

UNDERSTANDING HOMEOWNER PREPARATION AND INTENDED ACTIONS WHEN THREATENED BY A WILDFIRE

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Abstract.—As wildland fires affect more houses, increasing attention is being paid to how homeowners in affected areas respond to the wildfire threat. Most research on homeowner responses to wildfire has focused on actions homeowners take before a fire to mitigate their fire risk, particularly vegetation management. Less attention has been paid to homeowner response during fires, their planned course of action, and whether or not they understand which preparation and response actions contribute to or reduce the risk to their property and lives during a fire. In addition, given anecdotal evidence that homeowners do not always choose to evacuate, a better understanding of intended actions during a fire is of growing importance. This paper presents preliminary findings from a survey in California, Florida, and Montana. The survey was designed to assess homeowners' mitigation actions before a fire, their planned course of action if their property is threatened by a fire, and factors that influence homeowners' responses before and during fires. Results indicate that homeowners are taking responsibility for mitigating their property's risk and a significant proportion plan to protect their property during a fire.

1.0 INTRODUCTION

As wildland fires affect more houses, increasing attention is being paid to how homeowners living in the wildland-urban interface (WUI) respond to the wildfire threat. Actions homeowners take before a fire to mitigate their fire risk, particularly what shapes willingness to modify vegetation (Brenkert-

Smith et al. 2006, McCaffrey 2008, Nelson et al. 2004, Steelman 2008), have been the subject of most research on homeowner response to wildfire. Recently, more attention has begun to be paid to homeowner response during fires (Cohn and Carroll 2006, McCaffrey and Rhodes 2009, Paveglio et al. 2010). There is growing, mostly anecdotal, evidence that homeowners do not always choose to evacuate during a fire (Cohn et al. 2006, Mozumder et al. 2008, Pool 2007). Therefore, any effort to decrease loss of life and property from wildfires depends on a better understanding of homeowners' intended actions during a fire, and homeowners' knowledge of what preparation and response actions put their property and lives at most or least risk.

This paper presents preliminary findings from a survey in three locations in the United States. We designed the survey to assess homeowners' mitigation actions before a fire, their planned course of action should their property be threatened by a fire, and factors that influence their responses both before and during fires. Findings provide information on specific actions homeowners are taking to mitigate their risk, the proportion of homeowners that intend to ignore an evacuation order and stay with their homes, and how well homeowners understand the factors that contribute to and mitigate the risk to lives and property. Better understanding of homeowners' intended actions can help fire agencies design outreach programs that provide information to ensure that homeowners fully understand the risks and take appropriate actions in response to a wildfire.

2.0 METHODS

The results presented in this paper are based on data from a self-administered mail survey sent to randomly selected homeowners in high-risk wildfire areas. Three sites were chosen to represent a range of WUI conditions: Ventura County, California (Oct.-Dec. 2009); Alachua County, Florida (Oct.-Dec. 2009);

and the area around Helena (Lewis and Clark, and Jefferson Counties), Montana (Feb.-April 2010). Within each site, local fire managers were consulted to delineate the high-risk areas and county tax assessor data were used to develop sample frames that included only those properties within high-risk areas.

At each site, local cooperators issued a press release announcing the survey and at least one newspaper article resulted in each community. Survey mailings contained a cover letter, the survey questionnaire, and a postage-paid return envelope. Reminder postcards were sent to the entire sample 1 week after the initial mailing, and a replacement mailing was sent 2 weeks later to individuals who had not yet returned a survey. The overall sample included 4,762 households; 1,483 responded for an overall response rate of 31 percent. By site, the response rate ranged from 25 percent in Florida to 36 percent in Montana.

The three study sites are diverse in population demographics, mix of land use and ownership, and the regulatory nature of wildland fire mitigation guidelines for homeowners. Of the three sites, Ventura County is the most densely populated and most affluent, and has the most actively enforced regulations requiring regular vegetation management by private homeowners. The Helena area is the least densely populated of the three sites and has the highest proportion of seasonal homes. Alachua County, FL has the lowest median income (more than 20 percent of the population is below the federal poverty level) and the lowest proportion of land in public ownership. Like many other WUI communities, all three sites are challenged by the co-occurring phenomena of high fuel accumulation and increasing residential development.

In this paper, we report on survey items that measured homeowners' actions to mitigate their fire risk as well as their intended actions in the event of a wildland fire. In a few cases, we note differences between communities, but due to space constraints, these differences will be examined in more detail in subsequent papers.

3.0 RESULTS

In Ventura and Alachua Counties, more than 90 percent of respondents were full-time residents while 73 percent of Montana respondents were full time. Average length of homeownership was 16 years. The two Montana counties and Ventura were dominated by single-family homes (89 and 95 percent, respectively); 25 percent of Alachua County homes were manufactured or mobile homes and the remainder were single-family. Overall, 43 percent of respondents were retired and 62 percent were male; these proportions were higher in Montana. The average age was 59 years old.

3.1 Mitigation Actions Taken

Overall, respondents indicated that they were taking more actions on their properties to manage vegetation than to make their homes fire-resistant, although a large majority of respondents at each site had taken at least some actions to prepare their property for fire (Table 1). Ventura County appears to be most prepared, particularly in terms of vegetation management; 77 percent of Ventura respondents indicated they had done a great deal of vegetation management. Alachua County was least active, with the largest proportion of respondents who indicated they had taken little or no action to manage vegetation (24 percent) or make their buildings fire-resistant (39 percent).

At least two-thirds of respondents indicated that they had done a lot or some degree of work on seven specific vegetation management activities (Table 2). For the remaining respondents, results indicate that these seven actions were often not applicable to their property. Overall, when these actions were relevant for a property, only a very small portion of respondents (12 percent or less) had taken no action.

Several patterns are noteworthy regarding actions to make homes more fire-resistant (Table 3). For almost half of the homes, structural elements such as a fire-resistant roof or covered vent openings were already in place when the home was purchased—or were not applicable. In homes where the homeowner had taken the action since the home was purchased, roughly

Table 1.—How much work respondent had undertaken to prepare for wildfire (all respondents).

	A great deal (%)	Somewhat (%)	Only a little or Not at all (%)
Managed vegetation (e.g., cleared or pruned weeds, brush, and trees; used fire-resistant plants or landscaping)	58	31	11
Made my house more fire-resistant (e.g., installed non-flammable roofing; installed dual pane windows; enclosed the space under my deck)	38	38	24

Table 2.—Vegetation management actions respondent had taken (all respondents).

	Have done a lot of work (%)	Have done to some degree (%)	Haven't done at all (%)	Not applicable to my home (%)
Removed dead or dying vegetation within 30 feet of my home	68	24	2	6
Removed leaf litter (dry leaves/pine needles) from yard, roof, and rain gutters	53	35	5	7
Relocated woodpiles or other combustible materials 30 feet from the house	46	26	9	19
Removed or pruned vegetation near windows	42	29	6	23
Removed combustible material and vegetation from around and under decks	40	22	6	22
Removed "ladder fuels" (low-level vegetation that allows the fire to spread from the ground to the tree canopy)	39	38	9	14
Trimmed tree canopies to keep their branches a minimum of 10 feet from structures and other trees	36	43	12	9

Table 3.—Fire-resistant features of home (all respondents).

	Already Existed	Have Done Since Purchased		Does Not Have		
	Existed when I purchased home (%)	Primarily for fire reasons (%)	Primarily for non-fire reasons (%)	Haven't done; plan to do in future (%)	Do not plan to do (%)	Not applicable to my home (%)
Roof is made of fire-safe material such as composition (asphalt), metal, or tile	60	18	13	4	4	2
All vent openings are covered with 1/8-inch mesh (or smaller) that is not plastic or fiberglass	46	8	10	11	12	12
Exterior walls are covered with or made of fire-resistant materials	45	5	6	7	30	7
Eaves are boxed in with non-combustible materials	36	5	6	10	31	12
Underside of decks is enclosed with fire-resistant materials	8	4	6	13	26	42

half took the action primarily for fire resistance and half took the action for other reasons. A particularly positive finding was that only 10 percent of homes did not have a fire-resistant roof; however, almost 30 percent indicated that they did not plan to box their eaves, enclose their decks, or cover their exterior walls with fire-resistant materials.

When asked about their reasons for undertaking specific actions, more than 80 percent indicated that protection from direct flame contact (87 percent), reducing ember ignition (86 percent), and improving survival odds without active firefighter protection (83 percent) were very important reasons. A smaller but still large proportion of respondents indicated that a very important reason they had taken action was to provide firefighters room to work (67 percent) or because firefighters would be more likely to protect their homes (63 percent). Legal requirements were the least common reason for taking actions—only 34 percent overall said legal requirements were a very important reason although 60 percent of Ventura County respondents indicated they were very important. This response likely reflects Ventura County’s long-term and well enforced weed abatement (vegetation management) ordinance.

Respondents were also asked their views about the relative importance of vegetation management compared to actions that would make their houses more fire-resistant (Table 4). Although 55 percent of all respondents indicated that the two categories were equally important (55 percent), 35 percent responded that vegetation management was more important or “all that was needed.” When asked who they felt was most responsible for protecting private property from wildfire, they clearly leaned toward individual homeowners (Table 5). Only 18 percent put most or all of the responsibility for protecting homes on firefighters whereas more than half put all (23 percent) or more (35 percent) of the responsibility on homeowners.

3.2 Planned Action during a Fire

Respondents were asked whether they had a household disaster plan in case of a wildfire. Overall, only 38 percent of respondents indicated that they had a plan; this percentage was largest in Ventura County (48 percent), followed by Montana (35 percent) and Alachua County (30 percent). When asked whether they had ever been threatened by a wildfire, 38 percent of respondents indicated they had, with the highest proportion in Ventura County (52 percent), followed

Table 4.—Importance of vegetation management compared to house fire-resistance in decreasing fire risk (all respondents).

	%
Vegetation management is all that’s needed to reduce the risk	3
Vegetation management is most important, but making the house fire-resistant helps, too	32
They are equally important	55
Making the house fire-resistant is most important, but vegetation management helps, too	8
Making the house more fire-resistant is all that’s needed to reduce the risk	0
Neither can significantly reduce the risk	1

Table 5.—Agent most responsible for protecting private property from wildfire (all respondents).

	%
Firefighters	2
Shared responsibility between homeowners and firefighters (more on the firefighters)	16
Equal responsibility between homeowners and firefighters	24
Shared responsibility between homeowners and firefighters (more on the homeowner)	35
Individual homeowners	23

by Montana (40 percent) and Alachua County (21 percent). Given the parallel overall response for the two questions, a chi-square analysis was conducted on overall responses. This analysis indicated that there was a significant difference in development of a disaster plan based on prior wildfire experience: respondents who had been threatened by a wildfire were more likely to have a disaster plan (50 percent) compared to respondents with no prior fire experience (31 percent) ($p < .001$).

When respondents who had been threatened by a wildfire were asked how they had responded during the most recent fire, a smaller proportion indicated they either left early or left when instructed by authorities (38 percent) than indicated they waited to see what would happen (48 percent) before they decided to stay or leave (Table 6). Overall 20 percent indicated that they stayed throughout the fire and tried to protect their property. Of the 14 percent that marked “Other,” the largest proportion (5 percent of all respondents whose property had been threatened)

indicated that they had not been at the property at the time of the fire, about half because it was a second home. Interestingly, a small number of respondents indicated that they either assisted with putting the fire out or stayed because there were firefighters on their property.

All respondents were asked to indicate what they would do if they were at home when a wildfire was in the area (Table 7). Only one-third would leave early or when authorities indicated they should leave while 11 percent said they would stay throughout to protect their property. (Although we had expected a large percentage of respondents in Montana would plan to stay, given its more rural nature, only 10 percent of Montana respondents planned to stay compared to 13 percent of the respondents from each of the other two sites.) Notably, half of our respondents indicated they would do what they could to protect their houses and leave if imminently threatened by the fire. In further analysis, we hope to explore what “imminently” may mean for our respondents.

Table 6.—Action taken when last threatened by a wildfire (respondents who indicated they had ever been threatened by a wildfire, n = 551)

	%
Left before there was a mandatory evacuation order for my area	8
Left as soon as I heard there was a mandatory evacuation order	14
Planned to evacuate but waited until I was personally told to leave by an authority	16
Waited to see what happened and stayed because the risk was not great	30
Waited to see what happened but left when the danger felt too great	17
Stayed throughout the fire and tried to protect my property	3
Other	14

Table 7.—Likely future action if at home when threatened by a wildfire (all respondents)

	%
I would not be home as I intend to leave the area on days of high fire danger	1
Leave as soon as I am aware that there is a fire in the area	5
Wait until authorities indicate I need to leave, and then leave	28
Do as much as possible to protect the house but leave if imminently threatened by the fire	50
Stay throughout the fire to try to protect the house and property	11
Don't know what I would do	2

Finally, we asked two questions about respondents' perceptions of how their lives were put at risk during a fire. When asked how common they thought various causes of death were during wildfires, respondents clearly indicated that they expected inability to breathe to be the primary cause of death. Smoke inhalation was listed as a very common cause of death by 80 percent of participants; 60 percent indicated lack of oxygen was a very common cause of death (Table 8). Radiant heat, which in Australia is generally believed to be the main cause of death during wildfires (Haynes et al. 2008), was considered a very common cause of death by only 48 percent of respondents. We also asked how safe different actions were in protecting life if the respondent could not evacuate safely (Table 9). Although few people saw any action as very safe, half said that lying down in a ditch, swimming pool, or open area was a reasonably safe course of action; 22 percent indicated leaving the area on foot or bike

was a reasonably safe response. Around half of the respondents thought going inside the house was a very unsafe action while driving through the flames or taking refuge in a car were perceived as the least safe options (67-70 percent rated each action as very unsafe).

4.0 DISCUSSION AND CONCLUSIONS

Our findings indicate that, although there is some variability between proportions in three very different areas of the United States, the vast majority of WUI homeowners in our study locations are taking action to reduce their risk from wildfire. According to our survey results, homeowners understand that mitigation measures apply both to their vegetation and to the home itself, although there is a sense that vegetation management is more important (see Tables 1 and 4). It is notable that making structural modifications is relevant for only a small proportion of the

Table 8.—How common is each potential cause of death during a wildfire (all respondents).

	Very Common (%)	Somewhat Common (%)	Not at all Common (%)
Smoke inhalation	80	18	2
Lack of oxygen	60	32	8
Superheated air (radiant heat)	48	44	8
Exacerbation of existing physical condition (e.g., heart attack)	38	54	8
Direct flame contact	11	41	48
Traffic accidents	10	58	32

Table 9.—How safe an action is in protecting life if evacuation route is blocked (all respondents).

	Very safe (%)	Reasonably safe (%)	Somewhat unsafe (%)	Very unsafe (%)
Lie down in a ditch, swimming pool, or an open area such as a horse paddock or playing field (n = 1,370)	8	53	29	10
Leave the area on foot or bike (n = 1,339)	5	22	37	37
Put out embers that land around/on my property, but if it gets too hot, go inside and monitor the fire from there (n = 1,382)	2	16	38	44
Wait inside my house until the fire front has passed through (n = 1,380)	2	11	33	54
Quickly drive through the flames to get out of the fire area (n = 1,384)	1	6	26	67
Take refuge in my car (n = 1,381)	1	4	26	70

population—either because their property already had the modifications at the time of purchase or because they do not apply to that particular structure. It is also notable that structural elements are put in place as often for non-fire reasons as for fire-related reasons. Therefore, fire managers who want to encourage certain actions, particularly those that a relatively large portion of our respondents indicated they had no intention of doing, may want to promote both the nonfire reasons and the fire-related reasons for taking the actions.

Responses also indicate that most homeowners see protecting their property from wildfire as predominantly their responsibility. While firefighter protection during a fire does appear to be a consideration in the decision process, more homeowners indicated they took mitigation actions because of their potential effect on decreasing home ignition and increasing structural survival, with or without firefighter protection. Although not as important, legal requirements appear to play a role in communities that have actively enforced ordinances.

In terms of actions during fire, only one-third to one-half of respondents had prepared a disaster plan, suggesting that homeowners are spending more energy on mitigation actions than on considering what they will do during a fire. This result is notable given that, depending on the location, one-fifth to one-half of the respondents had at some point felt threatened by a wildfire, although experience with a wildfire threat in the past does increase likelihood of having a disaster plan.

Results support anecdotal evidence that a number of homeowners intend to stay to defend their properties rather than evacuating during a fire. In addition, many respondents do not intend to evacuate based on official evacuation orders and advice but instead plan to wait to see conditions and make their own decision about the risk. This response raises questions about whether homeowners have the knowledge to accurately assess conditions and decide what will put them at risk. Although there is surprisingly little documentation about the causes of civilian deaths during wildfires

in the United States, studies from Australia suggest that radiant heat is the primary cause of death and that being outside, particularly on foot, is more dangerous than being inside a structure (Haynes et al. 2008). Respondents' perceptions that smoke inhalation was the most common cause of death and that being outside was safer than being inside raises questions as to whether people have the knowledge to make the safest decision should they, for whatever reason, be faced with direct exposure to a fire front.

Overall, our findings show that most people are thinking about fire risk, have a sense of responsibility for doing something to mitigate their risk, and are taking action. Further, a significant proportion of participants plan to protect their homes in the event of a wildfire, even after an evacuation order has been given. This finding suggests that many people view the evacuation decision as one they should make instead of automatically following orders from authorities. This dynamic further highlights the importance of providing appropriate information to residents of fire-prone areas to help them make the safest possible decisions before and during a fire event.

The results described here paint a picture of a population that is reasonably engaged when it comes to wildfire awareness and prefire mitigation, but they only touch on possible reasons for the actions people take. Our next step will be to examine these underlying reasons: What specific factors, such as cost and perceived effectiveness, affect mitigation actions; what considerations shape planned actions during a fire; and how are level of preparedness and planned course of action during a wildfire linked?

5.0 LITERATURE CITED

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