positive relationship to homeowners practicing mitigation activities. In a study by Champ et al. (2013) of a program in Colorado Springs “the fire department implemented a sophisticated program that involved rating every parcel in the wildland–urban interface area for wildfire risk” (839). Researchers found that individuals who accessed the parcel ratings website were more likely to perceive higher risk and also more likely to participate in mitigation activities. This suggests that “as individuals become better informed about the wildfire risk on their property, they simultaneously become better informed about the ‘how to’ of

mitigating wildfire risk” (Champ et al., 2013, p. 839). Thus, while education is necessary to inform people of risk and mitigation actions, it is not necessarily sufficient to encourage action. Instead, programs that focus more on providing property evaluations to individual homeowners may facilitate greater mitigation activities as people understand the exact risks to their homes and properties, and the actions necessary to protect their homes from wildfire (Brenkert-Smith et al., 2011).

In the broader context of public policy, programs like Firewise depend a great deal on capacity building, or providing information and guidance to residence to mitigate wildfire. Capacity building programs like Firewise assume that individuals will see the benefit to participation (Schneider & Ingram, 1990) and thus be incentivized to engage in fire mitigation strategies. Stidham, McCaffrey, Toman, and Shindler (2014) found that capacity building was one of the primary policy tools used in their research areas, but that other strategies like incentives (e.g. financial assistance) and in some cases persuasion tools (e.g. rules and laws) to encourage residents to participate. People with higher incomes are more likely to participate in reducing fuel loads on their property (Champ et al., 2013) possibly indicating a need for more incentives to help cover the cost of compliance. In some cases, persuasion may be effective, such as Oregon's Forestland–Urban Interface Fire Protection Act (SB360). This act requires homeowners in the WUI to take steps to reduce fuels around their property in order to reduce the dangers of wildfires and allows the state to collect up to \$100,000 of fire suppression costs from a landowner who does not comply with the certification program if a fire originates or spreads from their property. Each of these policy tools rests on behavioral assumptions, and as such will require analysis of how policies are enacted based on these assumptions and modified based on results (Schneider & Ingram, 1990). In this way, individual communities can be assessed for capacity, resiliency, and safety.

5. Conclusion

With more people building houses in the WUI, the costs of wildfire protection is significantly increasing for much of the West and draining the resources of existing state fire management. Programs like Firewise can aid in the reduction of fuels and provide some defensible space in the event of a wildfire, but alone may not be enough to suppress wildfires in the WUI. There are increasingly fewer options for mitigating wildfires in the WUI. Climate change effects (hotter summers, increased drought) combined with fire-prone regions means that the onus is on individuals and communities in the WUI to help moderate the impacts of wildfires. And, until there is greater participation in mitigation activities, overspent state budgets, overtaxed firefighters, and vulnerable communities will be the status quo. If current wildfire conditions continue the only real way to reduce wildfire danger is to minimize “changing where homes are developed in the future can reduce dangers, damages, and costs, including the amount of money agencies spend to defend homes from wildfire” (Headwaters Economics, 2015). While potentially

an unpopular option, minimizing fuels in the WUI for wild-fires could potentially reduce risk, cost, and human lives.

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