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Resident Evacuation Behavior During the 2016 Blue Cut Fire

A thesis submitted in partial satisfaction of the
requirements for the degree of Master of Science
in Community Health Sciences

by

Brian Scott Roberson

2017

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ABSTRACT OF THE THESIS

Wildfire Evacuation Timing in Southern California's Wildland-Urban Interface:
Using Survival Analysis to Identify Differences in
Resident Evacuation Behavior During the 2016 Blue Cut Fire

by

Brian Scott Roberson

Master of Science in Community Health Sciences

University of California, Los Angeles, 2017

Professor Linda B. Bourque, Chair

When wildfires threaten human populations, untimely or late evacuation can mean the difference between life and death. In the fire prone regions of the world, last minute evacuations have been responsible for hundreds of deaths and thousands of injuries. In Southern California, where fire season persists for the majority of the year and where human populations continue to expand into lands conducive to wildfire, emergency management officials commonly issue evacuation orders to initiate protective action behavior for those threatened. While early evacuation generally provides the safest course of action for people in the path of wildfire, past research has shown that for a variety of environmental hazards, humans do not always immediately heed official warnings, and delay evacuating. This cross-sectional study uses a mixed-mode survey design and survival analysis to investigate the evacuation timing behavior of residents drawn from a

simple random sample of Southern California households (n=221) during the 2016 Blue Cut fire in San Bernardino County, California. Findings from these analyses indicate that only half of those receiving a mandatory evacuation order evacuated because of the Blue Cut fire. Residents with past evacuation experience were almost twice as likely to evacuate compared to residents without prior experience. Gender and length of residence were found to be associated with shorter evacuation times and higher evacuation rates, with women and short-term residents more likely to evacuate compared to men and longer-term residents. The findings from this study suggest that if emergency managers and local public agencies can get wildland residents to evacuate when an evacuation order is issued, they may have future success getting them to evacuate during subsequent wildfire evacuation events. However, this study also identifies a significant number of residents who are resistant to evacuation. Addressing the concerns of this group may help increase the speed and rate of future evacuation events.

The thesis of Brian Scott Roberson is approved.

Ronald S. Brookmeyer

Deborah C. Glik

Linda B. Bourque, Committee Chair

University of California, Los Angeles

2017

DEDICATION

This thesis is dedicated to Kathy Clark, my 8th grade English teacher. Ms. Clark, thank you for encouraging a young boy, who didn't have the best grammar or spelling, to keep writing. Thank you for believing in me. We miss you.

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Introduction

Wildfire evacuation can be a risky and deadly endeavor. In California, the 1991 East Bay Hills fire killed 25 people and injured more than 150 others as residents fled the Oakland-Berkeley foothills from a rapidly spreading wildfire (Routley, 1992). A dozen years later in San Diego County, the 2003 Cedar fire killed 15 people and injured 113 as wind-driven flames overran evacuating residents (Mutch, 2007). Not exclusive to the United States, wildfire evacuation related death and injury have been documented in other fire prone regions of the world. The 1983 “Ash Wednesday” fires in Southeastern Australia killed 75 people and injured 111, many of whom were caught in last minute evacuations (Bardsley, Fraser, & Healthcote, 1983). In 2009, fueled by record temperatures and sustained drought, the “Black Saturday” fires in the Australian State of Victoria killed 173 and injured 414, as residents were unable to escape oncoming fire fronts (Cameron et al., 2009).

As the populations of both Southern California and South Australia continue to increase, so do the number of homes that are built in, or adjacent to, fire-prone landscapes (Hammer, Radeloff, Fried, & Stewart, 2007; Crompton, McAneney, Chen, Pielke Jr, & Haynes, 2010). Termed the wildland-urban interface (WUI), these lands mark the intersection of human development and wildfire in its naturally occurring environment. In the last 50 years, the increase in WUI development has been associated with an increase in wildfire related structure loss and a rise in civilian and rescuer injury and death (International Code Council, 2008).

The expansion of homes in Southern California’s WUI, coupled with a fire season in the Western U.S. that is more than 2 months longer than it was in 1970 (Westerling, Hidalgo, Cayan & Swetnam, 2006), expose Southern California WUI residents to the effects of wildfire nearly year-round. As a result, incident management officials are having to issue evacuation orders in

areas, and at times, never considered in the past. Meanwhile, WUI residents are faced with the critical decisions of where to go, how to get there, what to take, and arguably the most important decision, when to go.

Problem Statement

As early as “the Big Blow Up” of 1910, when scores of women and children from the town of Wallace, Idaho were loaded onto railroad boxcars and evacuated east to Missoula, Montana in advance of a raging forest fire (Pyne, 2001), evacuation has been one of the most instinctual, and most widely used protective actions against wildfire. While the fires of 1910 were extreme (3 million acres burned, entire towns destroyed, and 86 deaths) (Cohen & Miller, 1978), the continued expansion of homes into lands conducive to wildfire has made even small wildfires a threat to human populations. Making matters worse is the fact that much of the incremental housing development of the last 60 years, particularly in Southern California, has been done without corresponding improvements to roads and other traffic infrastructure, causing difficulty for those trying to evacuate when time is of the essence (Cova, 2005).

Despite a long and rich history of hazard and disaster research, very little inquiry has been made into the evacuation timing of residents living in Southern California’s WUI. While a number of cross sectional surveys (Benight, Grunfest, & Sparks, 2004; Mozumder, Raheem, Talberth & Berrens, 2008; McCaffrey & Winter, 2011; Roberson, Peterson & Parsons, 2012) investigate the evacuation intentions and behaviors of WUI residents in a number of U.S. locales, few focus specifically on the very populated and very flammable region of Southern California. Furthermore, while a small number of qualitative studies (Brenkert-Smith, Champ & Flores, 2006; Cohn, Carroll & Kumagai, 2006) identify some of the individual reasons residents react to

wildfire, none are designed to objectively and systematically measure the associations between wildfire evacuation timing and the characteristics of residents living in the WUI.

Given this research gap, and the well documented dangers of last minute evacuation (Handmer & Tibbits, 2005; Haynes, Handmer, McAneney, Tibbits & Coates, 2010), this study uses survival analysis to investigate the evacuation timing behavior of a sample of residents (n=221) who were issued an evacuation order during the 2016 Blue Cut fire in San Bernardino County, California. By identifying the characteristics of residents who evacuated early, late, and not at all, these analyses aim to assist community groups, researchers, and emergency managers in developing strategies to improve the rate and speed of future wildfire evacuation events. Particularly important in Southern California, where protective action options other than evacuation (e.g. shelter-in-place or stay-and-defend) may increase the risk residents face during high intensity wildfires, strategies that improve the speed of evacuation may help save the lives of residents living in the WUI and of the first responders tasked with protecting them.

Study Setting

The Blue Cut fire started on August 16th, 2016 at 10:36 AM in the Cajon Pass just west of Interstate 15 (Inciweb, 2016). Pushed by strong winds, low relative humidity, and six years of Southern California drought, the fire grew quickly. By noon of the first day, a full closure of Interstate 15 was ordered and the main railroad lines out of Los Angeles were shut down (Hill, 2016). By 10 PM of the first evening, the fire had grown to 15,000 acres, prompting Governor Jerry Brown to declare a State of Emergency for San Bernardino County (CAL FIRE, 2016).

Within the first 24 hours of the Blue Cut fire, the San Bernardino County Sheriff's Office issued evacuation orders for the communities of West Cajon Valley, Lytle Creek, Pinon Hills,

Phelan, Hesperia, Baldy Mesa, and Wrightwood (San Bernardino County Sheriff, 2016) (see Figure 1).

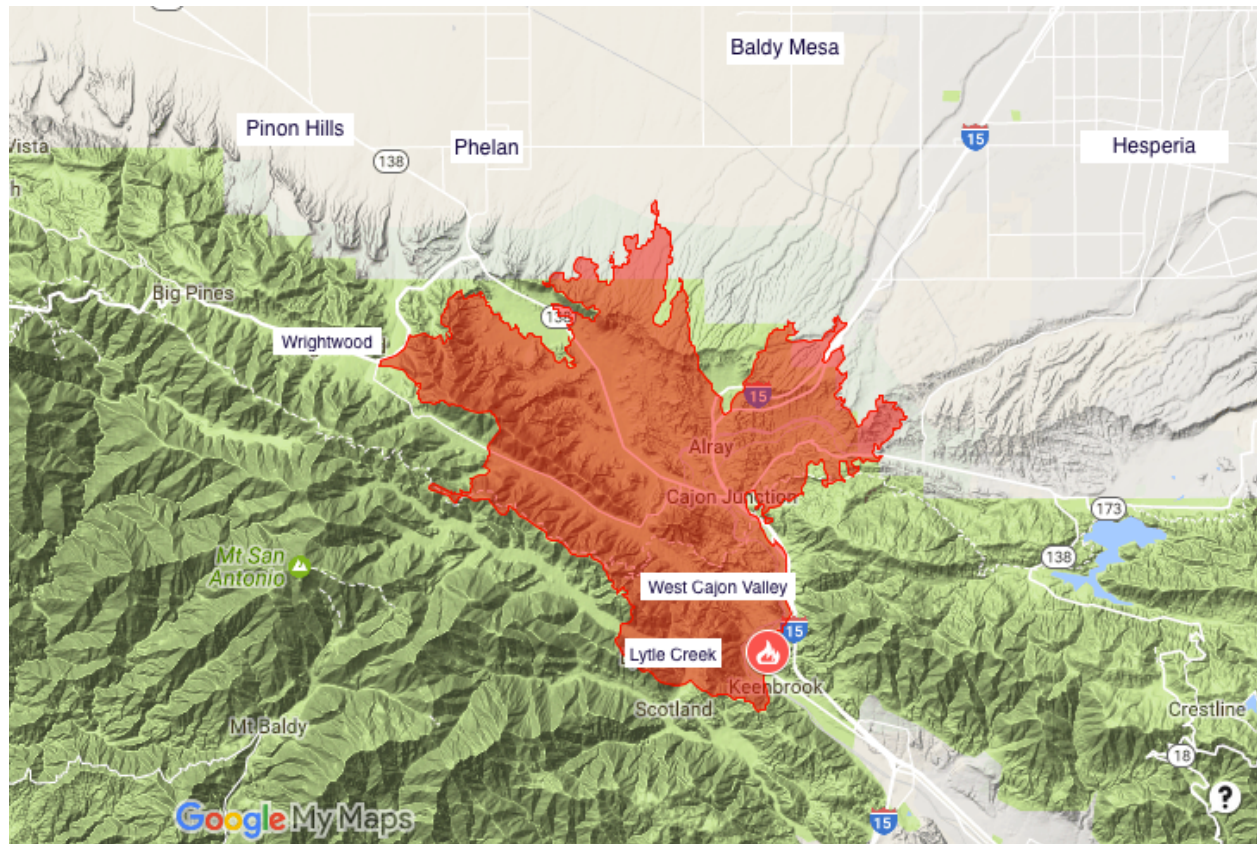
For just over a week, more than 2,600 firefighting personnel were called to battle the blaze as it grew to a final size of 36,234 acres (Inciweb, 2016). By the end of the incident, 105 single-family residences and 216 outbuildings were destroyed, and according to media reports and fire officials, up to 83,000 residents were under evacuation orders (CAL FIRE PIO, 2016; Esquivel, Jennings, & Newell, 2016).

Emergency Notifications and Public Warning

While first arriving firefighters focused on battling the fire, San Bernardino County Sheriff and Office of Emergency Services (OES) officials focused on issuing mandatory evacuation orders to affected communities. Using their reverse-911 system (called the Telephone Emergency Notification System), both listed and unlisted landline phone numbers within the evacuation perimeter were sent evacuation order telephone messages. Also included in the mass notification were telephone messages to residents with registered VoIP numbers and text messages to residents with registered cell phone numbers.

San Bernardino County also used the online notification service Nixle to send registered users text messages and email notifications (San Bernardino County Sheriff, 2016), as well as County social media pages (Facebook) and feeds (Twitter) to broadcast evacuation orders. Finally, the Santa Barbara County Sheriff's office issued official evacuation press releases (San Bernardino County Sheriff, 2016), which local media widely reported on throughout the duration of the incident.

Figure 1. Map of Blue Cut Fire and Affected Communities

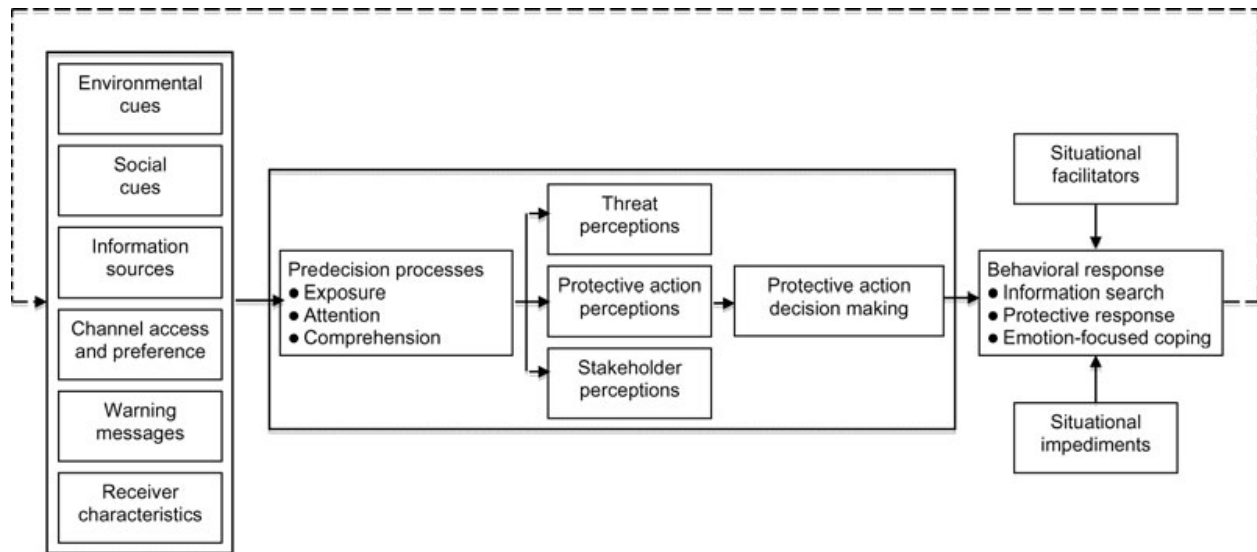


Conceptual Framework and Research Questions

Lindell and Perry's Protective Action Decision Model (PADM) (2012) guided this research. The PADM is a multistage sequential model that outlines a process of protective action decision-making and behavioral response when people are faced with environmental hazards and disasters (see Figure 2). The PADM posits that protective action behavior begins with environmental cues, social cues, and hazard warnings. These environmental and social constructs then interact with a series of psychological processes (pre-decisional, core perceptions, protective action decision making) creating a reflective process and ultimately a protective action choice and behavior.

While the present study does not measure all of the constructs identified in Lindell and Perry's PADM, their framework was used to develop the following research questions and hypotheses:

Figure 2. The Protective Action Decision Model



Source: Lindell and Perry (2012)

Research Question 1. What was the overall evacuation rate of residents under a Blue Cut fire evacuation order?

Hypotheses 1: From previous research on the *intended* evacuation behavior of residents living in the WUI (Mozumder et al., 2008; McCaffrey & Winter, 2011; Roberson et al., 2012), I expect that no more than 90% of residents issued a mandatory wildfire evacuation order will actually evacuate within two-hours of receiving the order.

Research Question 2. What effect do, proximity to the fire, past evacuation experience, years of residence, wildfire preparedness activities, children in the home, pet and livestock ownership, age, and gender, have on evacuation timing and compliance?

Hypotheses 2-6: I expect the time to evacuation will become shorter and the proportion who evacuate will become larger when:

H2: The proximity of a resident's home to the fire decreases.

H3: A resident has past wildfire evacuation experience.

H4: The number of wildfire preparedness activities in which a resident has engaged in increases.

H5: Gender is reported as female

H6: There is a child (or multiple children) in the household.

H7: The number of pets and livestock a resident owns increases.

Review of the Literature

The social impact of disasters has been studied in North America for at least 100 years. While Samuel Prince's work on the 1917 Halifax Harbor explosion (Scanlon, 1988; Dynes & Quarantelli, 1993) is generally recognized as the first systematic disaster study from a sociological perspective, it was not until the 1950's that the field began to receive broader attention. During this time, work by the National Opinion Research Center, supported by the United States Military, began to investigate public response to peacetime disasters to shed light on the public's expected response during potential wartime disasters (Quarantelli, 1987). From this early body of research, work from the 1960's onward from authors such as Bourque, Drabek, Dynes, Fritz, Lindell, Mileti, Perry, Sorensen, and Quarantelli established a wide collection of results across a variety of hazards. The present study builds on these findings by examining the following characteristics in its investigation into the response of residents threatened by the 2016 Blue Cut fire.

Evacuation rates.

Researchers have measured evacuation rates over a variety of environmental hazards and disasters. Baker (1991), who studied four hurricanes from 1961 to 1979, found that not only did evacuation rates vary from place to place within the same storm, but rates varied in the same place, from storm to storm. Rates reported by Baker (depending on location) ranged from 40-97% during Hurricane Carla (1961), 70-86% during Hurricane Camille (1969), 41-94% during Hurricane Eloise, and 33-97% during Hurricane Frederic (1979). Brown and colleagues (2016) studied the impact of Hurricane Sandy (2012) and reported a 49% evacuation rate in a sample of New York City residents. In a broader analysis of hurricanes, floods, tsunamis, and chemical accidents, Sorensen and Mileti (1988) reported evacuation rates of “at risk” residents between 32-98%.

Anticipated wildfire evacuation rates.

The few studies investigating the intended evacuation behavior of residents living in the WUI find that most people intend to evacuate given a mandatory wildfire evacuation order and that few are willing to disregard an evacuation order completely to stay with their property. For example, in an investigation of the intended evacuation behavior of WUI residents living outside of Albuquerque, New Mexico, Mozumder and colleagues (2008) found that 88% of those surveyed indicated they would evacuate given a mandatory evacuation order. In a two-community study of Santa Barbara County (CA) residents, Roberson et al. (2012) found that 83% of respondents stated they would evacuate given a mandatory order. Additionally, in a study of California, Montana, and Florida residents by McCaffrey & Winter (2011), only 11% of those surveyed said they would stay throughout the fire and protect their house.

Proximity to disaster.

There is strong evidence across a variety of hazards that people are more likely to respond to a disaster warning if they are in close proximity to the disaster. For example, Baker (1979), Aguirre (1991), and Bateman and Edwards (2002) found that residents closer to hurricanes were more likely to respond to hurricane warnings. Bourque and colleagues (1971) found that after the 1971 San Fernando earthquake, the likelihood of evacuation increased the closer someone was to possible threats. Studies of the 1979 Three Mile Island disaster (Flynn, 1979; Houts, Lindell, Weittu, Cleary, Tokuhata & Flynn, 1984) also found that proximity to the disaster increased the likelihood of someone responding to the disaster warning.

Past experience.

Many researchers over the last 40 years have looked at the relationship between a person's past disaster experience and the likelihood of responding to a disaster warning. Unfortunately, as Baker (1991) points out, different measures have been used throughout the years to represent past disaster experience, making it challenging to compare across studies.

When past experience is defined as past disaster damage, Mileti and O'Brien (1992) showed that those who experienced damage during the 1989 Loma Prieta earthquake were more likely to respond to hazard warnings compared to those who had not experienced damage.

When past experience is defined as knowledge of protective actions, the research indicates that the more knowledge a person has on how to protect him/herself, the more likely they are to respond to a hazard warning message (Leik, Carter, Clark, Kendall & Gifford, 1981; Liverman & Wilson; 1981; Rodgers, 1985; Lindell & Perry, 1987).

For the purposes of this study, which focuses on evacuation behavior, past experience is more narrowly defined as past evacuation experience. That said, Baker (1991), in an analysis of

12 hurricanes from 1961 to 1989, found the majority of people who evacuated because of past hurricanes did so again during future events.

Length of residence in home.

In geographies that experience reoccurring disasters such as hurricanes, floods, wildfires, and earthquakes, length of residence is sometimes used to represent hazard exposure. Findings on the relationship between length of residence and evacuation likelihood (or likelihood of responding to a hazard warning) are inconsistent in the literature. Zhang, Prater, and Lindell (2004) found that length of residence along coastal areas was negatively correlated with evacuation. Baker (1991), on the other hand, in a re-analysis of prior work on hurricane evacuation, argues that length of residence *may not* be a good indicator of evacuation behavior.

Age.

Findings on the relationship between age and response to hazard warnings have yielded mixed results. In a study of the public's response to Hurricane Gilbert in Cancun Mexico, Aguirre (1991) found socio-demographic characteristics such as age not a useful predictor of evacuation behavior. Bateman and Edwards (2002), who studied the public's response to Hurricane Bonnie (NC), came to similar conclusions. In studies on earthquake preparedness by Edwards (1993), Mileti, Darlington, Fitzpartick, and O'Brien (1993), and Mileti and Darlington (1997), no association between age and hazard warning response was found.

However, work by Cutter and Barnes (1982) reported older residents more likely to respond to a warning message issued during the Three Mile Island nuclear accident. Perry (1990), who studied three flood events, one volcano eruption, and one hazardous materials incident, found that older age was associated with a higher likelihood of warning message response.

Contradicting the findings that older residents are more likely to respond to hazard warnings, is work from Mileti and Beck (1975) and Mileti and O'Brien (1992) who found that older people were less likely to respond to a warning message than younger people.

Gender.

While Mileti et. al., (1993) and Mileti and Darlington (1997) found no relationship between gender and the likelihood of responding to an earthquake prediction warning message, research by other investigators has shown that women are generally more likely to respond to hazard warning messages than men. For example, Drabek (1969), who studied flood evacuation, found women more likely to respond to flood warning message. Aguirre (1998) reported similar findings in an analysis of hazard message response during the 1993 World Trade Center bombing. Meanwhile, Bateman and Edwards (2002), who investigated the Hurricane Bonnie (NC) evacuation, found women more likely to respond to hurricane hazard warnings. Lastly, Flynn (1979) found women were more likely to respond to a warning message than men during the Three Mile Island disaster.

Household composition (children in the household).

Across a variety of hazards, households with children have shown to be more likely to respond to hazard warnings compared to households without children. For example, Carter (1983) investigated public response to Hurricane Frederic and found that households with children were more likely to respond to hurricane hazard warnings. Edwards (1993), who examined earthquake preparedness, reported similar findings. Fischer III (1995) found an increased likelihood of evacuation in households with dependent children during a major fire emergency. Lastly, Quarantelli's (1980) meta analysis of 150 studies on evacuation behavior

reported people with children more likely to respond to a warning message than those without children.

Pets and Livestock.

Prior to Hurricane Katrina in 2005, only a few studies reported on the relationship between pet ownership and evacuation compliance. In work by both Nelson et al. (1989) and Whitehead et al. (2000) negative associations between pet ownership and hurricane evacuation compliance were reported. Heath, Kass, Beck & Glickman (2001) found households with pets at higher odds of evacuation failure than households without pets during a Northern California flood event.

After Hurricane Katrina hit the Gulf Coast states in 2005 and reports of residents not evacuating for fear of abandoning their pets widely surfaced (Brangham, 2015; Lam, 2016), the U.S. government enacted the Pets Evacuation and Transportation Act of 2006. The legislation directed the Federal Emergency Management Agency to ensure that state and local governments include both pets and humans in evacuation planning and preparation. In the case of wildfire evacuation, where many residents live in settings conducive to pet and livestock ownership, the relationship between pet and livestock ownership is investigated.

Methods

This study is an analysis of data collected after the 2016 Blue Cut fire in San Bernardino County, California. Approval to conduct the research was granted by the Office of the Human Research Protection Program at the University of California, Los Angeles on August 19, 2016 (IRB #16-001130). The following section describes the study population, the development of

the sampling frame, participant recruitment, the survey instruments, the analytic sample, and the study variables used in data analysis.

Study Population

To create a sampling frame of all households under a Blue Cut fire evacuation order, I used an online parcel mapping service (ParcelQuest) and street data from the San Bernardino County Sheriff's Department to re-create the fire's evacuation perimeter. By sorting out only residentially zoned parcels containing dwellings, I established a sampling frame of 12,308 eligible households. Not having the financial resources to send recruitment material to every household in the sampling frame, I used Microsoft Excel's RAND function to assign a random number to each case within the frame. I drew the simple random sample of households by sorting the cases by random number, from lowest to highest, and selecting the first 1500 (Microsoft, 2016). With the starting sample drawn, English language recruitment material was sent to all 1500 households.

Study Recruitment

To help maximize the study's response rate, all households in the initial sample were sent three separate mailings (Dillman, 2000). Beginning in mid-September 2016, recruitment postcards were sent to households. Recruitment postcards introduced the study, described its importance, and explained that individual responses were confidential and that participation was voluntary. Postcards also included contact information for respondents who had questions or concerns.

Approximately two weeks later, recruitment packets containing a cover letter, the study questionnaire, and a postage paid return envelope were sent to all households. Cover letters were printed on official University California Los Angeles letterhead to help stress the importance of

the study and provide information on the study's sponsor (Bourque & Fielder, 2003). Cover letters explained to respondents that they had three ways to participate in the study but that they had to be at least 18 years of age or older. Respondents could complete and return a self-administered mail questionnaire, utilize a web-link printed on the cover letter to access a web-based questionnaire, or call the phone number listed on the letter to participate by phone interview. Postage paid return envelopes with postage stamps were included to increase the likelihood of respondents returning completed study questionnaires (Bourque & Fielder, 2003).

Two weeks after the second mailing, I sent reminder postcards to households to encourage study participation. Reminder postcards included contact information for both residents who had questions, and/or those who needed an additional copy of the study questionnaire. A return address was listed in the event that respondents had misplaced the postage paid return envelope or had questions about where to send completed questionnaires.

Throughout the mailing process, recruitment materials returned by the Postal Service as "undeliverable," "no mail receptacle," "vacant," or "unable to forward" were cross-referenced against the sample's parcel database. Households with secondary addresses were re-mailed recruitment material and study questionnaires. If mail was returned a second time by the Postal Service, the address was removed from the sample. From the original sample of 1500 households, 112 households (addresses) were removed due to undeliverable mail, leaving 1388 households remaining.

Response Rate

The response rate for this survey was 19.5%. It was determined using the 2016 guidelines from the American Association for Public Opinion Research (AAPOR). The response rate calculation used (RR1), as defined by AAPOR, is "the number of complete interviews

divided by the number of interviews (complete plus partial) plus the number of non-interviews (refusal and break-off plus non-contacts plus others) plus all cases of unknown eligibility (unknown if house unit, plus unknown, other).”

I defined complete interviews as those with answers to more than 80% of applicable questions. Partial interviews were defined as those having answers to 50-80% of applicable questions and refusals/break-offs were those with less than 50% of questions answered.

The response rate to this survey fell within the range of those conducted in similar settings. For example, Mozumder and colleagues (2008) yielded a 25% response rate in a mail survey of households while investigating intended evacuation behavior in Albuquerque, New Mexico. Likewise, McCaffrey and colleagues (2013) used mail questionnaires to survey Arizona and Colorado households affected by three different wildfires during the 2010 fire season and achieved response rates of 18%, 26% and 16%. Lastly, while response rates have declined over the last several decades in all modes of survey administration (Baruch, 1999; De Leeuw & De Heer 2002; Curtin, Presser & Singer, 2005), low response rates alone do not necessarily lead to nonresponse bias (Curtin, Presser & Singer, 2000; Keeter et al 2000).

Study Questionnaire

Questionnaire content was developed after a review of the literature on protective action decision-making (Lindell & Perry, 2012), intended evacuation behavior (Mozumder et al., 2008; Roberson et al., 2012; McCaffrey & Winter, 2011), wildfire preparedness (McCaffrey & Winter, 2011; International Association of Fire Chiefs, 2011), WUI information needs (McCaffrey, 2013), and risk perception (Slovic, 2000).

Questionnaires asked residents about their evacuation experience, how they received evacuation orders, whether they witnessed environmental cues, how satisfied they were with

incident information, questions about risk, reasons for non-evacuation, wildfire preparedness activities, past experience, and basic demographic information.

Given the study's mixed-mode survey design, three versions of the instrument were created. First, a self-administered mail questionnaire was developed. The self-administered mail questionnaire was 11-pages in length and was printed on front and back. Font was 12-point for ease of reading and questions were spaced so respondents had room to provide complete answers to each question. Margins and white space were designed to give the questionnaire a less crowded feel and to allow room for longer than anticipated answers to open-ended questions. A mix of both open and closed-ended questions was asked and grids were used to help organize responses to questions with multiple question and answer options (Bourque & Fielder, 2003).

The content of the web-based questionnaire was adapted from the self-administered mail questionnaire using the online survey platform SurveyMonkey. Both instruments asked the same questions. However, one question (Did road or traffic conditions slow your evacuation?) was re-ordered to help with the web-based questionnaire branching.

When conducting phone interviews, I used an introductory script to obtain verbal consent from respondents and a blank copy of the self-administered mail questionnaire to record answers.

Pretesting

I pretested the self-administered mail questionnaire using a convenience sample of eight friends, family members, and work colleagues. Each respondent was handed a self-administered questionnaire and asked to fill it out and return it when finished. Completion times ranged from 8 to 20 minutes. The pretest sample was evenly divided between women and men. The age distribution of female respondents ranged from 31 to 70, while male respondents ranged from 34 to 47. Education levels of the sample ranged from "completed high school" to "completed an

advanced college degree.” Based on the feedback from pretesting, minor changes were made to improve question wording and understandability.

The web version of the questionnaire was pre-tested using a convenience sample of five friends, family members, and work colleagues. The sample consisted of three women and two men. Respondent ages ranged from 21 to 69 and completion times ranged from 7 to 24 minutes.

Pilot Testing

Pilot testing occurred in Wrightwood, California, nine days after Blue Cut fire evacuation orders had been lifted. Wrightwood was selected as the site of pilot testing because the entire community had been placed under a mandatory evacuation order. Testing consisted of in-person, face-to-face interviews. For six hours, a research assistant and I canvassed downtown Wrightwood interviewing respondents. Any person appearing to be 18 years of age or older was approached and asked if they would be willing to be interviewed. A total of 15 people were approached and asked if they would consent to an interview. All 15 agreed to be interviewed, although five were ultimately screened out because they were not affected by the Blue Cut fire evacuation order. The remaining 10 consisted of three women and seven men. Respondent ages ranged from 28 to 79. Interview lengths ranged from 11 to 25 minutes. Based on the results of pilot testing, only minor word changes were made to the instrument.

Instrument Validity

Face validity of the instrument was confirmed during questionnaire pilot testing. At the conclusion of each of the 10 face-to-face interviews, respondents were asked to evaluate the relevance, acceptability, and comprehensibility of the questionnaire. Small wording changes were made to the instrument based on the feedback of respondents. Once face validity was confirmed, and a final questionnaire was developed, the questionnaire was sent to three Southern

California fire officials specially trained in WUI fire prevention and suppression. Telephone interviews with each of the three fire officials were conducted to confirm that the content of the questionnaire matched the constructs the instrument was designed to measure.

Data Handling and Preparation

SPSS version 24 was used for all data preparation and analyses (IBM, 2016). Data were collected from September 27th to December 17th, 2016. Responses from returned questionnaires were manually entered into the data editor function of SPSS. Frequency distributions were run for each study variable in order to screen for missing values and outliers. Outliers were addressed by assigning logical minimum and maximum values to each variable. Outliers outside of a variable's logical range were treated as missing. All cases with missing dependent variable values were excluded from the analytic sample. All cases with missing independent variable values were excluded from multivariate regression analysis with the exception of the variable *AREA*, which was used in the bivariate analysis only (Afifi, May, & Clark, 2011).

Analytic Strategy and Study Variables

Since the focus of this study is the timing characteristics of residents receiving an evacuation order, I used survival analysis to analyze study data. Survival analysis is particularly useful when analyzing time-to-event data and when data contains censored observations (Hosmer & Lemeshow, 1999). In these analyses, the outcome of interest was the "time to evacuation." The time scale was measured from the time a resident received a Blue Cut fire evacuation order to the time they evacuated. Residents who did not evacuate between the time evacuation orders were issued and the time they were rescinded, were considered censored observations. For this study, simple descriptive statistics, Kaplan-Meier survival estimates, and univariate and multivariate Cox proportional hazards regression were used to analyze study data.

Dependent variables.

Time to evacuation. The ratio variable *EVAC_TIME* was measured by asking respondents the following question: “How long after you received the (evacuation) order did you evacuate?” Respondents could answer in units of days, hours, or minutes. For ease of analysis, answers reported in minutes or days were converted to hours. However, since the variable *EVAC_TIME* only captured the timing characteristics of those who evacuated, the variable was transformed into a new variable named *SURV_TIME* to account for those that did not evacuate (censored observations). Because 5 days (or 120 hours) was the time between the issuing of evacuation orders and the time they were rescinded, those not evacuating were given a value of 120 hours. The new ratio variable *SURV_TIME* was then used as the time scale in the subsequent survival analyses.

Evacuation status. The nominal variable *EVAC* was measured by asking residents: “During the Blue Cut fire, did you evacuate from your home?” The response category allowed respondents to report either “1 – Yes” or “2 – No.” However, not picked up during questionnaire pretesting (which was performed using in-person interviews), was the fact that some property owners were either not home, or used the property receiving recruitment material as a vacation home. In these instances, respondents utilized margin space or space provided in open-ended questions to indicate that they were not at the property at the time the evacuation order was issued. Post-coding of *EVAC* was done to reflect this third option with a value of “3” and was assigned to people “not at home.” A total of 47 cases were dropped for this reason (See Figure 3).

Independent variables.

Age. The variable *AGE* is reported in years and was measured by asking respondents: “How old were you on your last birthday?” The eight cases not reporting age were dropped from the sample. *Age* is a continuous variable in both the univariate and multivariate Cox statistical models.

Gender. The variable *GENDER* asked respondents if they were male or female. Female respondents were coded as 1 and male respondents were coded as 0 (referent group). In one case, a respondent reported “other.” After reviewing the assessor parcel data, confirming that the respondent reported owning (versus renting) their home, and assuming the name on the study mailer matched the name of the person responding, the one case was recoded into the gender traditionally associated with the name found in the assessor parcel data. The new variable, named *rcrcGENDER*, reflects this change.

Wildfire preparedness activities. Respondents were asked if they had engaged in 11 common WUI preparedness activities. The variable *ANNUAL_PREPAREDNESS* represents how many of the 11 activities they had performed during the last 12 months. The variable *LIFETIME_PREPAREDNESS* represents how many of the 11 activities they had performed at any point during their lifetime. Endpoints for both variables ranged from “0 activities” to “11 activities.” Since some respondents only reported their annual preparedness and others only reported their lifetime preparedness, a new variable (*TOTAL_PREPAREDNESS*) was created to capture the highest number of preparedness activities reported by respondents regardless of whether it was in the last 12 months or over their lifetime. I ran a frequency distribution of the *TOTAL_PREPAREDNESS* variable and it revealed that only 5% of the sample reported engaging in seven or more preparedness activities. Given this unequal distribution, I recoded

TOTAL_PREPAREDNESS into the final study variable. *WUI_PREPAREDNESS* was used in the regression model and it is an ordinal variable ranging from “1 - preparedness activity” to “6 or more preparedness activities.”

Years lived in current home. The ratio variable *YEARS_LIVED* was used in the Cox regression model. It is reported in years and was measured by asking respondents: “How many years have you lived in your current home?” Only three cases were excluded from the sample due to missing data.

Prior evacuation experience. Respondents were asked two yes/no questions having to do with past wildfire evacuation experience. The first question asked whether they had evacuated in the past because of wildfire (variable name: *PRIOR_EVAC*). The second question asked whether they had ever disregarded evacuation orders and chosen not to evacuate because of wildfire (variable name: *PRIOR_NON_EVAC*). These two variables were cross-tabulated to identify four unique groups of people (see Table 4):

- 1) Those who have evacuated in the past and have never refused an evacuation order.

Variable name: *PRIOR_EXP_EVAC_ONLY* (n=61).

- 2) Those who have never evacuated in the past but have refused a past evacuation order.

Variable name: *PRIOR_EXP_REFUSAL_ONLY* (n=33).

- 3) Those who have both evacuated in the past and have refused a past evacuation order.

Variable name: *PRIOR_EXP_EVAC_AND_REFUSAL* (n=35).

- 4) Those who have no experience evacuating and have no experience refusing a past evacuation order.

Variable name: *PRIOR_EXP_NO_EVAC_OR_REFUSAL* (n=92).

The four new variables were evaluated individually using Kaplan-Meier analyses and all four were used in the Cox regression model. A total of six cases were excluded from the sample due to missing data.

Family composition. The variable *HOUSEHOLD_KIDS* was measured by asking respondents: “How many people under 18 are there in your household?” Since 70% of respondents reported having no children under the age of 18, the variable was recoded into an ordinal measure ranging from “0 children” to “4 or more children” (variable name: *rcrcHOUSEHOLDKIDS*). The new variable was used in both the univariate and multivariate Cox regression models.

Households with pets and livestock. The ratio variable *TOTAL_ANIMALS* was measured by asking respondents how many cats, dogs, horses, or livestock they owned. The variable was used in both the univariate and multivariate Cox regression models.

Area. The variable *AREA* categorizes respondents into one of three unique Blue Cut fire geographies. First, responses from the High Desert communities of Phelan, Pinon Hills, Hesperia, and Baldy Mesa (all located at the base of the San Bernardino mountain range) were coded as *1 = High Desert*. Next, responses from the mountain top community of Wrightwood were coded as *2 = Wrightwood*. Lastly, responses from communities located on the lower and middle slopes of the San Bernardino Range including Lytle Creek and West Cajon Valley were coded as *3 = Canyons and Foothills*.

Reasons for evacuation refusal. Respondents indicating they did not evacuate during the Blue Cut fire were asked two open-ended questions aimed at identifying the reason(s) for evacuation refusal. Responses to the questions were post-coded and grouped into one of 12

variables having dichotomous yes/no end points. Some respondents reported multiple reasons.

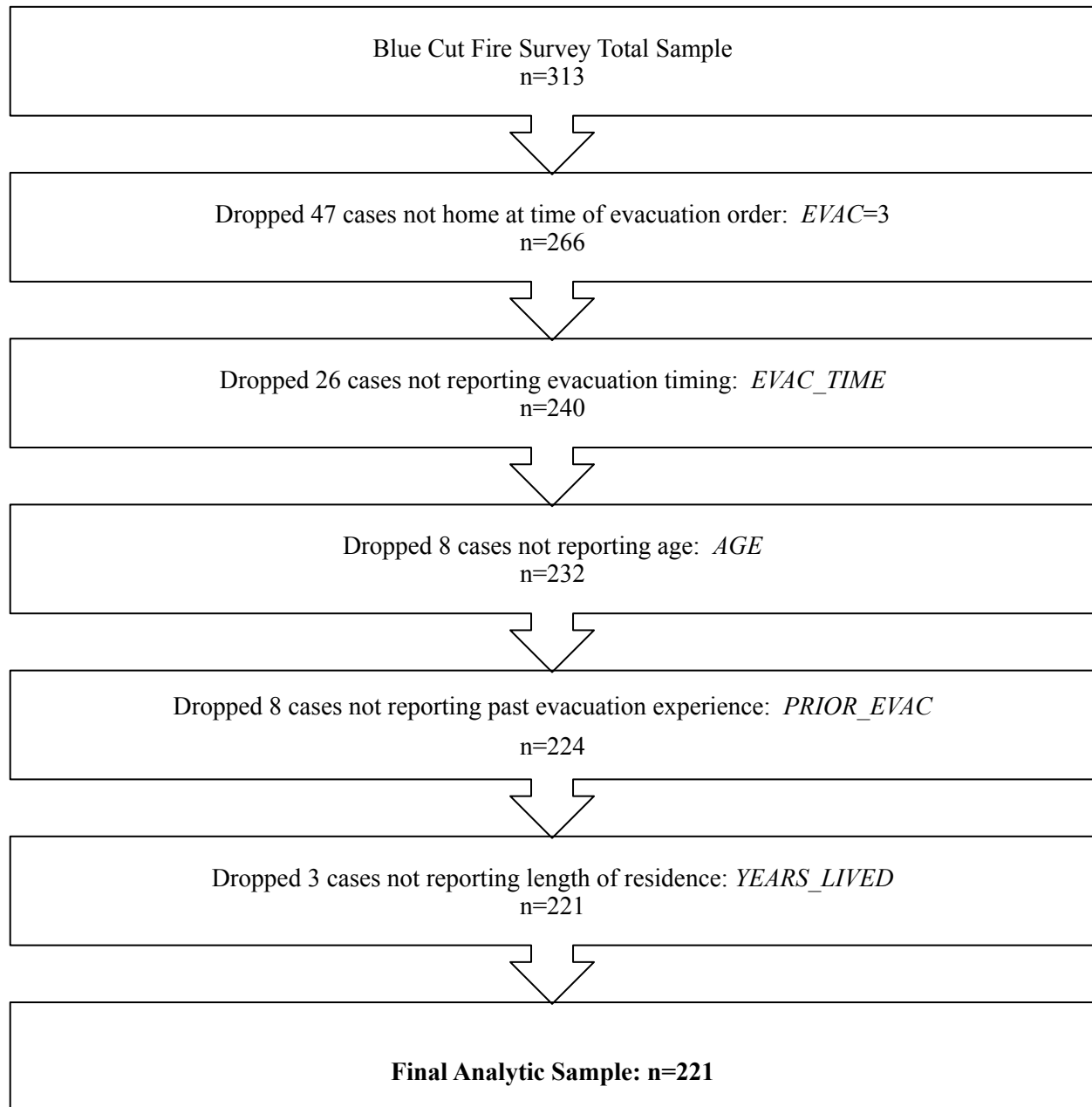
The common themes and corresponding variables are:

- The fire was too far away. *FAR_AWAY* (n=56)
- Felt safe. *NO_DANGER* (n=36)
- Stayed to defend property. *STAY_AND_DEFEND* (n=8)
- Concerned about leaving/sheltering animals. *ANIMAL_CONCERN* (n=6)
- Evacuation is unnecessary. *EVAC_UNNECESSARY* (n=6)
- Evacuation periods are too long. *TOO_LONG* (n=4)
- Prepared to go but wanted to make own decision. *PREP_BUT_WAITING* (n=19)
- Unsure they were under an evacuation order. *NOT_SURE_ORDERS* (n=19)
- Worried about looting and/or thieves. *LOOTERS* (n=12)
- Were unhappy with information about fire and evacuation. *BAD_INFO* (n=7)
- Did not trust the government. *NO_TRUST_GOV* (n=2)
- Did not know why they refused evacuation orders. *DONT_KNOW* (n=2)

Development of the Analytical Sample

Although a total of 313 households responded to the Blue Cut fire survey, only 221 were included in the final analytic sample. Most of the cases excluded from the final sample were from respondents who reported not being home (and outside of the evacuation area) at the time of the fire (n=47). Included in this group were those who reported being at work, on vacation, or who used the property receiving study recruitment material as a vacation home. The remaining cases excluded from the final analytic sample were done so because of missing data to important study variables (see figure 3).

Figure 3.



Statistical Analyses

Univariate analyses.

I used simple descriptive statistics to summarize the profile of study participants (Table 1) and the reasons given for evacuation refusal (Table 8). Results are displayed in tabular form and categorical variables are presented as both counts and percentages.

Kaplan-Meier curves were created using self-reported evacuation timing data from study participants and were formatted to display the proportion of households that had evacuated. Each of the study's categorical independent variables was analyzed and results report median time to evacuation and 95% confidence intervals. The assumption of proportionality was confirmed through visual inspection of the survival curves. Log-rank tests identified statistically significant differences among groups.

Multivariate Analyses

Cox proportional hazards regression analysis was used to identify the independent variables associated with time to evacuation. In an effort to decrease the standard error and 95% confidence intervals of study covariates, only variables with univariate test p-values < 0.25 were included in the final model. (Bendel & Afifi, 1977; Hosmer & Lemeshow, 1999). However, a full model was fit to the study data to confirm that no confounding or statistically significant covariates were left out of the final model. Results of the final regression model are reported as hazard ratios. A hazard ratio, which is sometimes called relative risk, is how often an event occurs in one group, relative to another group (Kleinbaum & Klein, 2012).

Results

Overall Mixed-Mode Survey Response

The overwhelming majority of respondents (94%) chose to participate in the study by filling out and returning self-administered mail questionnaires. Only a small percentage (5.7%) responded using a web-based questionnaire and only a single respondent participated by phone interview (0.3%). Table 1 illustrates the number of interviews and their level of completion by mode of administration.

Table 1

Responses per Mode of Administration

	Complete	<u>Number of Interviews</u>		Break-Offs	Total	(%)
		Partial				
Self-Administered Mail	278	5		11	294	(94.0)
Web-Based	11	0		7	18	(5.7)
Phone Interview	1	0		0	1	(0.3)
Total	290	5		18	313	(100.0)

Characteristics of the Analytical Sample

The age of respondents in the analytical sample ranged from 19 to 87 years with an average age of 57 years. The average length of time respondents reported living in their home was 13.9 years and ranged from two months to 58 years (see Table 2).

Table 2

Profile of Analytic Sample's Continuous Variables (n = 221)

	Mean	SD	Range	n
Age (years)	57.02	14.34	19 to 87	221
Time in Current Home (years)	13.9	10.13	.16 to 58	221

The sample was well balanced on gender with 49.3% men and 50.7% women reporting (see Table 3). All respondents reported having engaged in at least one wildfire preparedness activity over their lifetime while 90% reported that they had engaged in at least 2 or more. Past evacuation experience was relatively balanced with 43% reporting having evacuated in the past due to wildfire. Only 30% of the sample reported refusing a past evacuation order. The majority of respondents reported having no children under the age of 18 in the household (72.4%) and a majority reported owning one or more pet or livestock (77.3%)

Table 3

Frequency Distribution of Analytic Sample's Categorical Variables (n=221)

	n	(%) ^{a,b}
Area of Evacuation Order (n=214)		
High Desert	157	(73.4)
Wrightwood	43	(20.1)
Canyons and Foothills	14	(6.5)
Gender (n=221)		
Male	109	(49.3)
Female	112	(50.7)
Wildfire Preparedness Activities (n=221)		
1 Preparedness Activity	22	(10)
2 Preparedness Activities	40	(18.1)
3 Preparedness Activities	39	(17.6)
4 Preparedness Activities	42	(19)
5 Preparedness Activities	39	(17.6)
6+ Preparedness Activities	39	(17.6)
Children Under 18 in the Household (n=221)		
No Children Under 18	160	(72.4)
1 Child Under 18	21	(9.5)
2 Children Under 18	24	(10.9)
3 Children Under 18	9	(4.1)
4+ Children Under 18	7	(3.2)
Households with Pets and/or Livestock (n=221)		
No Pets or Livestock	50	(22.6)
1 Pet or Livestock	39	(17.6)
2 Pets or Livestock	46	(20.8)
3 Pets or Livestock	27	(12.2)
4+ Pets or Livestock	59	(26.7)

^a Percentages may not add to 100% due to rounding

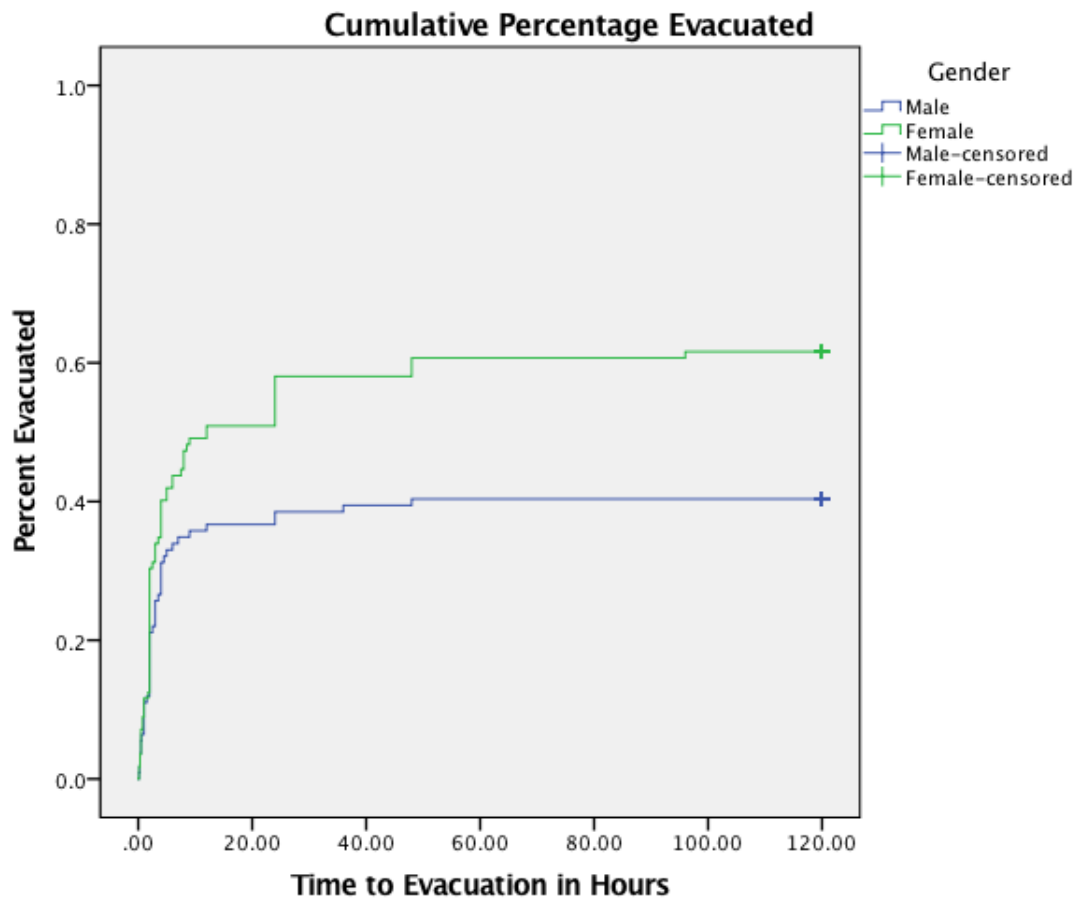
^b Valid percents reported

Kaplan-Meier Survival Analyses

The time to evacuation characteristics of each of the study's independent categorical variables are presented in below. The Kaplan-Meier curves presented in Figures 4 through 7 illustrate the number of evacuations, over time, between two groups of interest. The curves are formatted with the time scale along the x-axis, which begins at "0 hours" (the time a respondent receives the evacuation order), and extends to "120 hours" (the time Blue Cut fire evacuation orders were rescinded).

Gender. Time to evacuation by gender is presented in Figure 4. The one minus survival function curve compares the evacuation rate of men to the evacuation rate of women.

Figure 4



Only 40.4% (44/109) of men reported evacuating compared to 61.6% (69/112) of women. The median time to evacuation for women was 12 hours, 95% CI [0.6-23.4]. No median time to evacuation for men was calculated because less than 50% of men reported evacuating. A log-rank test indicated a statistically significant difference between the evacuation distributions of each group at the $\alpha = .05$ level ($\chi^2=7.96$, $df=1$, $p = .005$). Based on this difference, *GENDER* was selected as a covariate in the Cox regression model.

Prior Evacuation Experience.

Study respondents were categorized into one of four unique groups according to their past evacuation and evacuation refusal experience (see Table 4). Each group was then compared to the remaining three in the series of survival curves (see Figures 5 through 8).

Table 4.

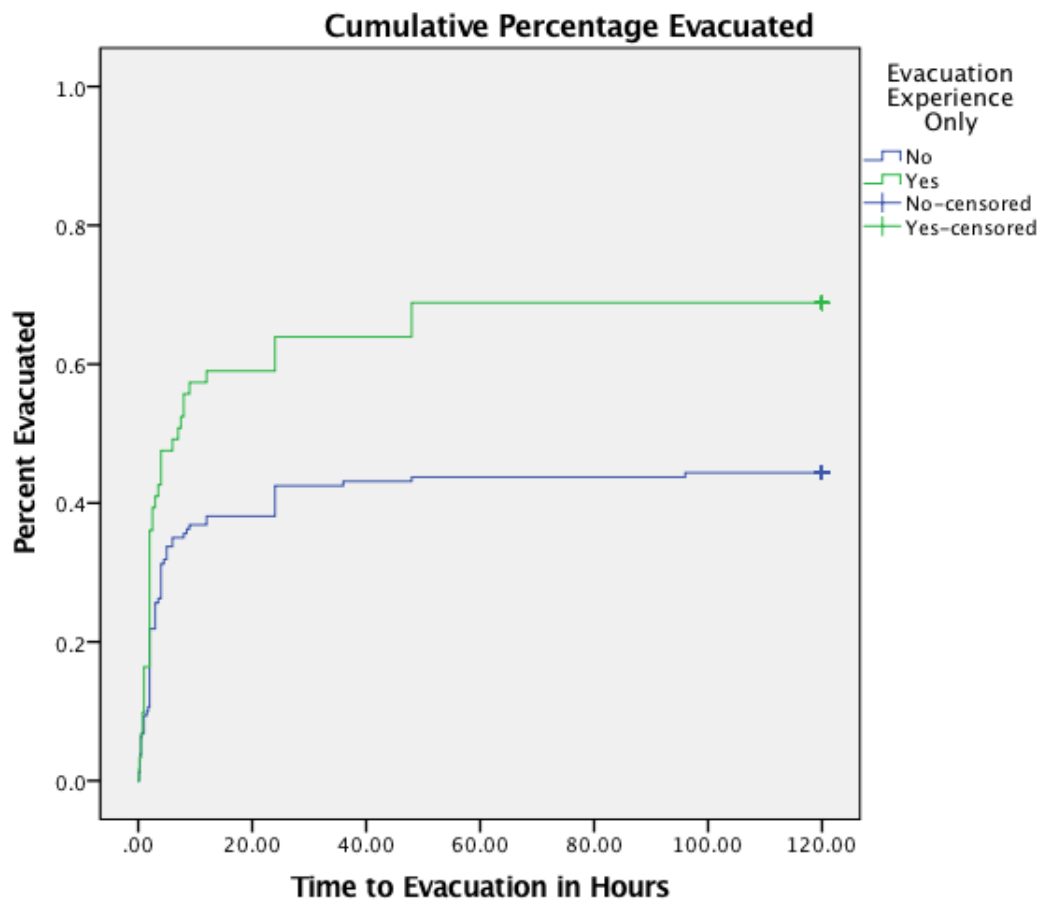
Past Evacuation and Refusal Groupings

<u>Group Name</u>	<u>Past Evacuation Experience</u>	<u>Past Evacuation Refusal</u>
Evacuation Experience Only (n=61)	Yes	No
Refusal Experience Only (n=33)	No	Yes
Neither Evacuation or Refusal Experience (n=92)	No	No
Both Evacuation and Refusal Experience (n=35)	Yes	Yes

The survival curves in Figure 5 compare the group “evacuation experience only” to the remaining three. The one minus survival function curve illustrates that those with evacuation experience only were more likely to evacuate compared to the other three groups (68.9%, or 42/61 cases, compared to 44.4%, or 71/160). The median time to evacuation for those with evacuation experience only was 7 hours, 95% CI [2.7-11.3]. No median time was calculated for remaining three groups because less than 50% reported evacuating. A log-rank test confirmed a

statistically significant difference between the evacuation distributions of each group at the $\alpha = .05$ level ($\chi^2=10.98$, $df=1$, $p < .001$). Based on this difference, the variable *PRIOR_EXP_EVAC_ONLY* was selected as a covariate in the Cox regression model.

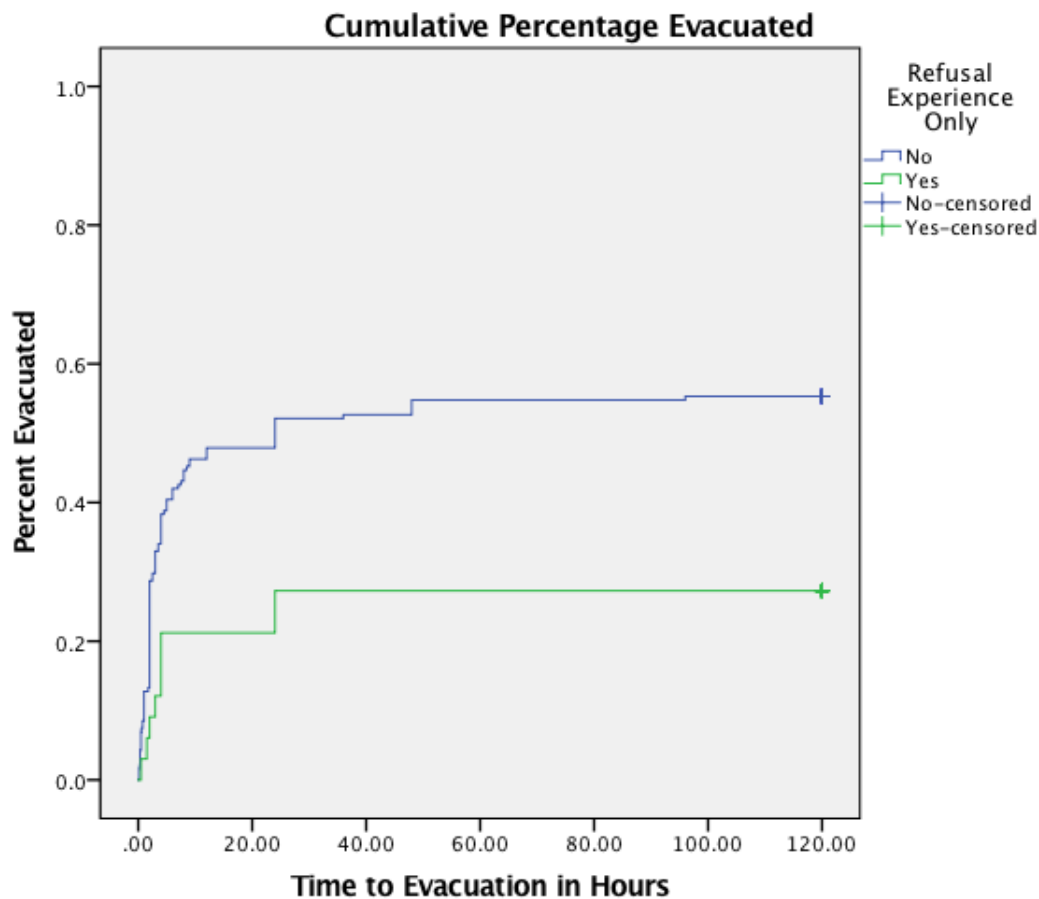
Figure 5.



The survival curves in Figure 6 compare the group “refusal experience only” to the remaining three. The one minus survival function curve illustrates that those with evacuation refusal experience only were less likely to evacuate (27.3% evacuation rate, or 9/33 cases) compared to the other three groups (55.3% evacuation rate, or 104/188 cases). No median time

to evacuation was calculated for those with the refusal experience only because less than 50% reported evacuating. However, the median time to evacuation for the combined other three groups was 24 hours, 95% CI [0.01-83.07]. A log-rank test confirmed a statistically significant difference between the evacuation distributions of each group at the $\alpha = .05$ level ($X^2=7.81$, $df=1$, $p = .005$). Based on this difference, the variable *PRIOR_EXP_REFUSE_ONLY* was selected as a covariate in the Cox regression model.

Figure 6.

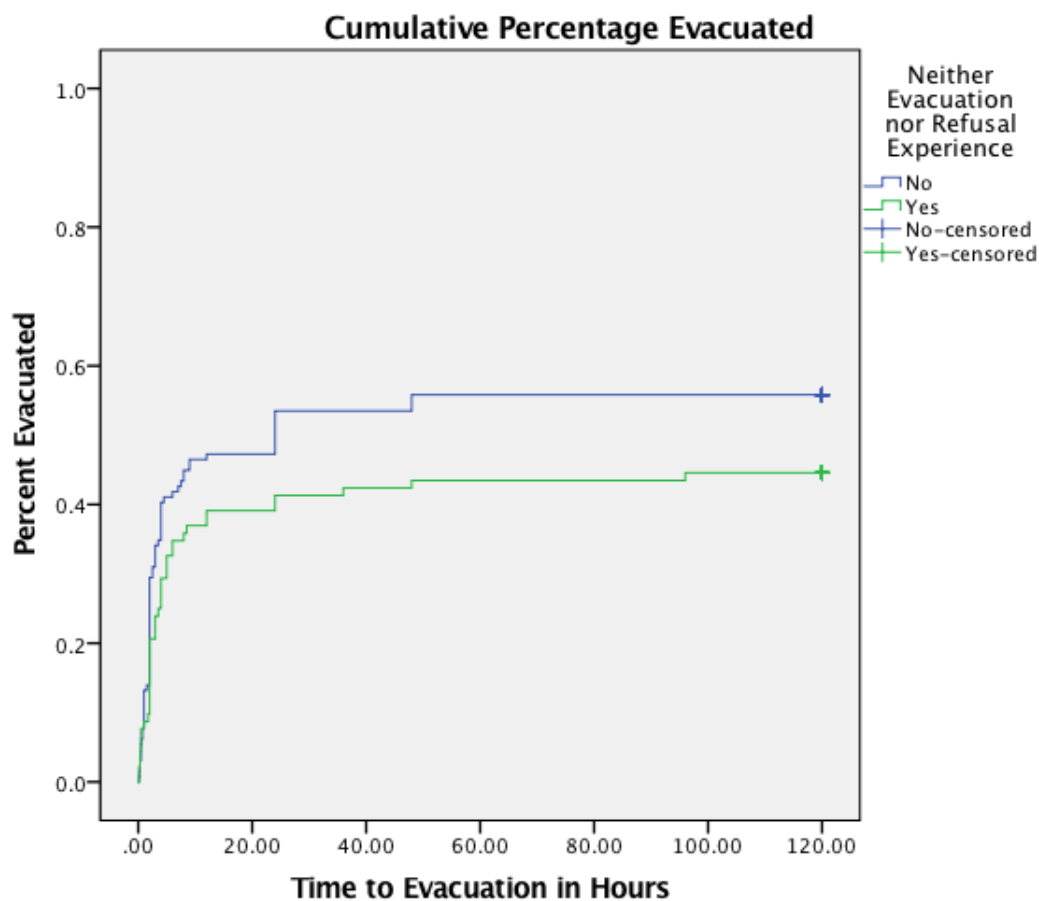


The survival curves in Figure 7 compare the “neither evacuation nor refusal experience” group to the remaining three. The one minus survival function curve illustrates that those with

neither evacuation nor refusal experience were less likely to evacuate (44.5% evacuation rate, or 41/92 cases) compared to the other three groups (55.8% evacuation rate, or 72/129 cases).

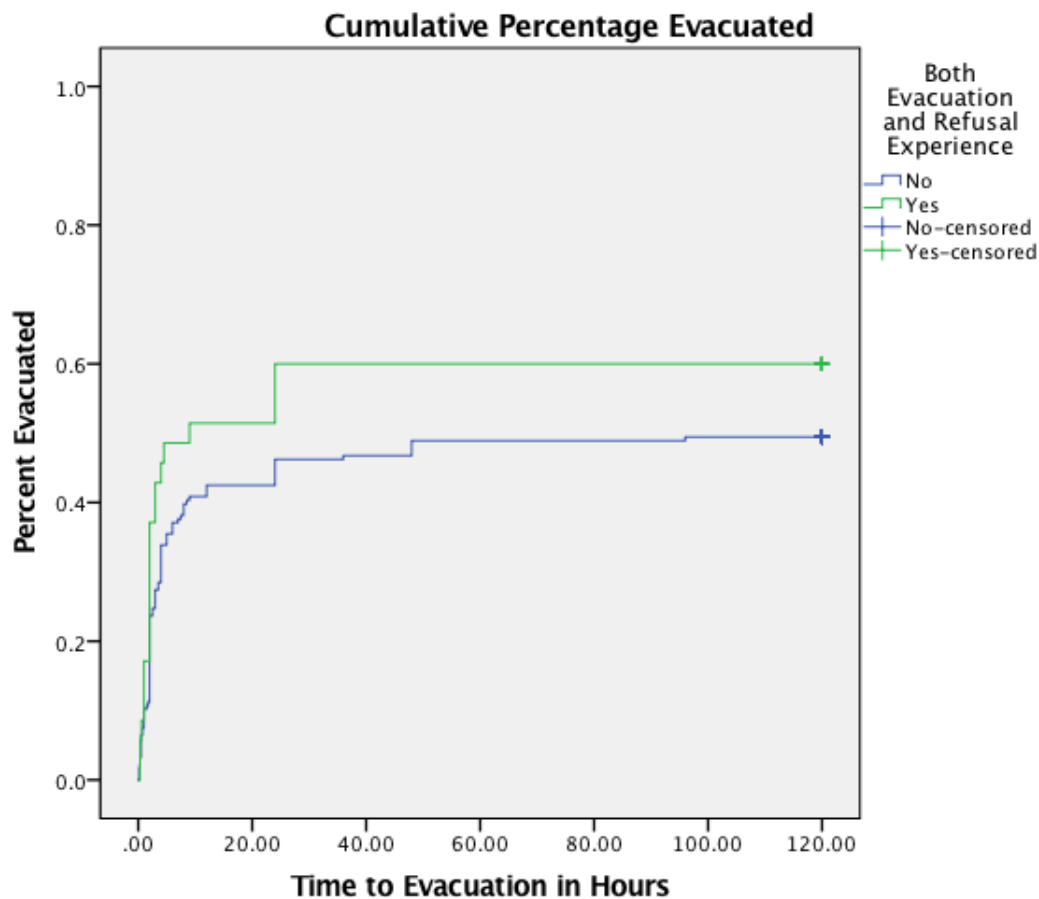
No median time to evacuation for the “neither evacuation nor refusal” group because less than 50% reported evacuating. The median time to evacuation for the combined remaining groups was 24 hours, 95% CI [.000-55.72]. A log-rank test confirmed a statistically significant difference between the evacuation distributions of each group at the $\alpha = .05$ level ($X^2=2.75$, $df=1$, $p = .097$). Based on this difference, the variable *PRIOR_EXP_NO_EVAC_OR_REFUSAL* was selected as a covariate in the Cox regression model.

Figure 7.



The survival curves in Figure 8 compare the “both evacuation and refusal experience” group to the remaining three. The one minus survival function curve illustrates that those with both evacuation and refusal experience were more likely to evacuate (60% evacuation rate, or 21/35 cases) compared to the other three groups (49.5% evacuation rate, or 92/186 cases). The median time to evacuation for the “both evacuation and refusal” group was 9 hours, 95% CI [.001-29.3]. No median time to evacuation was calculated for the other group because less than 50% reported evacuating.

Figure 8.



A log-rank test confirmed a statistically significant difference between the evacuation distributions of each group at the $\alpha = .05$ level ($X^2=1.8$, $df=1$, $p = .178$). Based on this difference, the variable *PRIOR_EXP_EVAC_AND_REFUSE* was selected as a covariate in the Cox regression model.

Univariate Cox Proportional Hazards Regression

While Kaplan-Meier analyses were most appropriate for examining the associations between time to evacuation and the study's categorical variables, univariate Cox proportional hazards regression was necessary to examine the associations between time to evacuation and the study's continuous variables.

Table 5 illustrates each of the study's continuous variables and their corresponding regression coefficient, hazard ratio, and p-value. The coefficient (β) in Cox proportional hazards regression relates to the hazard or event. A positive coefficient is associated with increased evacuation while a negative coefficient is associated with decreased evacuation. The hazard ratio is calculated by exponentiating a variable's parameter estimate and describes the expected increase (or decrease) in event for every unit of increase in the predictor variable.

Table 5

Univariate Cox Proportional Hazards Regression of Study's Continuous Variables (n=221)

Variable	Coefficient (β)	Hazard Ratio (e^{β})	P-value
Age	0.001	1.001	0.889
Number of WUI Preparedness Activities	-0.01	0.99	0.831
Years Lived in Home	-0.018	0.983	0.086*
Number of Children (Under 18) in Household	-0.004	0.996	0.96
Number of Pets or Livestock	-0.032	0.968	0.197*

* Meets final model inclusion criteria of $p < .25$

Using inclusion criteria of $p < 0.25$, the univariate Cox regression analyses identified both *time lived in home* and *pet ownership* as appropriate variables for the final regression model.

Bivariate Analysis

Blue Cut fire evacuation rates varied by geographic region. The sample of respondents drawn from the High Desert communities of Phelan, Pinon Hills, Hesperia, and Baldy Mesa reported an evacuation rate of 39.5%. Those in Wrightwood reported a rate of 83.7%. The Canyon/Foothill communities of Lytle Creek and West Cajon Valley reported an evacuation rate of 92.9% (See Table 6).

Table 6

Cross-tabulation of evacuations by geographic area (n=214)

<u>Status</u>	<u>Geographic Area</u> ^a			
	High Desert (%)	Wrightwood (%)	Canyons/Foothills (%)	Total N (%)
Evacuated				
Yes	62 (39.5)	36 (83.7)	13 (92.9)	111 (100)
No	95 (60.5)	7 (16.3)	1 (7.1)	103 (100)
Total N	157 (100)	43 (100)	14 (100)	214 (100)

^a Seven cases did not report geography

Multivariate Analyses

Cox Proportional Hazards Regression

The results from the multivariate model presented in Table 7 reveal that after controlling for other model covariates, statistically significant differences were observed in time to evacuation by gender, years lived in home, and two of the prior evacuation and refusal variables (those with evacuation experience only and those with both evacuation and refusal experience).

Table 7

Multivariate Cox Proportional Hazards Regression Model (n=221)

Variable	Hazard Ratio (e)	95% CI	P-value
<u>Gender</u>			
Female	1.53	[1.04-2.26]	0.03*
Male	1		
<u>Prior Evacuation Experience</u>			
Evacuation Experience Only	1.89	[1.22-2.94]	0.005**
Refusal Experience Only	0.66	[0.315-1.37]	0.236
Both Evacuation and Refusal	1.8	[1.05-3.08]	0.031*
Neither Evacuation nor Refusal	1		
<u>Years Lived in Home</u>	0.98	[0.959-0.998]	0.036*
<u>Number of Pets or Livestock</u>	0.965	[0.916-1.018]	0.195

*Significant at the $p < 0.05$ level**Significant at the $p < 0.01$ level

Sub-Analysis of Evacuation Refusal

When respondents were asked why they did not evacuate during the Blue Cut fire, more than half cite the fire's distance as a reason (i.e. the fire was too far away). More than one-third report they felt safe and were not in danger or at risk. A smaller number reported animal concerns, alternative protective actions, and other reasons (see Table 8).

Table 8

*Those not evacuating because of the Blue Cut fire were asked: "why did you not evacuate?"
These are the reasons given (n=105)*

Variable Description	n	% ^{a,b}
Fire was too far away	56	(53.3)
Felt safe	36	(34.3)
Prepared to leave but wanted to make own decision	19	(18.1)
Unsure whether they were under an evacuation order	19	(18.1)
Worried about looting/thieves	12	(11.4)
Stayed to defend property	8	(7.6)
Unhappy with fire and evacuation information	7	(6.7)
Evacuations are unnecessary	6	(5.7)
Concerned about leaving/transporting/sheltering animals	6	(5.7)
Evacuation periods are too long	4	(3.8)
Did not trust the government	2	(1.9)
Don't know	2	(1.9)

^a Valid percent reported

^b Percentages do not equal 100% due to multiple responses

Discussion

Understanding the evacuation behavior of residents threatened by wildfire may help emergency management officials better plan and prepare for future evacuation events. The present analysis adds to the understanding of wildfire evacuation behavior by indentifying the timing characteristics of those who evacuated during the 2016 Blue Cut fire.

Overall Evacuation Rate

The results of this study support the hypothesis (H1) that no more than 90% of residents issued a mandatory evacuation order would actually evacuate within two-hours of receiving the order. While these results partially support work by Mozumbder et al. (2008) and Roberson et al. (2012) by demonstrating that not everyone evacuates when faced with a mandatory evacuation order, they also highlight the discrepancy between *intended* evacuation behavior and *actual* evacuation behavior. While the literature on intended wildfire evacuation behavior shows that up to 90% of residents state they will evacuate when faced with a mandatory order, only 51.1% (113/221) actually did so during the Blue Cut fire. More alarming, given the danger of last minute evacuation (Handmer & Tibbits, 2005; Haynes et al., 2010), was the fact that only 25.8% (57/221) evacuated in two hours or less. These two findings confirm that it takes more than just issuing a mandatory evacuation order to motivate people to leave their home and that the social and psychological processes in which people engage add time to the evacuation decision making process.

Evacuation Rates Across Different Communities

While the overall Blue Cut fire evacuation rate of surveyed residents was only 51%, the individual evacuation rates of affected communities varied based on proximity to the fire. Backed by a strong body of literature (Bourque et al., 1971; Flynn, 1979; Baker, 1979; Aguirre, 1991; Bateman & Edwards, 2002; Houts et al., 1984) and supporting the hypothesis (H2) that communities closest to the fire would demonstrate greater overall evacuation rates and a shorter time to evacuation, was the finding that evacuation rates decreased the farther away a community was from the fire. For example, the communities of West Cajon Valley and Lytle Creek (classified as the Canyon/Foothill communities) reported a 92.9% (13/14) evacuation rate. The

next closest community, Wrightwood, reported a 83.7% (36/43) evacuation rate and the communities of Phelan, Pinon Hills, Hesperia, and Baldy Mesa (classified as the High Desert communities) reported an evacuation rate of 39.5% (62/157).

In addition to the relationship between fire proximity and evacuation rate, other factors that may have influenced the decision to evacuate from those closest to the fire including fire intensity, the damage caused by the fire, and the number of structures lost in the communities closest to the fire.

Past Experience

Results from the multivariate analysis demonstrate that after considering and controlling for resident age, gender, general wildfire preparedness, years lived in home, children in the household, and pet and livestock ownership, residents with past evacuation experience were more likely to have evacuated in response to the Blue Cut fire compared to those without past wildfire evacuation experience. In support of hypothesis 3 was the finding that residents who had evacuated in the past because of wildfire (and had never refused an order) had 1.89 times the odds of evacuating due to the Blue Cut fire, compared to those with no experience. Likewise, those with both prior evacuation experience and refusal experience were at 1.8 times the odds of evacuation, compared to those with no experience whatsoever.

The association between past evacuation experience and current evacuation behavior may be explained by self-efficacy. Since we do know that those with more knowledge of protective actions are more likely to respond to hazard warnings (Leik et al., 1981; Liverman & Wilson; 1981; Rodgers, 1985; Lindell & Perry, 1987), and that those with past evacuation experience have been shown to be more likely to do so again during future events (Baker, 1991), it is reasonable to assume that self-efficacy is enhanced in residents who successfully navigate the

sometimes laborious and disruptive process of wildfire evacuation. However, self-efficacy was not directly measured during the course of this study and therefore deserves further investigation.

Wildfire Preparedness Activities

In contrast to hypothesis (H4) was the finding that there was no association between a respondent's general wildfire preparedness level and their Blue Cut fire evacuation timing and compliance rate. Given this result, a logical follow-up question is whether Southern California WUI residents performed wildfire preparedness activities for reasons other than evacuation, such as sheltering-in-place or staying and defending property. Results from the sub-analysis of non-evacuees, however, show that only 7.6% refused evacuation orders because of alternative protection actions. The lack of association between preparedness and protective action may be due to mediating variables such as risk perception (Martin, Martin, & Kent; 2009), and/or more complex relationships between variables like homeowner motivation, readiness to change, risk perception, and subjective knowledge (Martin, Bender, & Raish; 2007).

Gender

Consistent in much of the literature across a variety of hazards, and supporting hypothesis 5, was the finding that female respondents were at 1.5 times the odds of evacuating in response to the Blue Cut fire, compared to male respondents. While past research on the relationship between gender, evacuation, and hazard response has theorized that traditional family roles, socio-economic status, and risk-perception may account for these differences, a more detailed investigation is needed to explain why women reported a higher evacuation rate and a shorter time to evacuation in comparison to men.

Children in the Household

In contrast to hypothesis 6 was the fact that no association was found in the evacuation timing and compliance between households with and without children. While a number of studies have reported associations between children in the household and response to hazard warnings (Flynn, 1979; Quarantelli, 1980; Carter, 1983; Edwards, 1993; Fischer III, 1995), this study did not.

Pets and Livestock

Also lacking support is the hypothesis (H7) that as pet and/or livestock ownership increased, so would an increase in time to evacuation and a decrease in overall evacuation compliance. While pet and livestock ownership was included in the multivariate analysis, results did not yield statistically significant differences. Additionally, only 5.7% of those not evacuating in response to the Blue Cut fire stated animal concerns as the reason.

Additional Findings

Number of residents affected by evacuation order.

While not an initial aim of this study, identifying the total number of people affected by Blue Cut evacuation orders became a priority after discovering the skepticism local residents had about the evacuation totals communicated by incident management officials and media outlets. At the time of the fire, the claim that up to 82,000 residents and 34,500 households were under a mandatory evacuation order was widely reported (Parvini, Vives, & Shyong, 2016; “Blue Cut fire: latest on evacuations,” 2016; Madison & Gull, 2016). I first questioned the accuracy of this claim when I began to pre-test the study questionnaire on residents living in Wrightwood. During pre-testing, residents familiar with the communities impacted by the Blue Cut fire expressed doubt about the official figures reported in the news. Investigating the claim was

easily accomplished, since I had to re-create the evacuation perimeter and identify all affected households in order to create the study's sampling frame. Mapping the evacuation perimeter and identifying all affected residential parcels containing dwellings yielded 12,308 households. Using 2015 San Bernardino County specific U.S. Census estimates of 3.3 people per household (US Census Bureau, 2016), I estimate that only 40,616 people were affected by Blue Cut fire evacuation orders, which is less than half of the 82,000 reported in the media. If this finding is accurate, it validates the complaints some members of the community had about the quantity, timeliness, and accuracy of information coming from incident management officials and the media.

Limitations

Several limitations of this study deserve mention. First, since this is a cross-sectional observational study and not a controlled experiment, causal ordering cannot be assumed. Therefore, only associations between the study's dependent and independent variables are reported.

Next, while a simple random sample of households was drawn for this study, a within-unit randomization technique was not used to randomize individuals within households. Anticipating that the majority of survey responses would be by mail questionnaire and not by phone interview, I decided against using the Kish selection procedure for fear it would be too complex for respondents to self-administer. The last-birthday method was also considered for within-household randomization but as Battaglia, Link, Frankel, Osborn & Mokdad (2008) demonstrate, the technique may yield the same results as the any-adult method. In the end, I chose to use the any-adult member selection procedure to minimize the potential burden placed on respondents by including complex or confusing instructions.

Finally, due to financial constraints, the survey instruments were administered in English only. This may have kept non-English speakers, and those who have varying degrees of literacy, from participating. While attempts were made to craft language appropriate for those with lower literacy skills, the fact that 2003 San Bernardino County data shows that up to 20% of the population lacked basic prose literacy skills (National Center for Educational Statistics, 2003) remains a concern. Likewise, while U.S. Census figures for San Bernardino County show that 41% of people age 5 or older speak a language other than English at home (75% of which is Spanish), the figures also show that more than half of those report speaking English “very well” (U.S. Census Bureau, 2015). Nevertheless, the fact that non-English speakers may have been excluded from participating remains a limitation.

Assumptions

This study assumed that all members of households behaved in the same fashion when faced with the decision to evacuate. For single member households, and many multi-member households, this may be true. However, at least a handful of respondents indicated they had stayed with their home while the rest of their family evacuated. This topic deserves further study.

This study also assumed that respondents would be able to accurately recall the details of their evacuation experience. While Bourque and colleagues (1997) found that memory fade might not be as common as widely assumed, data collection for this study began three weeks after the end of the Blue Cut fire to minimize the effects of recall bias on study results.

Finally, this study wrongly assumed that people would be at home at the time of evacuation. While this assumption did not negatively impact the results of this work, small changes to the survey instruments could have been made to reflect this reality.

Conclusions and Recommendations

Given the fact that the most significant finding of this study was that those with past evacuation experience were almost twice as likely to evacuate compared to those with no experience, emergency management officials may want to consider conducting wildfire evacuation drills to make WUI residents more accustomed to the physical and mental tasks associated with the act of evacuation. While the effect of evacuation drills on evacuation compliance has not been studied in the wildland setting, some Southern California fire organizations have initiated the practice (Boxall & Saillant, 2009). In addition, given the unequal evacuation rates among different communities based on proximity to the fire, law enforcement may want to reduce the size of its reverse-911 evacuation zones and/or reduce the size of future evacuation perimeter footprints by excluding blocks of homes in traditional urban neighborhoods (where house-to-house fire spread is not common). Comments from respondents such as: “500 homes would have had to burn before the fire got to mine;” “Fire was over 10 miles away;” and “received an automated phone call but Sheriff never came by and did not see fire trucks;” reinforce the fact that many felt the evacuation zone was too large. While designing smaller evacuation zones would initially be time consuming, smaller zones would create smaller areas to patrol by law enforcement and would result in more deputies per unit of area. More deputies per unit of area would also mean that residents would have more visual cues that evacuation was necessary and increase the confidence of residents that their homes would be safe if they chose to evacuate.

Finally, local emergency management officials may want to consider the quality of the information they release to the media and to the public. Reports that 83,000 residents were under evacuation orders did not reassure those skeptical of media and government agency accuracy and

reporting. Building trust between local agencies and the local community is essential, so that the next time a threatening wildfire strikes and threatened populations are asked to evacuate they will do so.

APPENDICIES

Appendix A: Preliminary Postcard

Dear resident,

Next week you will receive a questionnaire from UCLA about how your community responded to the Blue Cut fire. We expect it to take 10 to 20 minutes to complete and invite you to participate.

Results from this study will help identify more effective ways of communicating with and protecting, residents who live in areas prone to wildfire. The findings will be shared with community groups and emergency officials, and may be published in professional journals.

There are no known risks associated with participating in this study. Your participation is completely voluntary but you must be at least 18 years of age to complete a questionnaire. Your responses are confidential and the results will not include any information that identifies you, such as your name or address.

If you have any questions about this research study please contact me by phone at (xxx) xxx-xxxx, or by email at xxxxxxxxx@ucla.edu

Sincerely,

Brian Roberson – UCLA Fielding School of Public Health
650 Charles E Young Dr S, Los Angeles, CA 90024

Appendix B: Recruitment Letter and Study Questionnaire

UNIVERSITY OF CALIFORNIA, LOS ANGELES

BERKELEY - DAVIS - IRVINE - LOS ANGELES - MERCED - RIVERSIDE - SAN DIEGO - SAN FRANCISCO



UCLA

SANTA BARBARA - SANTA CRUZ

FIELDING SCHOOL OF PUBLIC HEALTH
P.O. BOX 951772
LOS ANGELES, CALIFORNIA 90095-1772

Dear resident,

My name is Brian Roberson and I am a graduate student working under the direction of Dr. Linda Bourque at UCLA's Fielding School of Public Health. I am conducting a research study on how Southern California residents respond to wildfire. I invite you to participate by taking 10 to 20 minutes to fill out the enclosed questionnaire.

The goal of this research study is to develop more effective ways of communicating with, and protecting, residents who live in areas prone to wildfire. The research findings will be shared with community groups and emergency management officials, and may be published in professional journals.

There are no known risks associated with participating in this study. Your participation is completely voluntary but you must be at least 18 years of age to complete the questionnaire. Your responses are confidential and the results will not include any information that identifies you, such as your name or address.

If you have any questions about this research study please contact me by phone at (xxx) xxx-xxxx, or by email at x.xxxxxxxx@ucla.edu. If you have questions about your rights while taking part in this study, please call the Office of the Human Research Protection Program at (310) 825-7122.

Returning this questionnaire in the envelope provided is considered your consent to participate.

If you would like to participate in this research study by phone please call (xxx) xxx-xxxx. An online version of the study questionnaire is also available at:
<https://www.surveymonkey.com/r/bluecutfire>

Thank you very much for your time and assistance. Brian Roberson
UCLA Fielding School of Public Health. 650 Charles E Young Dr S, Los Angeles, CA 90024

VARIABLE NAMES APPEAR IN RED

ID#_____ ID (4)

Mode_____ MODE (1)

Area_____ AREA (1)

Question 1-19 ask about your experiences during the Blue Cut fire. For each question, circle the number that corresponds with your answer or fill in the blank.

1. During the Blue Cut fire, did you evacuate from your home?

YES.....1

EVAC_STATUS (1)

NO.....SKIP TO QUESTION 20.....2

2. What was the date and approximate time of your evacuation?

DATE:_____

DATE (1)

TIME:_____

TIME (1)

3. Did you evacuate after receiving or learning about a...

Voluntary evacuation order,..... 1

TYPE (1)

Mandatory evacuation order,..... 2

Not sure what type of order it was, or..... 3

I did not know of any evacuation orders,

I left on my own?.....SKIP TO QUESTION 8.....4

4. How did you find out about the evacuation order(s)?

CIRCLE ALL THAT APPLY

a) Saw them on the television..... 1 HOW_A (1)

b) Heard about them on the radio.....1 HOW_B (1)

c) Learned of them through social media..... 1 HOW_C (1)

d) Saw them on the Internet (non-social media).....1 HOW_D (1)

e) Through face-to-face communication..... 1 HOW_E (1)

f) Through telephone/cell phone..... 1 HOW_F (1)

g) Saw neighbors evacuating..... 1 HOW_G (1)

h) Announcement was made by loudspeaker..... 1 HOW_H (1)

i) In some other way: 1 HOW_I (1)

Please specify_____

HOW_QUAL (100)

5. How long after you received the order did you evacuate?

NUMBER OF DAYS: _____

NUMBER OF HOURS: _____ EVAC_TIME (3)

NUMBER OF MINUTES: _____

6. Who told you about the evacuation order(s)?

CIRCLE ALL THAT APPLY

- | | | |
|---------------------------------------|---|---------------|
| a) Incident Management Officials..... | 1 | WHO_A (1) |
| b) Firefighters..... | 1 | WHO_B (1) |
| c) Law Enforcement..... | 1 | WHO_C (1) |
| d) TV Anchors or Reporters..... | 1 | WHO_D (1) |
| e) Radio Hosts or Reporters..... | 1 | WHO_E (1) |
| f) Friends..... | 1 | WHO_F (1) |
| g) Relatives..... | 1 | WHO_G (1) |
| h) Neighbors..... | 1 | WHO_H (1) |
| i) Other Source:..... | 1 | WHO_I (1) |
| Please specify _____ | | WHO_QUAL (50) |

7. How long were you evacuated?

NUMBER OF DAYS: _____ EVAC_LENGTH (3)

NUMBER OF HOURS: _____

8. Where did you stay after you evacuated your home?

_____ WHERE (200)

9. Did you return to your property before evacuation orders were lifted?

YES..... 1 RETURN (1)

NO.....SKIP TO QUESTION 10..... 2

9A. Why did you return to your property?

_____ WHY_RETURN (200)

10. Did you contact any neighbors who did not evacuate to ask for updates or to check on your home?

YES..... 1 UPDATES (1)

NO..... 2

11. When you evacuated your home, how far were you from the fire in miles or number of city blocks?

_____ DISTANCE (4)

12. Could you see smoke when you evacuated?

YES..... 1 SMOKE (1)

NO.....SKIP TO QUESTION 13..... 2

12A. How long was it between the first time you saw smoke and your eventual evacuation?

NUMBER OF DAYS: _____

NUMBER OF HOURS: _____

NUMBER OF MINUTES: _____

SMOKE_EXPOSURE (4)

13. Could you see flames when you evacuated?

YES..... 1 FLAMES (1)

NO.....SKIP TO QUESTION 14..... 2

13A. How long was it between the first time you saw flames and your eventual evacuation?

NUMBER OF DAYS: _____

NUMBER OF HOURS: _____

NUMBER OF MINUTES: _____

FLAME_EXPOSURE (4)

14. Could you see firefighters when you evacuated?

YES..... 1 FF (1)

NO.....SKIP TO QUESTION 15..... 2

14A. How long was it between the first time you saw firefighters and your eventual evacuation?

NUMBER OF DAYS: _____

NUMBER OF HOURS: _____

NUMBER OF MINUTES: _____

FF_EXPOSURE (4)

15. Could you see law enforcement personnel when you evacuated?

YES..... 1 LAW (1)

NO.....SKIP TO QUESTION 16..... 2

15A. How long was it between the first time you saw law enforcement personnel and your eventual evacuation?

NUMBER OF DAYS: _____

NUMBER OF HOURS: _____

NUMBER OF MINUTES: _____

LAW_EXPOSURE (4)

16. Did road or traffic conditions slow your evacuation?

YES..... 1 **TRAFFIC (1)**

NO..... 2

TRAFFIC_QUAL (100)

17. Before you evacuated, how satisfied were you with the information you received from news sources and/or emergency officials on the following topics? Circle 1 for “very dissatisfied,” 6 for “very satisfied” or any number in between.

	Very Dissatisfied	Somewhat Satisfied	Very Satisfied	
a) Status of the fire	1.....2.....3.....4.....5.....6			INFO_BEFORE_A (1)
b) Evacuation warnings	1.....2.....3.....4.....5.....6			INFO_BEFORE_B (1)
c) Evacuation center locations	1.....2.....3.....4.....5.....6			INFO_BEFORE_C (1)
d) Road closure information.....	1.....2.....3.....4.....5.....6			INFO_BEFORE_D (1)
e) Hazards posed by fire.....	1.....2.....3.....4.....5.....6			INFO_BEFORE_E (1)

18. After you evacuated, how satisfied were you with the information you received from news sources and/or emergency officials on the following topics? Circle 1 for “very dissatisfied,” 6 for “very satisfied” or any number in between.

	Very Dissatisfied	Somewhat Satisfied	Very Satisfied	
a) Status of the fire	1.....2.....3.....4.....5.....6			INFO_AFTER_A (1)
b) Evacuation center locations ..	1.....2.....3.....4.....5.....6			INFO_AFTER_B (1)
d) Road closure information.....	1.....2.....3.....4.....5.....6			INFO_AFTER_C (1)
e) Status of your home.....	1.....2.....3.....4.....5.....6			INFO_AFTER_D (1)
e) Status of your community.....	1.....2.....3.....4.....5.....6			INFO_AFTER_E (1)
e) Length of evacuation.....	1.....2.....3.....4.....5.....6			INFO_AFTER_F (1)

19. During this fire, evaluate the amount of risk you faced for each of the following.
Circle 1 for “no risk,” 6 for “lots of risk” or any number in between.

	No Risk	Some Risk	Lots of Risk
a) Risk of injury to myself	1.....2.....3.....4.....5.....6		RISK_A (1)
b) Risk of death to myself	1.....2.....3.....4.....5.....6		RISK_B (1)
c) Risk of injury to my family.....	1.....2.....3.....4.....5.....6		RISK_C (1)
d) Risk of death to my family.....	1.....2.....3.....4.....5.....6		RISK_D (1)
e) Risk of fire damage to my home....	1.....2.....3.....4.....5.....6		RISK_E (1)
f) Risk of total home loss.....	1.....2.....3.....4.....5.....6		RISK_F (1)

SKIP TO QUESTION 23

20. You stated that you did not evacuate, why did you choose not to evacuate your home?

_____ Q20_WHY_NOT_EVAC (250)

(POST CODE – SEE LAST PAGE)

21. While staying with your home, did you actively defend your home from wildfire?

YES..... 1 DEFEND (1)

NO.....SKIP TO QUESTION 22..... 2

21A. What did you do to defend your home?

_____ DEFEND_ACTIONS (175)

22. Did you check on, or care for, neighboring properties while you stayed with your own property?

YES..... 1 CHECK_NEIGHBORS (1)

NO..... 2

The following questions ask about your house and your neighborhood.

23. Do you consider your home to be in a high fire hazard area?

YES.....	1	HAZARD (1)
NO.....	2	

24. Is your home immediately surrounded by:

Other homes,.....	1	FUEL (1)
Natural vegetation, or.....	2	
A mix of other homes and natural vegetation?.....	3	

25. In your opinion does your home have “defensible space”?

YES.....	1	DEF_SPACE (1)
NO.....	SKIP TO QUESTION 26.....	2
NOT SURE.....	SKIP TO QUESTION 26.....	3

25A. How many feet of “defensible space” do you have?

NUMBER OF FEET: _____	SPACE_FEET (4)
-----------------------	----------------

26. What is the roof on your house made of? Is it:

Wood shake shingle,.....	1	ROOF (1)
Asphalt shingle,.....	2	
Ceramic tile,.....	3	
Metal,.....	4	
Some other material, or	5	

Please specify:_____	ROOF_QUAL (50)
----------------------	----------------

You are not sure?.....	6
------------------------	---

Questions 27-31 ask about your past experience with wildfire.

27. Prior to the Blue Cut fire, had you ever evacuated because of a wildfire?

YES..... 1 **PRIOR_EVAC (1)**

NO..... SKIP TO QUESTION 28..... 2

27A. How many times have you evacuated because of wildfire?

NUMBER OF TIMES: _____ **NUMBER_EVAC (1)**

28. Prior to the Blue Cut fire, had you ever received an evacuation order and chosen not to evacuate?

YES..... 1 **PRIOR_NON_EVAC (1)**

NO..... SKIP TO QUESTION 29..... 2

28A. How many times had you received an evacuation order and chosen not to evacuate?

NUMBER OF TIMES: _____ **NUMBER_NON_EVAC (1)**

29. Prior to the Blue Cut fire, had your home ever been damaged by wildfire?

YES..... 1 **PRIOR_DAMAGE (1)**

NO..... 2

30. Prior to the Blue Cut fire, did you know anyone whose home had been damaged by wildfire?

YES..... 1 **KNOW_DAMAGE (1)**

NO..... 2

31. The following is a list of activities that homeowners living in high fire hazard areas sometimes do. For each activity listed, please indicate whether you have done the activity in the last 12 months or at any time in your life.

	In your lifetime?	In the last 12 months?
a. Removed brush, grass or vegetation around your home?	YES...1 ACT_LIFE_A NO....2	YES...1 ACT_YEAR_A NO....2
b. Boxed in eaves to help prevent firebrands or embers from entering your home?	YES...1 ACT_LIFE_B NO....2	YES...1 ACT_YEAR_B NO....2
c. Installed screens or mesh to cover home openings?	YES...1 ACT_LIFE_C NO....2	YES...1 ACT_YEAR_C NO....2
d. Designated a family meeting place away from your home?	YES...1 ACT_LIFE_D NO....2	YES...1 ACT_YEAR_D NO....2
e. Made improvements to your property's water storage capacity?	YES...1 ACT_LIFE_E NO....2	YES...1 ACT_YEAR_E NO....2
f. Duplicated important documents?	YES...1 ACT_LIFE_F NO....2	YES...1 ACT_YEAR_F NO....2
g. Purchased home firefighting equipment such as hose, pumps or fire sprinklers?	YES...1 ACT_LIFE_G NO....2	YES...1 ACT_YEAR_G NO....2
h. Purchased fire gel?	YES...1 ACT_LIFE_H NO....2	YES...1 ACT_YEAR_H NO....2
i. Had a home safety inspection by the fire department?	YES...1 ACT_LIFE_I NO....2	YES...1 ACT_YEAR_I NO....2
j. Purchased a fireproof safe?	YES...1 ACT_LIFE_J NO....2	YES...1 ACT_YEAR_J NO....2
k. Participated in a wildfire evacuation drill?	YES...1 ACT_LIFE_K NO....2	YES...1 ACT_YEAR_K NO....2

There are many sources that provide information about fire conditions. Question 32 asks how trustworthy you find them.

32. On a scale of 1 to 6, with 1 meaning “no trust” and 6 meaning “lots of trust”, how trustworthy do you rate the following information sources?

	No Trust	Some Trust	Complete Trust	
a) Incident Management Officials ..	1.....2.....3.....4.....5.....6			TRUST_A (1)
b) Fire Department	1.....2.....3.....4.....5.....6			TRUST_B (1)
c) Law Enforcement.....	1.....2.....3.....4.....5.....6			TRUST_C (1)
d) Red Cross.....	1.....2.....3.....4.....5.....6			TRUST_D (1)
e) TV Anchors or Reporters.....	1.....2.....3.....4.....5.....6			TRUST_E (1)
f) Radio Hosts or Reporters.....	1.....2.....3.....4.....5.....6			TRUST_F (1)
g) Friends.....	1.....2.....3.....4.....5.....6			TRUST_G (1)
h) Relatives.....	1.....2.....3.....4.....5.....6			TRUST_H (1)
i) Neighbors.....	1.....2.....3.....4.....5.....6			TRUST_I (1)

The last set of questions are about you. All responses are confidential.

33. Are you:

Male, or 1

GENDER (1)

Female?..... 2

34. How old were you on your last birthday?

AGE IN YEARS: _____

AGE (3)

35. What was your total household income before taxes in 2015?

TOTAL INCOME: _____

INCOME (7)

36. Including yourself, how many people are there in your household?

NUMBER OF PEOPLE: _____

HOUSEHOLD (2)

37. How many people under 18 are there in your household?

NUMBER UNDER 18: _____

HOUSEHOLD_KIDS (2)

38. How many (if any) cats, dogs, horses, and other livestock do you own

NUMBER OF CATS:..... _____ CATS (2)
NUMBER OF DOGS:..... _____ DOGS (2)
NUMBER OF HORSES:..... _____ HORSES (2)
NUMBER OF OTHER LIVESTOCK:..... _____ LIVESTOCK (2)
TOTAL_ANIMALS (3)

39. Do you own or rent the home that was subject to evacuation orders?

Own..... 1 OWN (2)
Rent..... 2
Other..... 3
Please explain: _____ OWN_QUAL (50)

40. How many years have you lived in your current home?

NUMBER OF YEARS: _____ YEARS_LIVED (2)

41. How many years have you lived near wildfire prone areas?

NUMBER OF YEARS: _____ YEARS_WUI (2)

42. Do you have any other information that would help us understand decisions to evacuate, or not, during a wildfire?

CLOSING_QUAL (1350)

Thank you for your assistance!

Please mail your completed questionnaire using the enclosed self-addressed stamped envelope. If you misplaced your envelope, please mail to:

UCLA Research Study
c/o Brian Roberson
xxxx Street, xxxxx, CA.

Q.20 POST CODING

The fire was too far away

NO..... 0 FAR_AWAY

YES.....1

Not at risk or in danger from fire

NO..... 0 NO_DANGER

YES.....1

Stayed to defend property

NO..... 0 STAY_AND_DEFEND

YES.....1

Concerned about leaving/transporting/sheltering animals

NO..... 0 ANIMAL_CONCERN

YES.....1

Evacuation is unnecessary

NO..... 0 EVAC_UNNECESSARY

YES.....1

Evacuations periods are too long

NO..... 0 TOO_LONG

YES.....1

Prepared to leave but wanted to make own decision

NO..... 0 PREPARED_BUT_WAITING

YES.....1

Unsure whether they were under an evacuation order

NO..... 0 NOT_SURE_ORDERS

YES.....1

Worried about looting and/or thieves (variable name: *LOOTERS*)

NO..... 0 LOOTERS

YES.....1

Were unhappy with information about fire and evacuation

NO..... 0 BAD_INFO

YES.....1

Did not trust the government

NO..... 0 NO_TRUST_GOV

YES.....1

Did not know why they refused evacuation orders

NO..... 0 DONT_KNOW

YES.....1

Appendix C: Reminder Postcard

Dear resident,

A few weeks ago our UCLA research team sent you a questionnaire and invited you to participate in a Blue Cut fire research study. If you have not already done so, we encourage you to fill out the questionnaire and return it using the stamped envelope that was provided.

To request another questionnaire, please call (xxx) xxx-xxxx. You can also participate online at: <https://www.surveymonkey.com/r/bluecutfire>

Thank you again for your help. Your responses will help identify more effective ways of communicating with and protecting residents who live in areas prone to wildfire.

Sincerely,

Brian Roberson - UCLA Fielding School of Public Health

Questionnaire mailing address: 123 Main Street. Los Angeles, CA. 90031

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