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**Evacuation compliance and actual wildfire risk in
Austin, Texas: Determining the effects of risk
education through online community surveys**

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Introduction

In 2011 Texas experienced the most destructive wildfire in the state's history. Prior to August of that year, Texas was ranked low on the list of U.S. states for its wildfire behavior, especially when compared to California and Montana. However, by October Texas was internationally recognized for its severe wildfires. The Bastrop Complex Fire, which took place in the Bastrop County area of Central Texas, permanently scarred the landscape. Over 35,000 acres were consumed and much of that land still shows no sign of vegetative regrowth. Moreover, the risk perceptions of those who lived there at the time were forever changed.

One community in the region, the Steiner Ranch neighborhood located in Austin, suffered through their own personal fire. The Steiner Ranch Fire destroyed 23 homes and caused the evacuation of over 14,000 residents. While no lives were lost in this fire, many residents waited in their cars for hours trying to evacuate. Because of this event, the way people think about and fear wildfire not only changed, but their intention to take action against wildfire has likely increased. This study aims to analyze this particular interaction: how wildfire risk can change future actions.

To assess how perceptions of wildfire risk influence future behavior, this research builds on previous research and literature to gain an understanding of the importance of risk perception. As academic and practitioner research increases awareness of environmental hazards, public risk perception changes. Through an IRB approved online survey, this study collected data from the Steiner Ranch community regarding risk perception, intended action, and demographic characteristics. A similar set of

questions was posed for respondents both before and after the introduction of actual risk; this research analyzes how the treatment changed the perceptions of the survey participants. This analysis is significant in that it examines how information on actual risk influences *perceptions* of risk and offers insights into how professionals might better manage community education and outreach related to hazards such as wildfire.

Background

Central Texas has an extensive history with environmental hazards. Severe drought, flash flooding, and tornados have all posed a threat to the area's residents. In recent years, wildfires have also become a part of the environmental and political climate of the region, but the problem has actually been growing, both literally and figuratively, for decades. In 1935, the United States Forest service established the '10am Policy', recommending that any wildfire throughout the country should be extinguished by 10 am the following morning (**Southard 2011**). Over time, this caused a variety of problems for fire adapted ecosystems across the United States including central Texas. In the 1930s, an average of 30 million acres of wildland fuels burned annually because of wildfires throughout the country. Due to the United States Forest Service recommendation, this number steadily decreased over the following decades, and by the 1960s an average of only 5 million acres burned annually. This policy was officially abandoned in 1978 for a more ecologically healthy 'Let-Burn' style of wildfire management (**Cohen 2008**). However, because of the United States Forest Service recommendation and the gradual decline of acres burned due to wildfire, it is estimated

that an additional 50 million acres of vegetative wildland fuels accumulated through the United States during the 43 year lifespan of the 10am Policy (**Cohen 2008**). These events created an increasingly dangerous wildfire risk to the residents of central Texas. Not only are wildfires in the region more dangerous due to this buildup of fuels, but individuals living in the area also have little historical reference when dealing with wildfires compared to other regions. Therefore, when a wildfire did occur, the extreme danger posed by the incident was compounded by the fact that no one, including residents and emergency service personnel, had experience dealing with this type of situation. However, fuel buildup and lack of experience were not the only contributing factors to the worst wildfire in Texas state history.

In 2011, central Texas was witness to a series of meteorological events that helped to create the Bastrop Complex fire. In this particular year, the state was experiencing three record breaking extreme weather conditions: Texas was undergoing its most severe drought since the 1950s; it had received its lowest rainfall since 1895; and Texas' 2011 summer was the hottest summer of any state, ever (**Climate Central 2011**). This last statement is not an exaggeration. Averaging the high temperatures throughout the state from the summer solstice (beginning of summer) to the fall equinox (end of summer), no state had experienced a hotter summer in recorded meteorological history. The final contributing factor was Tropical Storm Lee, impacting the United States gulf coast in late October and early September, 2011. Although this tropical storm did not directly impact many residents in Texas, the western tail of the storm generated powerful southerly winds in the center of the state. As such, decades of

vegetative fuel build up, a summer of extreme drought, record breaking temperatures, and gusting winds all contributed to the enormity of the 2011 Bastrop Complex Fire.

On September 4, 2011, 30 mile-per-hour gusting winds knocked over many trees in central Texas; trees that had already died or were severely weakened by the extreme drought conditions. In two separate locations, trees fell into power lines causing sparks which ignited decades worth of dried fuels near Bastrop State Park. Over the next 36 days 34,356 acres burned, 1,673 homes were destroyed, \$325 million in property damages were incurred, and 2 people lost their lives (**Texas A&M Forest Service 2011**). The extent of the wildfire, which can be seen in its burn scar, destroyed over 98% of Bastrop State Park (**Figure 1**). This fire burned down approximately ten times the number of homes than the previous most destructive wildfire, demonstrating how unprepared wildland firefighters and emergency service personnel were for a wildfire event of this magnitude (**Figure 2**). Making matters worse, the Bastrop Complex Fire was only one of many wildfires that occurred in Texas at the same time. Known collectively as the Labor Day Fires of 2011, the Bastrop Complex Fire was the largest in a series of fires that included the Bear Creek Fire, the Colorado County Fire, the Delhi Fire, the Pedernales Bend Fire, the Pinnacle Fire, the Riley Road Fire, and the Steiner Ranch Fire to name a few.

The Steiner Ranch Fire was one of the few Labor Day fires that occurred within Austin city limits, approximately 40 miles west of the Bastrop Complex Fire. Similar to the Bastrop fire, the Steiner Ranch Fire also started on September 4, 2011 and was caused by winds knocking down power lines into an abundance of dead and dried

vegetative fuels. Unlike the Bastrop Complex Fire, this fire was much smaller in magnitude, lasting only a matter of days, consuming 160 acres, and destroying 23 homes. Thankfully, no lives were lost (**Travis County Fire Marshal's Office 2011**). As this fire initially grew and began to threaten homes, incident command responsible for initial attack at the Steiner Ranch Fire decided that an evacuation of the community would be necessary. This evacuation would become an increasingly difficult problem over the next two to three hours. Bounded on the western, southern, and eastern sides by the Lower Colorado River, Steiner Ranch has only one evacuation route. Even though incident command took this into consideration when ordering the evacuation be done in stages, the evacuation occurred all at once, causing traffic jams throughout the neighborhood. The majority of residents trying to evacuate ended up sitting in their cars, inside the neighborhood, only miles away from the wildfire, for an average of 2 hours (**Gabbert 2011**). If the Steiner Ranch Fire had been more severe, or if wildland firefighting personnel had been reallocated due to other incidences during the Labor Day Fires, many people might have perished in their cars trying to evacuate.

It is understandable that because of these events many evacuated residents consider this to be a failed evacuation. Austin Fire Department (AFD), however, classifies this as a successful incident since no lives were lost and the 23 homes that burned down were empty. A major goal of AFD is 'Zero Fire Deaths', and regarding wildfire evacuation, if this metric is achieved, the incident was successful. These divergent perspectives on defining a successful or failed evacuation may lead to a breakdown in trust and communication between residents and AFD. These breakdowns

in communication lead to further evacuation complications that need to be addressed. An effective evacuation plan undoubtedly details the actions and responsibilities of all emergency service personnel, but also maximizes citizen compliance through effective communication. This directed research study was created to better understand the latter component - evacuation compliance through effective communications methods.

Purpose

The purpose of this research is to understand evacuation compliance and what actions, if any, can be conducted to ensure evacuation compliance and reduce the risk of loss of life in a wildfire event. During the Steiner Ranch Fire of 2011, an evacuation was ordered but not properly conducted. Instead of evacuating in stages, the residents of this community were evacuated all at once, causing gridlock on the only evacuation route out of the neighborhood. It is here, in regards to evacuation compliance, that this research paper looks to increase the general body of knowledge. In gathering information from the residents of this community, this research examines what factors, both positive and negative, influence the likelihood that an individual will fully comply with future evacuation orders. One factor in particular that is analyzed in this research is the knowledge of actual risk. Specifically, how the knowledge of actual risk affects evacuation compliance, and whether this has a positive or negative effect. In understanding these results, this research outlines specific recommendations for fire departments, emergency service personnel, and wildfire educational programs regarding evacuation preparedness. For example, if the knowledge of actual risk has no

effect or a negative effect on evacuation compliance, then a recommendation for more evacuation preparedness education is warranted. On the other hand, if the knowledge of actual risk has a positive effect on evacuation compliance, then a recommendation for an educational program that includes risk knowledge demonstration as well as evacuation preparedness is appropriate.

Literature Review

Due to increased wildfire threats in many countries around the globe, and as more people populate wildland-urban interfaces, wildfires have become a popular research topic from a variety of scales and perspectives. The majority of historical literature about wildfire, both academic and informal, comes from the United States Forest Service. It is important to study the history of wildfire management and mitigation because these practices have shaped modern perceptions of wildfire as well as played a major role in creating the abundance of vegetative fuels causing current elevated risk levels.

Created in 1905 by President Theodore Roosevelt, the United States Forest Service was initially conceived as a governing body to protect national forests through wildfire research and understanding. However, in 1910, the Big Blowup wildfire consumed 3,000,000 acres across Montana, Washington, and Idaho. In just two days, 86 people lost their lives. This single event established a nationwide fear and hatred of wildfires. In 1935 the United States Forest Service established the '10am Policy', which wasn't abandoned until 1978 and allowed for the buildup of approximately 50 million

acres of additional vegetative wildfire fuels. Ironically, although much research has been conducted in recent years to bring about a greater understanding of wildfires and their ecological function, this historic fear of wildfire persists in part due to the increased wildfire threat and severity caused by the United States Forest Service and their wildfire management practices.

One of the major topics of modern wildfire research is post-wildfire analysis through remote sensing imagery. As satellite imagery has become more accessible, the ability for researchers to compare and contrast pre-fire and post-fire conditions has become an integral part of wildfire predictive modeling. Remote sensing allows wildfire researchers to capture this data independently from time consuming individual home assessments. Bhandary and Muller (2009) identify a number of variables that are commonly analyzed in wildfire research including vegetation density, road width, road type, slope, and aspect. Bhandary and Muller (2009) further identify three land use strategies that can reduce the risk of wildfire: vegetative treatments, site selection with respect to topography, and increasing fire station access. These three factors also play a major role in evacuation planning.

As more information regarding wildfire modeling and behavior is created, there is a greater need to understand human behavior and what particular risks have been created due to human intervention on the landscape. One very particular but incredibly important factor that plays a role in risk analysis is the existence of limited access neighborhoods. For example, research conducted by Stewart and Hagelman (2010) categorizes and ranks central Texas neighborhoods in terms of wildfire evacuation and

egress risk. As Steiner Ranch is one of these limited access neighborhoods, this research is important because future evacuation plans need to address these factors in order to avoid potentially dangerous wildfire evacuation events like that of the 2011 Steiner Ranch Fire studied here.

Further research in the field of risk perception was also conducted to fully understand how evacuation compliance and participation in mitigation actions relate to risk perception. Mileti and Sorensen (1987) conducted research on precautionary actions and described why individuals choose to participate in risk mitigation activities. As perceived risk increases, people are more likely to participate in activities they feel will protect them. Then, as wildfire reduction practices become commonplace, wildfire risk reduces, lowering an individual's perceived threat and the likelihood that they will comply with evacuation. Additionally, research by Perry, Lindell, and Greene (1981) emphasizes the complexities between loss of life and property damage. As individuals evacuate, they are essentially abandoning their property to environmental damage, but if they stay and choose to protect their home, the risk to loss of life is increased. Given a substantial warning, people should have enough time to harden their home against identified hazards, but they regularly choose not to participate because the threat is not imminent.

Nox (2015) takes the research on risk perception one step further and analyzes the differences between behavioral intention and behavior as it relates to wildfire mitigation. Understanding why individuals choose to mitigate is vital in understanding why individuals choose to evacuate. The identification of homeowner attitude as the

most important variable in shaping intentions was used during the development of the survey for this research to capture how perceived risk's transition to actual risk modifies behavioral intent regarding evacuation compliance.

Methodology

This study was conducted in the Steiner Ranch Community of Austin, Texas, and was chosen because it underwent an evacuation during a wildfire event that occurred in 2011. Compared to other wildfire evacuation events in the area, this site has a defined homeowners association boundary and a lower population compared to other neighborhoods that were similarly threatened by wildfire. This lower population and defined geography allowed for the easy dissemination of the online survey as well as the collection and analysis of pertinent survey data. The Steiner Ranch study area consists of 14,822 individuals living in 4,829 households (**U. S. Census Bureau 2010**). According to this census, Steiner Ranch residents break down in the following demographic ways:

- 50.7% female
- 76.5% with a bachelor's degree or higher
- Over 95% earning \$75,000 or more annually
- Over 90% that identify as white alone as their race

The survey questions in this study were developed from the hazards risk communication literature. Emphasis was placed on the extent to which individuals "heard", "understood", and "believed" notifications regarding risks and threats (**Blanchard 1993; Drabek 1986**). Questions relating to wildfire evacuation practices

were created with input from subject matter experts in the field of wildland firefighting and wildfire education at Austin Fire Department. Questions regarding home hardening practices were built using National Fire Protection Association's Firewise Community guidelines (**Figure 3**). Questions pertaining to demographic data collection were created following the 2010 United States Census formatting to ensure cultural, racial, and gender sensitivity (**U.S. Census Bureau 2010**).

Google Forms was used to create the online survey as well as to host the questionnaire and provide a secure server to store confidential data collected in this research in accordance with the International Review Board. The survey was disseminated through an email list server managed by the Steiner Ranch Homeowners Association. As per recommendations by the International Review Board, researchers in this study had no direct contact with the survey participants and all communications were conducted through the homeowners association, unless direct contact was made by the participants themselves. The survey contains a total of 39 questions, keeping in mind that some questions were not presented to all participants depending on their responses to specific prompts, following an "if then" protocol. For example, question six asks: "Were you living in Steiner Ranch during the Labor Day Fires of September, 2011?" If the survey participant answered "No", they were asked a set of questions regarding their previous city, state, and country. If they stated that they were living in Steiner Ranch at the time of the wildfire, these additional questions were skipped using Google Forms' survey interface. Over the course of three weeks, 281 surveys were submitted by Steiner Ranch residents. Of these 281 submissions, 3 participants opted

to not take the survey. In compliance with the International Review Board, participants were given the opportunity to opt out of the survey if they chose to do so. Steiner Ranch residents who participated in the survey break down in the following demographic ways:

- 53.7% female
- 82.9% with a bachelor's degree or higher
- 92.2% earning \$75,000 or more annually
- 90.1% that identify as white alone as their race

In all four of these demographic categories, the survey participants were within 7% of the overall demographics of Steiner Ranch as recorded in the 2010 census.

Analysis

This analysis focuses on 8 questions in the survey. For a comprehensive list of all the questions in the survey, please refer to **Appendix A**. The 8 specific questions in the survey that are analyzed in this research, and their answer options, are as follows:

Question 23 - Do you intend to fully comply with any/all future evacuation orders?
(Absolutely not; Probably not; Not sure; Probably yes; Absolutely yes),

Question 24 - What do you perceive is the risk of another wildfire event threatening your home? (Low; Moderate; High; Very High; Extreme; Not Sure),

Question 25 - Which of the following actions have you performed to fortify your home against wildfire and/or aid in wildland firefighting efforts: (Removed dead and down material adjacent to home?; Pruned all trees on your property?; Cleaned gutters of all

structures on your property? Registered with 911 addressing?; Moved all burnable material (wood piles, gas tanks, etc.) at least 30 feet away from your home?; Mowed/maintained all vegetation on your property?; None of the above),

Question 26 - If you are unable to evacuate, to what degree do you feel you could survive a wildfire in your home? Answers were given on a five-point Likert scale from 1 (Not at all confident that I would survive) to 5 (Confident that I would survive).

At this point in the survey, participants were directed to an ArcGIS Online web interface that allowed them to type in their address and view where their home ranked in relation to a county wide relative wildfire risk map. Through this, participants were able to learn the actual wildfire risk of their home. Once this was completed, survey participants were directed to answer questions similar to the four above, but now with the knowledge of actual wildfire risk.

Question 29 - With the knowledge of your actual wildfire risk, do you intend to fully comply with any/all future evacuation orders? (Absolutely not; Probably not; Not sure; Probably yes; Absolutely yes),

Question 30 - With the knowledge of your actual wildfire risk, what do you perceive is the risk of another wildfire event threatening your home? (Low; Moderate; High; Very High; Extreme; Not Sure),

Question 31 - With the knowledge of your actual wildfire risk, which of the following actions do you intend to perform in order to fortify your home against wildfire and/or aid in wildland firefighting efforts: (Removed dead and down material adjacent to home?; Pruned all trees on your property?; Cleaned gutters of all structures on your property? Registered with 911 addressing?; Moved all burnable material (wood piles, gas tanks, etc.) at least 30 feet away from your home?; Mowed/maintained all vegetation on your property?; None of the above),

Question 32 - With the knowledge of your actual wildfire risk, if you are unable to evacuate, do you feel you could survive a wildfire in your home? (Yes; No)

It is important to note that while questions 26 and 32 were meant to follow the same format, the survey was inadvertently disseminated with an error such that the two questions collect results in two different formats, binary and Likert scale. To adjust for this oversight, the results of question 26 were reclassified into a binary format. Option one on the Likert scale was reclassified as a 'No' in relation to the question: "...do you feel you could survive a wildfire in your home?". Options two through five were reclassified as a 'Yes' in relation to this question because options two through five were viewed as varying degrees of certainty that one would survive a wildfire if they were unable to evacuate, while option one was the only answer that clearly defined no chance of being able to survive. Subject matter experts in the field of statistics were

consulted and confirmed that while this method of reclassification contained potential issues, it was overall statistically sound and would produce valid results.

Since the comparable questions before and after the treatment of new knowledge were answered by the same survey participant, a test for related samples was necessary to address the dependent variables. In all four tests on related samples in this research, the null hypothesis was the same: N_0 : The distribution after the treatment is the same as before, regardless of the introduction of new knowledge. A comparative analyses of questions 23 and 29, 24 and 30, and 25 and 31 were all conducted using a related samples nonparametric test to see if there was a shift in the distribution. The Wilcoxon Signed Ranks Test was used instead of a paired sample T test because the latter is robust to the assumption that the variables are normally distributed and cannot be used when the distribution of data is not normal, as is true with all four comparisons in this research (**Rogerson 2015**). Questions 25 and 31 were analyzed on the number of home fortifying activities conducted before and after the treatment of new knowledge, with no significance given to the specific activities themselves. After recoding the results of question 26, as described above, questions 26 and 32 were analyzed using the McNemar test, a chi-square test for related samples because of the existence of dependent variables.

Results

First, analyzing the results from questions 23 and 29 after the Wilcoxon Signed Ranks Test, 3 respondents chose not to take the survey while 29 responded with 'not

sure' and were excluded from the results (**Table 1**). 221 participants showed no change in their survey response after the treatment of actual risk knowledge. Eight participants showed a positive change, and 20 showed a negative change after the treatment (**Table 2**). With a 95% level of confidence, the test statistic indicates that the distribution of this sample shifted to the left. This is interpreted as the intent to comply with evacuation orders is negatively affected by the introduction of the knowledge of actual risk. In other words, there is a higher likelihood that the knowledge of actual risk will lower the chances that an individual will comply with future evacuation orders.

Second, analyzing the results from questions 24 and 30 after the Wilcoxon Signed Ranks Test, 3 respondents chose not to take the survey while 17 responded with 'not sure' and were excluded from the results (**Table 3**). 149 participants showed no change in their survey response after the treatment of actual risk knowledge. 40 participants showed a positive change, and 72 showed a negative change after the treatment (**Table 4**). With a 99% level of confidence, the test statistic indicates that the distribution of this sample shifted to the left. This is interpreted as an individual's perception of wildfire risk is negatively affected by the introduction of the knowledge of actual risk. As such, there is a higher likelihood that the knowledge of actual risk will lower the perception of wildfire risk.

Third, analyzing the results from questions 25 and 31 after the Wilcoxon Signed Ranks Test, 3 respondents chose not to take the survey while zero participants were excluded from the results (**Table 5**). 103 participants showed no change in their survey response after the treatment of actual risk knowledge. 128 showed a positive change,

and 47 showed a negative change after the treatment (**Table 6**). With a 99% level of confidence, the test statistic indicates that the distribution of this sample shifted to the right. This is interpreted as an individual's likelihood to perform certain home fortifying actions is positively affected by the introduction of the knowledge of actual risk. Therefore, there is a higher likelihood that the knowledge of actual risk will increase the number of home fortifying actions an individual intends to do.

Fourth, analyzing the results from questions 26 and 32 after the McNemar Chi-Square Test, 3 respondents chose not to take the survey while zero participants were excluded from the results (**Table 7**). 207 participants showed no change in their survey response after the treatment of actual risk knowledge. Ten showed a positive change, and 61 showed a negative change after the treatment (**Table 8**). With a 99% level of confidence, the test statistic indicates that the distribution of this sample shifted to the left. This is interpreted as an individual's perception that they will survive a wildfire event if unable to evacuate is negatively affected by the introduction of the knowledge of actual risk. In this way, there is a higher likelihood that the knowledge of actual risk will increase the perception that one will die in a wildfire if they are unable to evacuate.

The relative distribution of these results in a summary histogram visually compares the positive, negative, and lack of changes in responses to the four sets of questions before and after the introduction of actual risk (**Figure 4**). It is important to note that while only one set of questions showed a positive shift after the treatment, the results do not represent the colloquial definitions of 'positive' and 'negative'. The results

refer only to the statistical shift of the answers following the introduction of actual risk and are not necessarily a reflection of 'good' or 'bad' in the colloquial sense.

Discussion

As previously mentioned, the survey in this study contained errors that should be corrected prior to conducting future research. For example, question 19 asked: "Do you have a wildfire/emergency evacuation plan for your pets?". Survey participants only had the option of selecting "Yes" and "No". They did not have the ability to say they did not have a pet, and therefore had no need for a pet evacuation plan. For future research, a third option to indicate that participants do not have a pet will be necessary. Question 26 asked: "If you are unable to evacuate, to what degree do you feel you could survive a wildfire in your home?". Question 32, which was meant to be identical, asked: "With the knowledge of actual risk, if you are unable to evacuate, do you feel you could survive a wildfire in your home?". Because question 26 collected Likert results, and question 32 collected binary results, it is necessary to update these questions for future research. In order to collect pertinent data while still making this survey comparable to future iterations, the following recommendations are made regarding these two questions:

- Pre-treatment question: "If you are unable to evacuate, do you feel you could survive a wildfire in your home?" (Yes; No)
- Pre-treatment question: "If you are unable to evacuate, to what degree do you feel you could survive a wildfire in your home?" (5 point Likert Scale)

- Post-treatment question: “With the knowledge of your actual wildfire risk, if you are unable to evacuate, do you feel you could survive a wildfire in your home?” (Yes; No)
- Post-treatment question: “With the knowledge of your actual wildfire risk, if you are unable to evacuate, to what degree do you feel you could survive a wildfire in your home?” (5 point Likert Scale)

While this solution adds 2 additional questions to the survey, it allows for comparability and accuracy in future research with minimal effects on participant time management.

There are a number of ways that future research can be conducted with this research topic. More effort can be made to analyze potential control variables within the survey results. A key factor that has yet to be studied is whether or not living in Steiner Ranch during the 2011 wildfire had any effect on the survey results. This control variable was initially left out of this research analysis because it fell out of the scope of the research study question: how does actual risk affect risk perception variables? Additional survey questions were included for future analysis and potential comparison studies. Understanding how living through a wildfire affects risk perception and intended actions is important when considering what types of educational programs are presented to varying groups of individuals. Wildfire survivors may respond positively to evacuation education, while others who have not lived through a wildfire may be more interested in their risk levels. In addition, demographic factors like age, race, income, and education level may play key roles in shaping risk perception and deserve further analysis.

Future iterations of this research should also be conducted at a variety of scales and perspectives. Employing the same survey in another area of Central Texas with differing demographics and wildfire education levels will highlight how these factors can play a role in wildfire risk perception. Surveying participants with similar questions regarding a different type of hazard (flooding or hazardous materials, for example) could prove useful in understanding the overall perception of natural and technological hazards.

Conclusion

The results of this research indicates that the introduction of actual risk has four distinct effects on the survey participants:

1. reduced likelihood that individuals will comply with an evacuation,
2. reduced perception of wildfire risk,
3. increased intention to perform home hardening activities, and
4. increased perception of risk of death in a wildfire if unable to evacuate.

It initially seems counterintuitive for all four of these outcomes to exist simultaneously. Logically, it would make more sense that as evacuation compliance and risk perceptions decrease, so too should the number of home hardening activities and the perceptions of loss of life decrease. Previous studies indicate that as risk is reduced, so is the likelihood of engaging in wildfire mitigation activities. However, when actual risk lowers risk perception in this research, the number of home hardening activities an individual intends to do has been statistically shown to increase. To begin to understand

these interactions, a number of additional influential factors must be taken into consideration.

First, due to the anonymity of this IRB survey, the exact location of these residents within Steiner Ranch is not known. There is a chance that the majority of participants do not live in the higher risk sections of this neighborhood. Therefore the perceived risk of these survey participants may have been uncharacteristically lowered in this study. Second, it must be acknowledged that the treatment of actual risk was not the only treatment in this study. At the point in the survey where actual risk is introduced, participants were sent to a web map where they could locate their home by typing in their address. However, they were not limited to viewing only their home and had the ability to look around their neighborhood and view the relative risk of Steiner Ranch as a whole. This treatment of neighborhood-level risk potentially changed the scale at which survey participants answered questions. Before the treatment of actual risk, individuals were answering questions at the home and property level. After the treatment, there may be a higher likelihood that participants are answering questions at the larger neighborhood scale, which may have skewed post-treatment survey answers. Finally, it is possible that these four outcomes, when viewed holistically rather than independently, can in fact exist at the same time. If one were to assume that perceived risk was higher than anticipated, then the treatment of actual risk would lower a participant's perceived risk. As perceived risk is lowered, evacuation compliance becomes less likely. Taking the modification of scale into account, as post treatment questions are answered at the neighborhood level, participants may become more

aware of a larger risk to their neighborhood in contrast to the smaller risk of their individual home. This may create a perceived need to participate in more wildfire mitigation activities that not only lowers risk at the home scale, but the neighborhood scale as well. Additionally, viewing risk at the neighborhood scale highlights evacuation problems that occurred during the 2011 Steiner Ranch Fire. With only one major route of evacuation, residents would still face the same core evacuation problem with future wildfire events. Therefore, with an elevated perception of neighborhood level risk, it makes sense that participants believed they are more likely to perish in a wildfire if they are unable to evacuate.

Another important component collected from open responses in this research is the concern in the perceived lack of wildfire evacuation planning. This concern exists on both the homeowner as well as City / County levels. Some residents in Steiner Ranch do not believe that enough city and county wide evacuation planning has been done since the Labor Day Fires of 2011. At the same time, a large number of residents honestly admitted in the survey that they have not created personal / family evacuation plans in case of emergency. In reality, the City of Austin and Travis County through the Joint Wildfire Coalition and in conjunction with the Office of Homeland Security and Emergency Management have been working diligently to develop a city and county wide wildfire evacuation plan, but this complex issue has taken many years to complete. At this point, an increase in evacuation communication is necessary to inform the public on the current status of evacuation planning as well as to encourage homeowners to develop their own home level emergency plans, which are just as if not more important.

Overall, given these mixed and somewhat unexpected results, a confident recommendation cannot be made to wildfire mitigation agencies regarding wildfire risk education and outreach since the treatment of actual risk had both positive and negative effects. Educating individuals on actual risk may in fact increase their intention to participate in wildfire mitigation activities. However, the same treatment lowers the chances of complying with future evacuation orders. Increased communication between residents and local government is certainly vital in the evacuation planning process, but this research study was not able to delineate clear communications components that could be improved upon at this time. A breakdown in communication may have led to a failed evacuation from the perspective of the Steiner Ranch residents, but further research will be necessary to quantify and potentially weigh these effects against each other to understand the overall net changes to perception and intention.

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Tables & Figures

		Q29				Total
		0	1	2	3	
Q23	0	1	0	0	0	1
	1	0	3	1	0	4
	2	0	1	77	7	85
	3	0	1	18	140	159
Total		1	5	96	147	249

Table 1. A crosstabulation of the results after a Wilcoxon Signed Ranks Test was run questions 23 and 29: “Do you intend to fully comply with any/all future evacuation orders?” & “With the knowledge of your actual wildfire risk, do you intend to fully comply with any/all future evacuation orders?”

8	Positive changes
221	No changes
20	Negative changes
29	'Not Sure' responses
3	Chose not to take the survey

Table 2. A summary of the results and participant trends from the analysis on questions 23 and 29.

Count		Q30					Total
		0	1	2	3	4	
Q24	0	23	8	1	0	0	32
	1	26	75	14	4	0	119
	2	2	17	28	6	3	56
	3	1	5	13	17	4	40
	4	2	2	0	4	6	14
Total		54	107	56	31	13	261

Table 3. A crosstabulation of the results after a Wilcoxon Signed Ranks Test was run questions 24 and 30: “What do you perceive is the risk of another wildfire event threatening your home?” & “With the knowledge of your actual wildfire risk, what do you perceive is the risk of another wildfire event threatening your home?”

40	Positive changes
149	No changes
72	Negative changes
17	'Not Sure' responses
3	Chose not to take the survey

Table 4. A summary of the results and participant trends from the analysis on questions 24 and 30.

Count		Q31							Total
		0	1	2	3	4	5	6	
Q25	0	7	2	0	0	1	0	2	12
	1	0	10	3	1	5	0	1	20
	2	2	8	4	7	3	5	4	33
	3	1	4	5	10	14	9	5	48
	4	4	5	4	1	21	12	24	71
	5	2	5	0	0	2	26	30	65
	6	0	0	0	1	0	3	25	29
Total		16	34	16	20	46	55	91	278

Table 5. A crosstabulation of the results after a Wilcoxon Signed Ranks Test was run questions 25 and 31: “Which of the following actions have you performed to fortify your home against wildfire and/or aid in wildland firefighting efforts?” & “With the knowledge of your actual wildfire risk, which of the following actions do you intend to perform to fortify your home against wildfire and/or aid in wildland firefighting efforts?”

128	Positive changes
103	No changes
47	Negative changes
0	'Not Sure' responses
3	Chose not to take the survey

Table 6. A summary of the results and participant trends from the analysis on questions 25 and 31.

Count		Q32		Total
		0	1	
Q26	0	56	10	66
	1	61	151	212
Total		117	161	278

Table 7. A crosstabulation of the results after a McNemar Chi-Square Test was run questions 26 and 32: “If you are unable to evacuate, to what degree do you feel you could survive a wildfire in your home?” & “With the knowledge of your actual wildfire risk, if you are unable to evacuate, do you feel you could survive a wildfire in your home?”

10	Positive changes
207	No changes
61	Negative changes
0	'Not Sure' responses
3	Chose not to take the survey

Table 8. A summary of the results and participant trends from the analysis on questions 26 and 32.

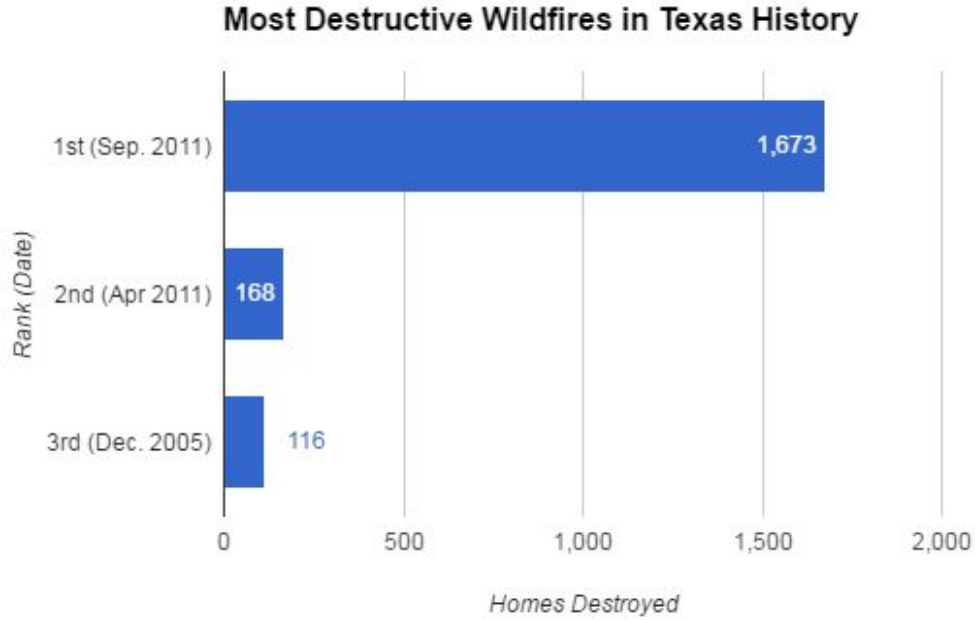


Figure 1 - Histogram showing the number of homes destroyed in the three most destructive wildfires in Texas' history. The Bastrop Complex Fire (top) destroyed 9.96 times the number of homes as the previously ranked destructive wildfire.

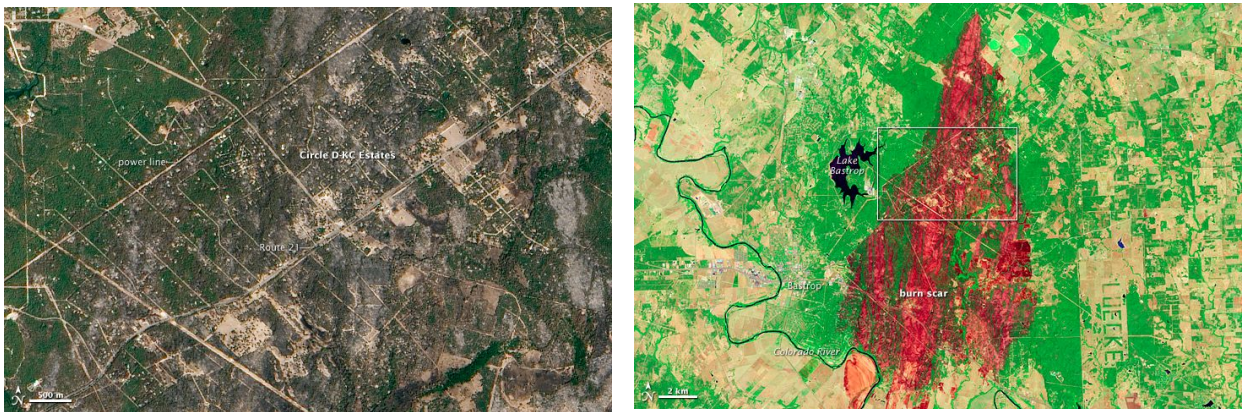


Figure 2 - True Color imagery and LiDAR photography of the Bastrop Complex Fire burn scar, which covered 98.3% of Bastrop State Park.

Are you Firewise?

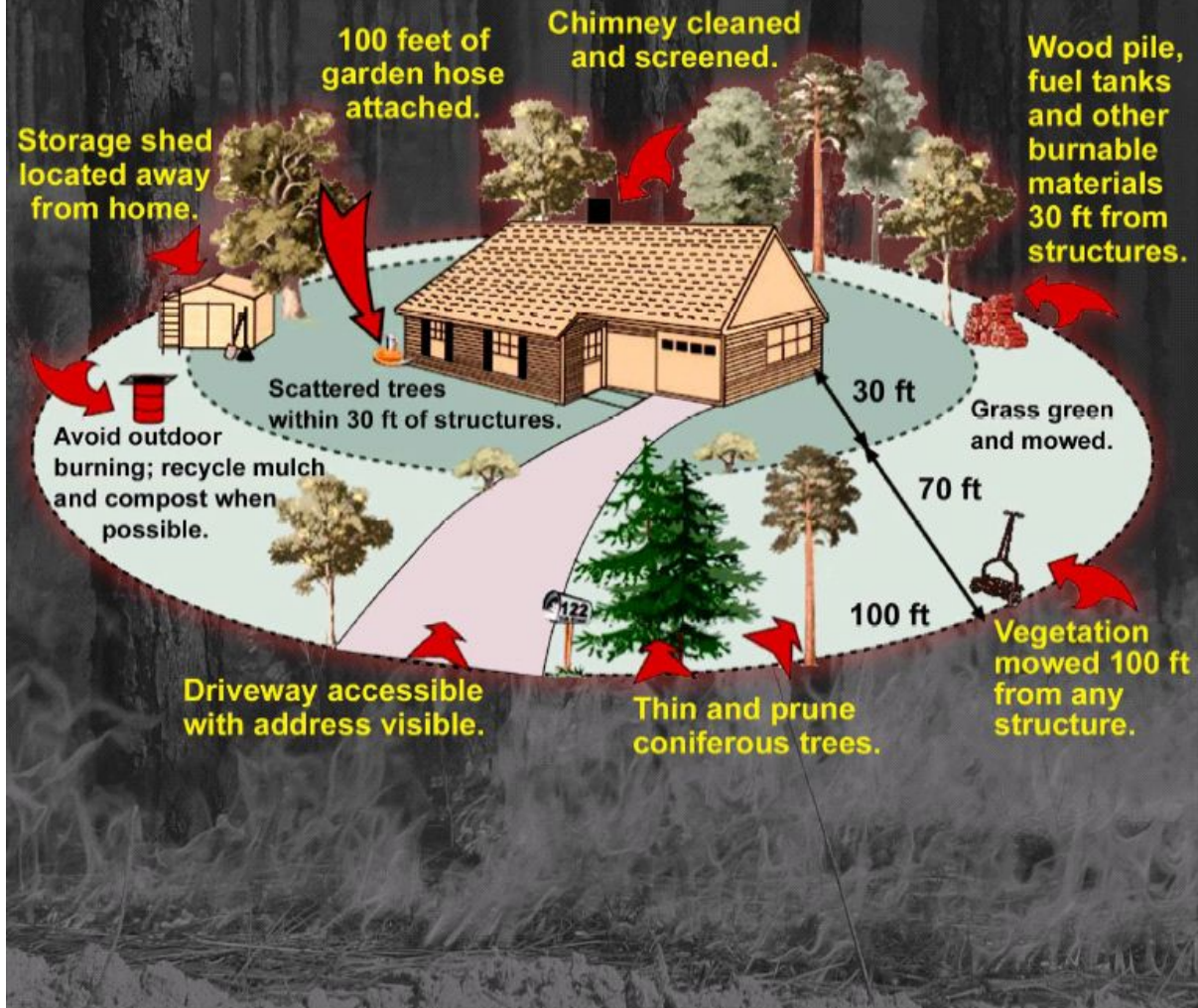


Figure 3 - Infographic from the National Fire Protection Agency illustrating Firewise Community recommendations and guidelines.

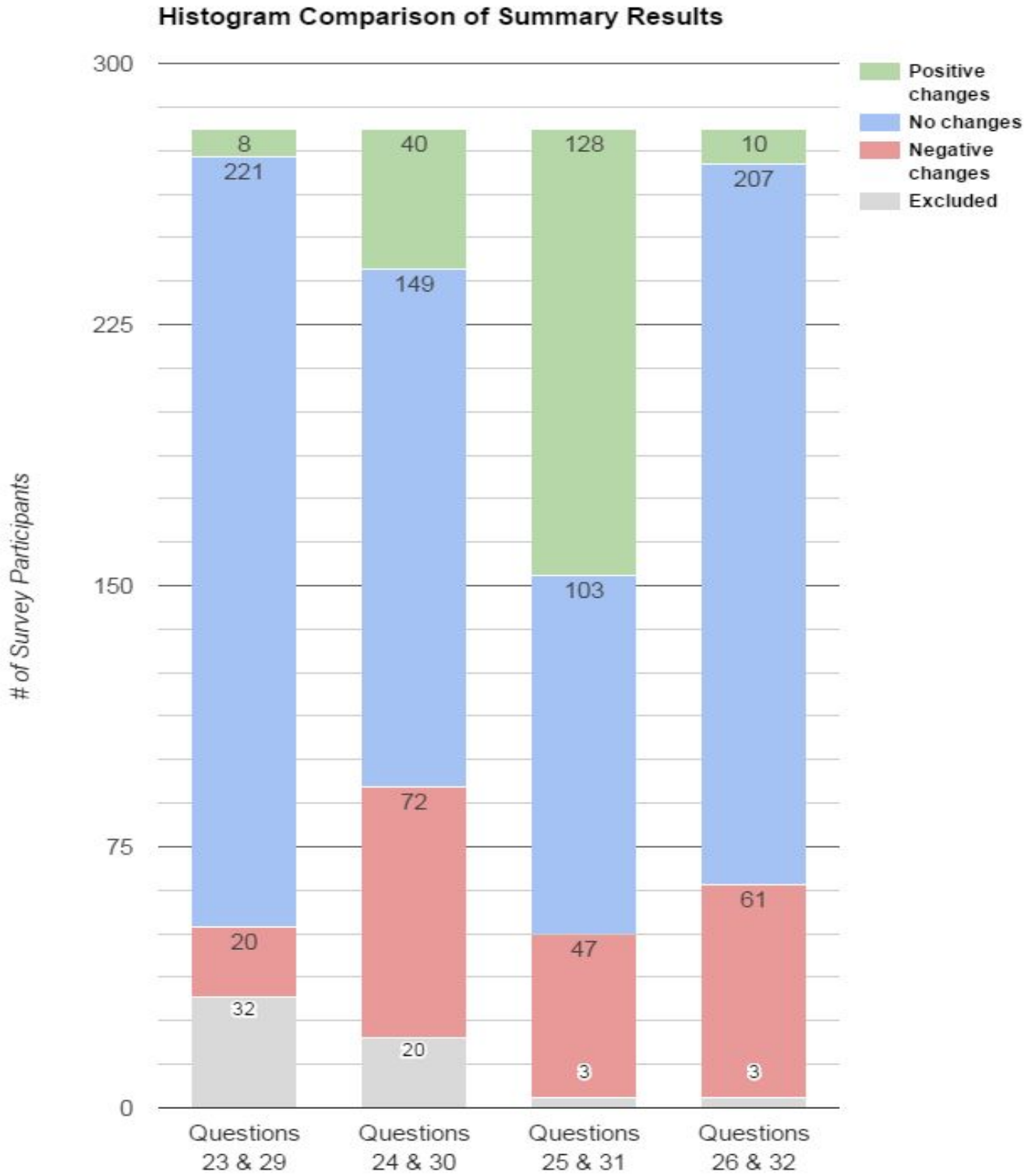


Figure 4 - Histogram comparing the summary of results and participant trends from the analysis on all four set of comparative questions.