



# If you love it, let it go: the role of home attachment in wildfire evacuation decisions

Hugh D. Walpole<sup>1</sup> · Robyn S. Wilson<sup>1</sup> · Sarah M. McCaffrey<sup>2</sup>

Published online: 15 October 2019

© This is a U.S. Government work and not under copyright protection in the US; foreign copyright protection may apply 2019

## Abstract

Evacuation is the preferred method in the U.S. for preserving public safety in wildfire. However, alternatives such as staying and defending are used both in North America and Australia. Dangerous delays in the decision to evacuate are also common. One contributor to the evacuation decision is attachment to the home, however, little research has examined its role in evacuation decisions. We explored the role of home attachment in the evacuation decision and the effectiveness of communication and other cues in motivating safer, more decisive response actions. Using an online sample ( $n = 268$ ), we conducted a 3 (information)  $\times$  2 (physical cue) experimental design. We hypothesized that higher home attachment would increase intentions to stay and defend the home, or to wait and see before making the decision to evacuate. We also hypothesized that the effect of information and cues on behavioral intentions would be conditional on residents' attachment to their home. Surprisingly, with high attachment, defense benefit information and the presence of physical cues decreased waiting intentions. With low attachment, defense benefit information increased waiting intentions and cues had no effect. Our findings suggest that caution should be used when communicating about the benefits of home defense in isolation, as this may motivate decision delays.

**Keywords** Decision-making · Communication · Risk

## 1 Introduction

Wildfire is a hazard that is threatening an increasing number of people and an increasing amount of property in the United States. Biophysical conditions resulting from more than a century of suppression-based management in the U.S. (Agee 1996) and hotter and drier conditions as a result of climate change (Barbero et al. 2015) make larger, more severe wildfires increasingly more likely in many locales. Additionally, migration into quasi-rural or outlying urban areas that make up the Wildland–Urban Interface (WUI) mean that more lives and more properties are at-risk from wildfire than ever before (Martin et al. 2008; Hammer et al. 2009). For instance, housing units in the U.S. WUI increased by 8 million (or a 22% increase) during the 1990s (Hammer

et al. 2009) and estimates from 2010 suggest that the total number of U.S. residences in the WUI is around 44 million (Martinuzzi et al. 2015). Taken together, these trends make understanding how and when people respond to wildfire an increasingly urgent issue. While evacuation is the default response to a wildfire in North America (McCaffrey et al. 2015; McLennan et al. 2019), interest in understanding different evacuation decisions, particularly why many do not evacuate immediately is growing among residents, managers, and researchers.

When faced with the threat of wildfire, residents have a difficult and complex decision to make about what actions they are going to take in response. While early evacuation is commonly considered the least risky strategy with respect to personal safety (Cova et al. 2009; Teague et al. 2010; McLennan et al. 2015a), it precludes the possibility of engaging in active strategies for reducing the risks of property damage such as patrolling the property before and after the flame front to extinguish spot fires and dislodge embers (a strategy commonly known as “staying and defending” the home). The tradeoff between the two strategies is highlighted in McNeil et al. (2015) who found that perceived similarity between the value of the two strategies

✉ Hugh D. Walpole  
walpole.23@osu.edu

<sup>1</sup> School of Environment and Natural Resources, The Ohio State University, 210 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210, USA

<sup>2</sup> Rocky Mountain Research Station, USDA Forest Service, 240 West Prospect, Fort Collins, CO 80526, USA

resulted in delays in committing to a course of action. Just as important as whether people choose to evacuate or not is *when* they choose to evacuate if they do so. Because fire behavior is unpredictable, leaving late can put people at risk of being caught by the fire-front or being exposed to dangerous amounts of radiant heat (Tibbitts and Whittaker 2007; Haynes et al. 2010). Delaying the decision to evacuate, then, is one of the more dangerous response strategies a resident can engage in when faced with the threat of wildfire. Yet, a significant portion of people (in some studies as much as 30–60%) consistently display waiting behavior or even plan to wait and assess the risk when faced with wildfire in the future (Rhodes 2005; McCaffrey and Winter 2011; McLennan et al. 2014, 2015b; McCaffrey et al. 2018). Delaying commitment to a course of action in evacuations has been attributed to a number of possible causes including a desire for more information before making a decision (McNeill et al. 2015), anxiety about the severity of the threat when it becomes apparent (McLennan et al. 2012), and uncertainty regarding the level of threat or safe evacuation routes (McLennan et al. 2019). Other potential explanations include a variety of cognitive biases such as confirmation bias, anchoring, and the planning and sunk cost fallacies, which all contribute to how available information about wildfire may be attended to and subsequently interpreted to inform action or inaction in a crisis (Adam and Gaudou 2017; Adam et al. 2018; Kinsey et al. 2019). Finally, some who plan to stay and defend retain evacuation as a last resort option, which subsequently leads to late evacuation (Tibbitts and Whittaker 2007), while some who plan to evacuate plan to wait for an official or other cue to do so (McCaffrey and Winter 2011; McCaffrey et al. 2018).

While some research has examined social and psychological determinants of residents' preferences for one response strategy or another (Cohn et al. 2006; Paveglione et al. 2010; McLennan et al. 2014, 2015a), less research has examined how communication about the risks and benefits of different wildfire response strategies might affect people's perceptions of these strategies or intentions to engage in them. However, a recent exception (Adam et al. 2018) employing agent-based modeling to examine potential impacts of messaging during a fire event, shows promising results for increasing early evacuation in computer simulations by using messages that highlight the effectiveness of evacuation in the face of a wildfire for agents most motivated to avoid threats. In light of the findings by McNeill et al. (2015), that difficulty in distinguishing between the value of early evacuation versus staying and defending (what they call low "distinctiveness" in benefits between strategies) can delay commitment to a response strategy, a better understanding of the effects of communicating the risks and benefits of different wildfire strategies is needed. If early evacuation is the default strategy and is subsequently perceived as high value

due to the well-documented human preference for the status quo (Samuelson and Zeckhauser 1988), then increasing the value of defending may reduce the perceived difference in value between the two strategies. In line with results from McNeill et al. (2015), this in turn may increase the likelihood that residents choose to delay taking one beneficial course of action (i.e., evacuation) to preserve the possibility of engaging in the other, equally beneficial course of action (defense). This suggests that increasing the perceived value of an alternative strategy through communication about its benefits, however well intentioned, may be problematic if such information is provided in isolation. Such an approach could lead to a greater equality in perceived value between the two strategies and may actually increase objective danger by promoting waiting behavior rather than decreasing danger by promoting committed defense.

Mere presentation of information about the risks associated with hazards consistently fails to have a strong effect on behavior overall in the context of a range of hazards, including wildfire (see McCaffrey 2004 for a review). This may be because levels of knowledge about the risks associated with wildfire are already high and additional information will not change people's minds (Whittaker and Handmer 2010) or because informational messages may be ignored (Adam et al. 2018). However, another possibility is that communicating about hazard risks rather than the benefits of individual response strategies may be less motivating (Slovic 1987; Ascher et al. 2013). Rather, information highlighting the individual benefits of a wildfire response strategy may be more likely to motivate people to engage in that strategy than information about the risks of opposing strategies (Ascher et al. 2013; McCaffrey 2015) or of wildfire itself.

In addition to judgments about the risks and benefits of different strategies, natural hazards studies show that people often use various cues as "triggers" to help them decide whether or when it is appropriate to evacuate (Lindell et al. 2005; Huang et al. 2012; McLennan et al. 2012; McCaffrey et al. 2018). While there are many potentially relevant cues including those from friends, family, and neighbors to official notices from local public safety departments, late evacuations are most typically triggered by the physical cue of visible flames (Tibbitts and Whittaker 2007). This can be problematic because the visible presence of a physical cue means that the flames are close at hand. While other cues may or may not occur at a time where it is safe to evacuate, using the physical presence of flames as a trigger for evacuation is most frequently going to lead people to evacuate too late for them to do so safely. In light of this, because we are interested in elements of the decision process that are likely to contribute to late evacuation, we are also interested in whether and how the presence of a physical cue alters people's behavioral intentions in the face of an evacuation.

Whether risk-relevant information comes in the form of communication about benefits or physical cues, individual cognitive factors may influence how decision-makers interpret that risk information (Slovic 1987). As a result, the effectiveness of attempts to alter risk or benefit perceptions using information are likely to be dependent on the psychology of the decision-maker. One psychological factor that may be particularly relevant in the interpretation of risk information and cues in the context of wildfire risks to property is a sense of attachment to the home. Home attachment may have an effect on how people view risks that threaten their property as well as the benefits of different mitigation strategies. If a person is particularly emotionally or cognitively attached to their home, then they are likely to view risks associated with the home as more severe. As a result, they might also be more likely to take steps to mitigate that risk. While there is considerable variance in the exact definitions of attachment in the social scientific literature that consider attachment to a wide variety of different targets including people and objects, here we are solely concerned with attachment to the structure and environs of the home as a particular place. In this context, place attachment is often conceptualized as a cognitive, emotional, and behavioral connection between a person and a particular place (Jorgensen and Stedman 2001), in this case, the home. A small but growing body of research examines the role that place attachment that is specific to the home (henceforth, “home attachment”) plays in wildfire preparedness and decision-making. This work generally finds that greater home attachment is associated with a range of preparedness measures at both the individual and community levels (Jakes et al. 2007; Kyle et al. 2010; Anton and Lawrence 2016; McCaffrey 2015). Most relevant for this study is quantitative research from Australia that found that homeowners who intended to stay and defend against bushfire tended to have higher attachment to their homes than those who planned to evacuate (McLennan et al. 2015a), and a study of a First Nation in Canada where attachment to the reserve area made leaving the area to evacuate both unappealing and distressing (McGee et al. 2019). Similarly, a series of qualitative post-fire interview studies show that emotional and financial attachment to the home and other property is a primary motivation for people to defend their homes while an attitude that homes and possessions are replaceable and not worth your life is a common response for those who choose to evacuate (see McLennan et al. 2015b for a review). Additionally, some U.S.-based research suggests that higher attachment to the home is predictive of engagement in home-based Firewise activities (as opposed to community-based activities) (Kyle et al. 2010).

These findings suggest that greater attachment might increase the perceived value of a strategy that would allow for the defense of property and reduce the uncertainty

associated with whether the home might be lost (a possibility even when homes have been prepared). Levels of attachment to the home may also be important in determining how risk-relevant information about wildfire response is interpreted in the context of the wildfire response decision. We would expect that information about the property protection benefits (in addition to the safety protecting benefits) of defending may be more effective at motivating defending (and hence potentially motivating later evacuations) for those who are highly attached to their homes. Similarly, for those who are not particularly attached to the home, the presence of a physical cue may highlight the need to evacuate immediately. On the other hand, for those with strong attachments to the home, the presence of a physical cue may highlight the risk the fire poses to the home. This may drive a desire to protect the home, potentially leading to further decision delays by enhancing the perceived value of defense.

The goal of this research is to investigate the effects of information about the benefits of wildfire response strategies and the presence of physical cues on decision-maker’s behavioral intentions, and the extent to which these effects are conditional on decision-maker’s attachment to the home. Specifically, what effect does information highlighting the safety benefits of early evacuation or the property protection benefits of staying and defending have on decision-maker’s intentions? What effect might the presence of flames have on a decision-maker’s intentions? How does this influence decisions to evacuate early versus delay evacuation by either waiting for more information, or planning to stay and defend but retaining late evacuation as a last resort? Finally, do these effects vary based on an individual’s personal attachment to the home?

Our specific hypotheses are outlined below:

**H1** Early evacuation benefit information will motivate early evacuation, decreasing waiting behavior.

**H2** Defense benefit information will motivate staying and defending, potentially increasing waiting behavior (planning to defend but evacuating if the risks become too great).

**H3** The relationship between exposure to defense benefit information and increased waiting behavior will be explained through (mediated by) defense benefit information contributing to smaller differences in the perceived benefits between evacuation and defending (that is, lower distinctiveness in benefits between strategies).

**H4** The presence of a physical cue will motivate early evacuation, decreasing waiting behavior.

**H5** The effects of Evacuation benefit information on waiting intentions will be attenuated when attachment is high.

**H6** The effects of defense benefit information on waiting intentions will be enhanced when attachment is high.

**H7** The effects of physical cues on waiting intentions will be attenuated when attachment is high.

## 2 Methods

### 2.1 Participants

Participants included 274 adults recruited through Prolific Academic (an online panel service similar to Amazon Mechanical Turk that allows participants to sign up online to take studies posted on the platform) in February of 2016. There was an initial total of 300 responses, from which 26 cases were removed before the analysis phase due to highly incomplete data, leaving a final  $n$  of 274. Recruiting was limited to participants who listed their state of residence as one considered to be at risk for wildfire to ensure that the threat of wildfire was at least familiar to participants from representations in local media, etc. A list of acceptable states was derived from a set of 10 states listed by the National Interagency Fire Center (NIFC) as having the largest number of wildfires in 2015 (Claims Journal 2015). States were then added to the list at the discretion of the first author to include other states in the continental U.S. considered to be “at-risk” for wildfire (CO, SC, NM). The final list included Alabama, Arizona, California, Colorado, Florida, Georgia, Montana, New Mexico, North Carolina, Oregon, South Carolina, Texas, and Washington state. Subsequent consideration revealed that there are several states at severe risk for wildfire that were not considered, including Idaho and Alaska. Additionally, it is worth noting that participants were not drawn exclusively from high-risk areas in those states, as a result, the sample likely includes some individuals who are not themselves immediately at-risk from wildfire. However, given that this is experimental work examining how risk information is interpreted differently in the context of a hypothetical decision, under-sampling certain states or levels

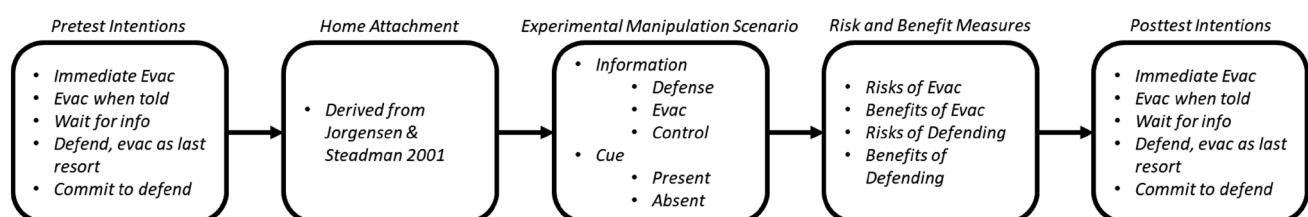
of experience is unlikely to invalidate the results. Participants were administered the experimental protocol online through Qualtrics online survey software and compensated \$1.35 for their participation.

## 3 Design

Figure 1 shows the layout of the experiment. Participants’ general intentions about what risk mitigation strategy they would engage in if threatened by a wildfire were measured first followed by items assessing attachment to the home. Participants were then randomly assigned to one of three sets of benefits information: early evacuation benefits, defense benefits, or a control (see experimental manipulation). Next, they received one of two additional sets of information in a scenario, one alerting the respondent to a physical cue of nearby flames, while the other scenario did not include a physical cue. The perceived risks and benefits of each strategy and participants’ post-test behavioral intentions were then measured. We carefully considered the order of questions and manipulations, while all participants answered questions in the same order, we believe that the potential for bias is minimal and that the question order was necessary in order to detect the experimental effects we needed in order to address our research questions.

### 3.1 Measurement

Pre-test behavioral intentions were measured with the following item: “Imagine you learn that there is a wildfire in a nearby natural area that may threaten you and your home, what do you think you would be most likely to do?” Participants were given 5 response options (Table 1) ranging from early evacuation to committed defense. Post-test intentions were measured with a similar item asking participants to respond specifically based on the scenario that was presented to them rather than more generally using the same 5 response options. Examination of the descriptive statistics (Table 1) showed that only 6 participants selected the committed defense option in the post-test. Because so few responses meant that there were insufficient data to make any analyses using these cases feasible, they were removed



**Fig. 1** Experimental design and order of measurement

**Table 1** Distribution of intended response strategies before and after experimental treatments

| Strategy                                                                                                                                                  | Pretest     |   | Posttest    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---|-------------|
| <i>Leave as soon as possible, even before an evacuation order is issued for my area<sup>a</sup></i>                                                       | 49 (17.9%)  | ↑ | 120 (43.8%) |
| <i>Leave as soon as an evacuation order is issued for my area<sup>a</sup></i>                                                                             | 158 (57.7%) | ↓ | 105 (38.3%) |
| <i>Leave only when I'm sure that it's going to be necessary, even if that means remaining after an evacuation order is issued for my area<sup>b</sup></i> | 43 (15.7%)  | ↓ | 29 (10.6%)  |
| <i>Plan to stay and defend but be prepared to leave if I decide the risk is too high<sup>b</sup></i>                                                      | 21 (7.7%)   | ↓ | 14 (5.1%)   |
| <i>Commit to staying and defending my property throughout the fire (assume that you've prepared to do so in advance)<sup>c</sup></i>                      | 3 (1.1%)    | ↑ | 6 (2.2%)    |

<sup>a</sup>Evacuation behavioral intention

<sup>b</sup>Waiting behavioral intention

<sup>c</sup>Excluded from analysis

from the dataset. The pre- and post-test measures were subsequently recoded as binary responses indicating early evacuation (responses 1 and 2) or waiting behavior (responses 3 and 4). This means that, while we are no longer able to account for those that committed to defending, we are able to more easily assess differences between those who choose to evacuate early and those who choose to delay their evacuation either to gather more information or because they retain evacuation as a last resort.

Home attachment was measured with a 12-item sense of place scale adapted from Jorgensen and Stedman (2001) (Table 2). Participants were asked to respond on a scale of 1 (strongly disagree) to 5 (strongly agree) for each of the statements shown in Table 2. Participants were asked to consider every aspect of their property (i.e., their house, other buildings, the land or property etc.) when responding. Participants' mean responses were used as a measure for the general attitude towards the home (we refer to this as

attachment to the home). A higher mean response indicated a higher level of home attachment.

The perceived benefits for the five mitigation strategies were measured by asking participants to respond to the following items: “For each of the following decisions, please indicate how beneficial you think the potential positive outcomes would be for you personally if you engaged in the following strategies?” using a scale from 1 (not very beneficial) to 8 (extremely beneficial) for each of the 5 behaviors described in the pre- and post-test intention measures. These items were designed to assess holistic perceptions of the benefits of each strategy rather than highlighting any particular safety or property-preserving benefits in isolation. Means were taken to create measures of the perceived benefits of evacuation behaviors (leaving either before or immediately following an evacuation order), waiting behaviors (waiting until certain it is necessary or planning to stay but leaving when the risks seem too great), and the defense behavior

**Table 2** Home attachment items

|    |                                                                                         |
|----|-----------------------------------------------------------------------------------------|
| 1  | Everything about my current home is a reflection of me                                  |
| 2  | I feel relaxed when I'm at my current home                                              |
| 3  | My current home is the best place for doing the things that I enjoy most                |
| 4  | My current home says very little about who I am <sup>a</sup>                            |
| 5  | I feel happiest when I'm at my current home                                             |
| 6  | For doing most things I enjoy most, no other place can compare to my current home       |
| 7  | I feel that I can totally be myself at my current home                                  |
| 8  | My current home is my favorite place to be                                              |
| 9  | My current home is not a good place to do the things I most like to do <sup>a</sup>     |
| 10 | My current home reflects the kind of person that I am                                   |
| 11 | I really miss my current home when I'm away from it for too long                        |
| 12 | As far as I'm concerned there are better places to be than my current home <sup>a</sup> |

<sup>a</sup>Reverse coded item



(staying and defending throughout the fire event). These binned scores were then standardized for use in the analyses. The unstandardized scores for the benefits of evacuation were subtracted from the scores for benefits of defending and the absolute value was taken to define the degree of perceived difference in value between evacuation and defense.

### 3.2 Experimental manipulation

Fire officials and researchers both internationally and in the US have conducted investigations into evacuation and alternatives to evacuation (such as staying and defending the home) in wildfire situations and have determined that waiting too long to evacuate is a leading cause of civilian fatalities in wildfire. Evacuating late, when a fire is too near, can lead to people becoming trapped by the fire-front and puts them in serious danger of injury or death from exposure to smoke, flames, and excessive heat along evacuation routes.

The first section of each of the informational messages was identical and described the risks of late evacuation and waiting and seeing to realistically reflect the information that is typically made available to residents in fire-prone areas, the section can be seen below.

Participants were randomly assigned to one of the three additional messages. Those assigned to the control condition for information saw no additional message. Participants in the experimental information conditions saw one of the two following passages immediately following the control passage:

For these reasons, early evacuation is one method used to protect the safety of people caught in the path of wildfire. Being far away from the affected area during a fire is considerably safer than being caught unprotected on the road. Further, under extreme fire conditions, early evacuation increases the likelihood that individuals and families in high-risk areas will survive the fire.

### 3.3 Evacuation benefits

For these reasons, staying and defending one's home is one way to protect the safety of people caught in the path of wildfire. Staying in a structure during a fire is considerably safer than being caught unprotected on the road. Further, under less severe fire conditions, well prepared, healthy, defenders can increase the survivability of structures in a firestorm, increasing the likelihood that the structure and its contents will survive the fire.

### 3.4 Defense benefits

#### 3.4.1 Physical cues

The presence or absence of physical cues was manipulated through the wildfire scenario which was adapted with minor modifications from McLennan et al. (2015a). The version used in our study is presented below:

Now imagine that during the fire season you and all those who normally reside with you are at home. It has been declared a day of "Extreme Fire Danger", and there is a Total Fire Ban for your region of the State. At about 3 pm you become aware of a warning (on the radio, or a website, or by email, or text, or telephone) that there is a large wildfire burning out of control and it will probably reach your area in 2–3 h.

All participants saw this scenario and were randomly assigned to receive one of two different endings either "You look outside and see a wide swath of flames approaching in the distance" (physical cue present) or "You look outside but don't see any sign of flames" (physical cue absent).

### 3.5 Analysis

We conducted logistic regressions to assess the baseline effects of proposed predictors on waiting intentions. We then conducted moderated logistic regression analyses to assess the effects of information on waiting intentions conditioned on attachment to the home. Significant interactions were then examined using the Johnson–Neyman method (Johnson and Neyman 1936) to identify values of the moderators that define where the effects of focal predictors transition from insignificant to significant, that is, to identify the boundary conditions for significant effects of the focal predictors.

### 3.6 Covariates

Age, gender, ownership of home (vs. renting), household income, and the pre-test measure of waiting intentions were included as covariates in each model, the moderated models also included standardized measures of the perceived risks and benefits of the strategies. Each model included proposed moderators as covariates when they were not being included in interaction terms.

## 4 Results

### 4.1 Logistic regression: how do information and cues impact intentions to wait? (H1, H2, H4)

Results of regressing waiting behavior on information, cues, perceived benefit differences, and our covariate measures are shown in Table 3, coefficients ( $b$  values) and odds ratios are provided. Out of 268 participants, 43 of them opted to engage in a waiting behavior in the post-test making the base odds of waiting 0.191. Results of the regressions revealed that only pre-test waiting intention ( $b = 0.501$ ,  $p < 0.0005$ , OR = 1.65) and perceived benefit difference ( $b = -0.031$ ,  $p = 0.001$ , OR = 0.97) were statistically significant predictors (at  $p < 0.05$ ) of waiting behavior. The odds ratios suggest that intending to wait in the pre-test increased the odds of intending to wait in the post-test by 65% (OR = 1.65), while each scale point that the perceived benefits of evacuation and defense differed by reduced the odds of waiting in the post-test by around 3% (OR = 0.97). The presence of a physical cue ( $b = -0.064$ ,  $p = 0.055$ , OR = 0.094) and female gender ( $b = 0.066$ ,  $p = 0.062$ , OR = 0.094) was marginally significant predictors of intending to wait instead of evacuating early. The effects of both kinds of information on waiting intentions were still insignificant when the difference in perceived benefits (the proposed mediator) was excluded from the model.

### 4.2 Mediated regression: does information about the benefits of defense reduce distinctiveness in perceived benefits between evacuation and defense? Does this impact intentions? (H3)

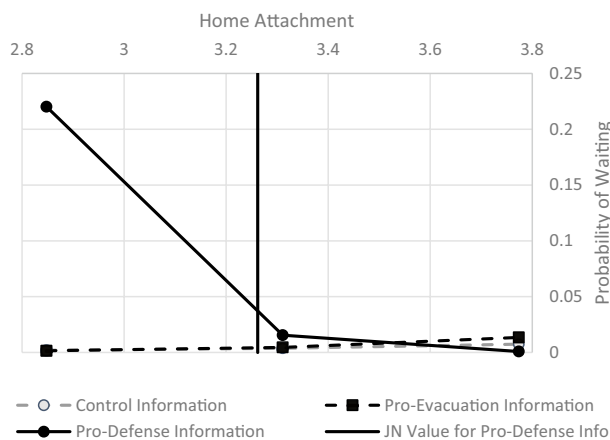
We conducted a mediated regression analysis to investigate if exposure to defense benefit information influenced waiting behavior by reducing the distinctiveness in perceived benefits between evacuation and defending. While we had not found a main effect of defense benefit information in our initial logistic regression, we did find an indirect effect of defense benefit information on waiting behavior through its influence on the difference in the perceived benefits of the two strategies. The effect reduced the distinctiveness in benefits and was significant according to a 95% bias corrected bootstrap confidence interval ( $b = 0.305$ , Bootstrap CI Between 0.013 and 0.733). The remaining direct effect of defense benefit information was not significant suggesting that the reduction in distinctiveness of the perceived benefits is sufficient to explain the effect. These findings support results from McNeill et al. (2015) suggesting that smaller differences in the perceived value of early evacuation and staying and defending (i.e., lower distinctiveness in benefits) create greater ambiguity over the best course of action. Further, these results suggest that providing information promoting the benefits of defense in isolation can reduce this difference to the extent that it affects people's intentions to wait even though all participants also received information about the dangers of waiting. However, it is unclear from this analysis if we would see the same pattern of results if participants were to receive both sets of information.

**Table 3** Logistic regression results

| Predictor                                       | Coeff ( $b$ ) | Odds Ratio | $t$    | $p$     |
|-------------------------------------------------|---------------|------------|--------|---------|
| Pre-test waiting intention                      | 0.501*        | 1.65       | 11.835 | <0.0005 |
| Home attachment                                 | -0.048        | 0.95       | -1.322 | 0.187   |
| Presence of a physical cue                      | -0.064†       | 0.94       | -1.926 | 0.055   |
| Female Gender                                   | -0.066†       | 0.94       | -1.878 | 0.062   |
| Age (in years)                                  | 0.002         | 1.00       | 1.435  | 0.153   |
| Owning (vs. renting)                            | 0.055         | 1.06       | 1.469  | 0.143   |
| Income                                          | -0.015        | 0.99       | -1.355 | 0.177   |
| Defense benefit information                     | 0.030         | 1.03       | 0.706  | 0.481   |
| Evacuation benefit information                  | 0.025         | 1.03       | 0.620  | 0.536   |
| Perceived benefit difference (evac vs. defense) | -0.031*       | 0.97       | -3.329 | 0.001   |

\*Significant at  $p < 0.05$

†Marginally significant at  $p < 0.1$



**Fig. 2** Information  $\times$  attachment interaction in the model of waiting intentions. This graphic assumes mean values for all covariates in the model

### 4.3 Moderated regressions: do the impacts of information and cues on waiting behavior vary as a function of home attachment? (H5, H6, H7)

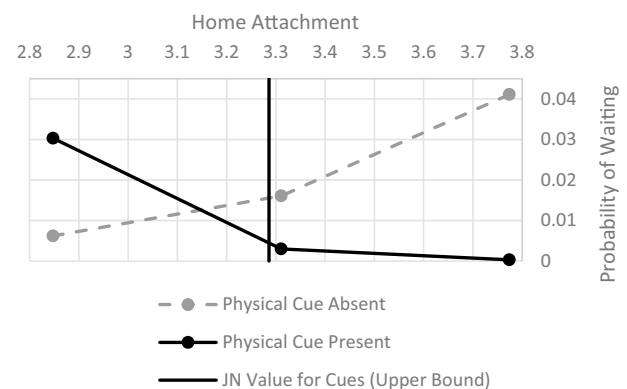
Allowing the effect of information on waiting behavior to depend linearly on attachment to the home revealed a significant interaction between defense benefit information and attachment ( $b = -7.661$ ,  $p = 0.0008$ ), suggesting that the effect of providing information about the benefits of defense on intentions to wait is dependent on the participant's attachment to their home. The results of probing this interaction using the Johnson–Neyman method are shown in Fig. 2, the three points on the line depict the mean and 1 standard deviation above and below the mean on attachment, the vertical line represents the value of home attachment where the effect of information on intentions transitions from non-significant to significant (this value is derived from the Johnson–Neyman method for probing interactions). This method is used to identify which values of attachment define when the effect of information on waiting behavior was significant, essentially describing how attached a person has to be (or not be) in order for the information to have a statistically significant effect on their waiting behavior. The results revealed that defense benefit information had a significant positive effect on waiting intentions for those with home attachment scores lower than 3.262 (roughly defining the 44th percentile on attachment in our sample, depicted in the area to the left of the vertical line in Fig. 2) and a significant negative effect on waiting behavior for those with attachment scores above 3.892 (roughly defining the 91st percentile in our sample, not shown in Fig. 2). There was no significant effect of defense benefit information relative to control information for those between these two values in attachment

(roughly 47% of the sample). We did not find a significant interaction between home attachment and evacuation benefit information suggesting that the effects of evacuation benefit information do not depend on the level of home attachment. These results suggest that the only people for whom defense information was impactful was for those with a relatively low attachment to the home, for everyone else, there was no impact of defense benefit information (or for evacuation benefit information) above and beyond the control.

Allowing the effect of physical cues on waiting behavior to depend linearly on attachment revealed a significant interaction ( $b = -7.165$ ,  $p = 0.0001$ ). Probing this interaction using the Johnson–Neyman method to identify which values of attachment define when the effect of physical cues on waiting behavior was significant (Fig. 3) revealed that physical cues have a positive effect on waiting behavior for those with attachment scores lower than 2.805 (roughly defining the 13th percentile in our sample, not shown in Fig. 3), and a significant negative effect on waiting behavior for those with attachment scores higher than 3.286 (roughly the 44th percentile, or to the right of the vertical line depicted in Fig. 3). There was no significant effect of physical cues on those with attachment scores between these two values (roughly 31% of the sample). These results suggest a counterintuitive impact of cues such that those with low home attachment were more likely to wait when a physical cue of fire was present (rather than absent), while those with greater attachment were less likely to wait in the presence of physical fire.

## 5 Discussion

Results from our study suggest that a person's pre-existing intentions have a strong influence on their later intentions and are difficult to shift in an online setting using the limited information presentation methods and time available. Contrary to our hypotheses, providing information about the



**Fig. 3** Cue  $\times$  attachment interaction in the model of waiting intentions. This figure assumes mean values for all covariates in the model



benefits of a particular strategy did not alter waiting intentions, whether or not we controlled for differences in the perceived benefits between the two strategies (H1 and H2). Though in retrospect, this is not terribly surprising given the documented effects of cognitive biases in the interpretation of risk communication evacuation (see Adam et al. 2018 for short review). For example, participants may have been demonstrating a confirmation bias where they attended to, assessed or believed the information about the benefits of the different strategies only to the extent that they conformed to their existing preferences or plans.

While in the post-test measure of intentions there were fewer who chose to wait overall, providing information about the risks of waiting did not prevent a substantial minority of our sample from reporting a consistent desire to wait and see in the pre- and post-test (i.e., either intending to wait for more information or choosing to stay and defend but retain late evacuation as a last resort). This supports the notion that is reflected in previous work in the wildfire context (McCaffrey 2015) and in the psychological literature (Slovic 1987), that mere presentation of risk information is unlikely to be sufficient to encourage significant changes in intended behavior. When we investigated a potential mechanism to understand when information did alter intentions, we found that exposure to defense benefit information (along with information about the risks of waiting) reduces the distinctiveness in the perceived benefits of the two strategies, and in turn increases the likelihood that a person will intend to engage in waiting behavior. The implications of this finding are twofold. First, it provides support for previous research (McNeill et al. 2015) suggesting that delays in committing to a course of action are brought on by a smaller degree of difference in the perceived value of early evacuation and staying to defend, which increases the difficulty of the decision leading to increased motivation to delay a final decision about a response. Secondly, this finding suggests that providing defense benefit information in conjunction with information about the dangers of late evacuation in our sample had very little effect at increasing intentions to engage in committed defense in our sample.

A critical next step would be to test whether these dynamics hold when individuals receive information about the benefits of both evacuation and defense. Exposure to information about the benefits of staying and defending may be important to provide for those who are considering the practice in the United States; however, we have shown that doing so may also have unintended consequences by decreasing the perceived difference in value for the two strategies and potentially contributing to increased tendencies to wait and see. When discussing the danger of late evacuation more explicitly pointing out that maintaining evacuation as a last resort inherently means late evacuation may help reduce the tendency towards this behavior.

Similarly, the presence of physical cues (H4) had only a limited negative effect on waiting intentions. The use of an online panel and the fact that we considered holding late evacuation as a resort a waiting behavior may have something to do with this finding. While previous research suggests that people often use visible flames as a cue for evacuation (Tibbits and Whittaker 2007) and that people who wait and see often rely upon physical cues more than others (McCaffrey et al. 2018), being presented with this cue in the form of a scenario is unlikely to have the same visceral effect that actually seeing smoke and flames in person would do. This would suggest that the manipulation for physical cues in the scenario may not have been sufficiently strong to make any main effect detectable in our sample. Overall though, the moderation results suggest that perhaps the effects of cues were only relevant for some individuals (i.e., those with more extreme scores on home attachment).

When we allowed the effects of information about the benefits of action and exposure to physical cues to depend on a person's attachment to their home we found some startling results. For those with low attachment to the home, exposure to physical cues or defense benefit information actually increased intentions to wait. On the other hand, those with particularly high attachment to the home were more likely to intend to evacuate early as a result of being exposed to defense benefit information or physical cues. These findings run directly counter to our hypotheses that higher levels of attachment to the home would enhance the effectiveness of communication aimed at home defense by making it more appealing and reduce the use of physical cues as triggers for early evacuation. It is possible that there are other individual differences that are associated with home attachment and determining one's intentions that we did not include. That is, some "third variable" may cause participants to respond to defense benefit information this way and also be very attached to their homes. For instance, younger, or newer residents individuals might be less likely to express sentimental attachment to a home but may also be more interested in protecting the home for practical or economic reasons. However, when we investigated possible predictors for home attachment including age, gender, length of residency, income, education, etc., none were found to be significant predictors of attachment. While this suggests that none of our basic demographics are sufficient to explain this possibility, this does not preclude the possibility that such a variable might exist.

It is possible that there are other correlates with attachment that could have confounded our results. For instance, the instructions for answering the attachment items ask participants to consider "every aspect of your current home (your house, other buildings, the land or property in general, etc.)". While this should confine responses to the physical aspects of their homes, it is possible that this also evokes

concerns over family or other people who also occupy the home. Those with high levels of attachment to their home because they have a family who is present may be more motivated to evacuate their home as a result, which would be consistent with previous research examining evacuation behavior in a series of post-fire Australian studies (McLennan et al. 2015b). However, when we created a binary variable to indicate whether or not there were dependents under 18 present in the home (an imperfect but available proxy for the presence of family) and included it in the model as a covariate, there were no significant changes to the results. While this cannot definitively rule out the possibility particularly because we did not ask about the presence of other vulnerable household members such as elderly or disabled family members, it does suggest that the answer may lie elsewhere.

While the causes for this result are puzzling, one remaining possible explanation may be that those who are highly attached to their property would have a more difficult time taking responsibility for the fate of their home by actively defending it. For those who are highly attached to their homes, the idea of it being destroyed would be particularly upsetting. Staying and defending the home requires both that one remain on the premises and potentially witness damage or destruction to a home and also that one take responsibility for the fate of the home. It is possible that imagining taking responsibility for the fate of the home is more difficult for those who are particularly attached to their homes. The presence of physical cues may also serve as a highly available, visual reminder of the destructive capacity of wildfire. Classic research in the avoidance of regret (Kahneman and Tversky 1982) and the “Status Quo Bias” (Samuelson and Zeckhauser 1988) show results consistent with the idea that people are less comfortable with the consequences of new actions taken than similar consequences resulting from inaction or the status quo. When the potential consequences are particularly severe (as would be the consequence of the loss of the home when attachment is particularly high) then witnessing and accepting the consequences of a deviation from the status quo (evacuation, in this context) is likely to actually become less desirable. While McLennan et al. (2015a) found that those who planned to stay in their homes had higher attachment to their homes, it is possible that, because staying and defending is endorsed by fire authorities in Australia (McCaffrey and Rhodes 2009), where that research was conducted, it would not represent as great a deviation from the status quo in Australia as it would in the United States. While in their paper investigating potential contributors to decision delay in wildfire, McNeill et al. (2015) also explored a desire to avoid responsibility for negative outcomes as a potential contributor to waiting in wildfire situations, they did not find it to be significant. Our research investigating the role of attachment suggests

that this possibility may need to be revisited. Since those with higher attachment to their homes may be more likely to avoid responsibility for negative outcomes than those with lower levels of attachment, the effects of responsibility avoidance may have been obfuscated in the absence of an attachment measure. We suggest that more research investigating the role of responsibility avoidance in the context of attachment to the home and affect associated with home loss is needed to reexamine these possible contributors to waiting before committing to a course of action.

## 5.1 Limitations

While this research attempts to experimentally investigate the role of home attachment in determining the effectiveness of information on intentions to wait in a wildfire situation, it was conducted as a series of self-reports online with a small monetary incentive. Because this artificial setting cannot replicate the circumstances surrounding actual wildfire evacuation behavior, the results must be interpreted cautiously in the context of how risk communication is likely to affect actual behavior. That being said, while the online context does not give us access to the wide variety of factors that contribute to the decision, it does allow us to make inferences about whether and how the factors that we can include may play a role in the mechanism underlying the decision process.

Similarly, because our sampling strategy involved the use of an online platform with limited capabilities for targeting participants, our sample is unlikely to be directly representative of those who will be making evacuation decisions in the future. While care was taken to ensure that participants were residents in states where wildfire is likely to be a salient concern, our sampling frame unintentionally excluded several states where this is also likely to be the case (i.e., Idaho and Alaska). Also, sampling specifically from wildland–urban interface areas, while more costly and difficult, would ensure higher issue salience. Because we are investigating the role of different intra-cognitive factors of the evacuation decision, effects of geographical area may be less prominent; however, a more complete sampling of more carefully targeted participants will be required before strong inferences about how risk communication may shape actual responses to wildfire can be made.

Perhaps most importantly, participants in our study were exposed to information on either the benefits of early evacuation or the benefits of defending their homes but never to both. It is important to note that exposure to both kinds of information may represent a more realistic communication scenario for residents at risk from wildfire. While our study provides some insight into the effects of exposure to each type of information in isolation, it does not allow us to draw conclusions about how participants

would respond if given all of the information. This will be a critical step in future research to address this topic.

## 6 Conclusions

Notably, results indicate that prior intentions of what one will do if threatened by a wildfire have a strong influence on later intentions. Further, providing information about the benefits of a particular strategy did not consistently alter waiting intentions, whether or not we controlled for differences in the perceived benefits between early evacuation and staying and defending. Even when provided information about the risks of evacuating late, many individuals who initially intended to wait still intended to wait. Attachment to the home played an interesting and unexpected role in the effect of information on wildfire evacuation decisions. Information aimed at increasing the perceived benefits of defending the home was found to increase intentions to “wait and see” for those with lower attachment to the home, while those with the highest home attachment scores were more likely to report a desire to evacuate early as a result of being exposed to defense benefit information. The presence of physical cues indicating the proximity of the fire were found to decrease waiting for those with high home attachment and increase waiting for those with low attachment. The work highlights the complexity of conducting risk communication with diverse audiences, where factors some may think can influence an individual to one course of action may in fact have the opposite effect. While the work suggests that solely providing information on the dangers of late evacuation and the benefits of property protection may be problematic, as it has the potential to increase waiting behavior, it is not clear whether this would remain the case if individuals received information about both the benefits of evacuating early and the benefits of defending which may represent a more realistic version of the type of messages individuals might receive. This research serves as a preliminary exploration of how information about the benefits of defending and the presence of physical cues like visible flames may influence evacuation intentions. However, more research is needed to understand what kinds of benefit information are most likely to lead individuals to choose and commit to a clear course of action before a fire event, and to explore reasons why lower home attachment interacts with defense benefit information to increase waiting intentions. We believe that this study presents some paths forward for risk communication, while identifying a number of additional avenues for exploration information effects on different types of individuals living in high fire risk communities.

## References

- Adam C, Gaudou B (2017) Modelling human behaviours in disasters from interviews: application to Melbourne bushfires. *J Artif Soc Soc Simul* 20(3):12
- Adam C, Bailly C, Dugdale J (2018) Communication during bushfires, towards a serious game for a serious matter: communication during bushfires. *Int J Inf Syst Crisis Response Manag IIJSCRAM* 10(2):79–105
- Agee JK (1996) Fire ecology of Pacific Northwest forests. Island Press, Washington, DC
- Anton CE, Lawrence C (2016) Does place attachment predict wildfire mitigation and preparedness? A comparison of wildland–urban interface and rural communities. *Environ Manag* 57(1):148–162
- Ascher T, Wilson RS, Toman E (2013) The importance of affect, perceived risk and perceived benefit in understanding support for fuels management among wildland-urban interface residents. *Int J Wildland Fire* 22(3):267–276
- Barbero R, Abatzoglou JT, Larkin NK, Kolden CA, Stocks B (2015) Climate change presents increased potential for very large forest fires in the contiguous United States. *Int J Wildland Fire* 24(7):892–899
- Claims Journal (2015) Top 10 states at risk for wildfires in 2015. *Claims Journal*. <http://www.claimsjournal.com/news/national/2015/04/29/263100.htm>. Retrieved 29 May 2015
- Cohn PJ, Carroll MS, Kumagai Y (2006) Evacuation behavior during wildfires: results of three case studies. *West J Appl For* 21(1):39–48
- Cova TJ, Drews FA, Siebeneck LK, Musters A (2009) Protective actions in wildfires: evacuate or shelter-in-place? *Nat Hazards Rev* 10(4):151–162
- Hammer RB, Stewart SI, Radeloff VC (2009) Demographic trends, the wildland-urban interface, and wildfire management. *Soc Nat Resour* 22(8):777–782
- Haynes K, Handmer J, McAneney J, Tibbits A, Coates L (2010) Australian bushfire fatalities 1900–2008: exploring trends in relation to the ‘Prepare, stay and defend or leave early’ policy. *Environ Sci Policy* 13(3):185–194
- Huang S, Lindell MK, Prater CS, Wu H, Siebeneck LK (2012) Household evacuation decision making in response to Hurricane Ike. *Nat Hazards Rev* 13(4):283–296
- Jakes P, Kruger L, Monroe M, Nelson K, Sturtevant V (2007) Improving wildfire preparedness: lessons from communities across the US. *Hum Ecol Rev* 14(2):188–197
- Johnson PO, Neyman J (1936) Tests of certain linear hypotheses and their applications to some educational problems. *Stat Res Mem* 1:57–93
- Jorgensen BS, Stedman RC (2001) Sense of place as an attitude: lakeshore owners attitudes toward their properties. *J Environ Psychol* 21(3):233–248
- Kahneman D, Tversky A (1982) The psychology of preferences. *Sci Am* 246(1):160–173
- Kinsey MJ, Gwynne SMV, Kuligowski ED, Kinatender M (2019) Cognitive biases within decision making during fire evacuations. *Fire Technol* 55(2):465–485
- Kyle GT, Theodori GL, Absher JD, Jun J (2010) The influence of home and community attachment on firewise behavior. *Soc Nat Resour* 23(11):1075–1092
- Lindell MK, Lu J, Prater CS (2005) Household decision making and evacuation in response to Hurricane Lili. *Nat Hazards Rev* 6(4):171–179
- McCaffrey SM (2004) Thinking of wildfire as a natural hazard. *Soc Nat Resour* 17(6):509–516

- McCaffrey SM (2015) Community wildfire preparedness: a global state-of-the-knowledge summary of social science research. *Curr For Rep* 1(2):81–90
- McCaffrey SM, Rhodes A (2009) Public response to wildfire: is the Australian “Stay and Defend or Leave Early” approach an option for wildfire management in the United States? *J For* 107(1):9–15
- McCaffrey SM, Rhodes A, Stidham M (2015) Wildfire evacuation and its alternatives: perspectives from four United States’ communities. *Int J Wildland Fire* 24(2):170–178
- McCaffrey SM, Winter G (2011) Understanding homeowner preparation and intended actions when threatened by a wildfire. In: *Proceedings of the second conference on the human dimensions of wildland fire*, pp 88–95
- McCaffrey S, Wilson R, Konar A (2018) Should I stay or should I go now? Or should I wait and see? Influences on wildfire evacuation decisions. *Risk Anal* 38(7):1390–1404
- McGee TK, Nation MO, Christianson AC (2019) Residents’ wildfire evacuation actions in Mishkeegogamang Ojibway Nation, Ontario, Canada. *Int J Disaster Risk Reduct* 33:266–274
- McLennan J, Elliott G, Omodei M (2012) Householder decision-making under imminent wildfire threat: stay and defend or leave? *Int J Wildland Fire* 21(7):915–925
- McLennan J, Cowlshaw S, Paton D, Beatson R, Elliott G (2014) Predictors of south-eastern Australian householders’ strengths of intentions to self-evacuate if a wildfire threatens: two theoretical models. *Int J Wildland Fire* 23(8):1176–1188
- McLennan J, Paton D, Beatson R (2015a) Psychological differences between south-eastern Australian householders’ who intend to leave if threatened by a wildfire and those who intend to stay and defend. *Int J Disaster Risk Reduct* 11:35–46
- McLennan J, Paton D, Wright L (2015b) At-risk householders’ responses to potential and actual bushfire threat: an analysis of findings from seven Australian post-bushfire interview studies 2009–2014. *Int J Disaster Risk Reduct* 12:319–327
- McLennan J, Ryan B, Bearman C, Toh K (2019) Should we leave now? Behavioral factors in evacuation under wildfire threat. *Fire Technol* 55(2):487–516
- Martin IM, Bender HW, Raish C (2008) Making the decision to mitigate risk. In: Martin WE, Raish C, Kent B (eds) *Wildfire risk: human perceptions and management implications*. Earthscan, London, pp 117–141
- Martinuzzi S, Stewart SI, Helmers DP, Mockrin MH, Hammer RB, Radeloff VC (2015) The 2010 wildland-urban interface of the conterminous United States. In: *Research Map NRS-8*. US Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA. 124 p.[includes pull-out map]., 8, pp. 1–124.
- Teague B, McLeod R, Pascoe S (2010) 2009 Victorian Bushfires Royal Commission Final Report.
- McNeill IM, Dunlop PD, Skinner TC, Morrison DL (2015) Predicting delay in residents’ decisions on defending v. evacuating through antecedents of decision avoidance. *Int J Wildland Fire* 24(2):153–161
- Paveglio TB, Carroll MS, Jakes PJ (2010) Alternatives to evacuation during wildland fire: exploring adaptive capacity in one Idaho community. *Environ Hazards* 9(4):379–394
- Rhodes A (2005) Stay or go: what do people think of the choice. In: *Australasian fire authorities and bushfire CRC conference*
- Samuelson W, Zeckhauser R (1988) Status quo bias in decision making. *J Risk Uncertain* 1(1):7–59
- Slovic P (1987) Perception of risk. *Science* 236:280–285
- Tibbitts A, Whittaker J (2007) Stay and defend or leave early: policy problems and experiences during the 2003 Victorian bushfires. *Environ Hazards* 7(4):283–290
- Whittaker J, Handmer J (2010) Community bushfire safety: a review of post-Black Saturday research. *Aust J Emerg Manag* 25(4):7–13

Reproduced with permission of copyright owner. Further reproduction prohibited without permission.