

THESIS

PREFERENCES FOR HAZARDOUS FUEL TREATMENTS: EVIDENCE FROM A SURVEY  
OF COLORADO AND UTAH RESIDENTS

Submitted by

Danielle Hoban

Department of Agricultural and Resource Economics

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2025

Master's Committee:

Advisor: Jordan Suter

Lynne Lewis

Yu Wei

Copyright by Danielle Hoban 2025

All Rights Reserved

## ABSTRACT

### PREFERENCES FOR HAZARDOUS FUEL TREATMENTS: EVIDENCE FROM A SURVEY OF COLORADO AND UTAH RESIDENTS

The United States has experienced measurable increases in the prevalence and severity of annual wildfire events for the last few decades. The management of hazardous fuels can mitigate the spread and severity of wildfire events by removing or reorganizing excess woody materials that could otherwise feed fires. However, recent wildfire severity has required a large portion of the United States Forest Service (USFS) budget to be allocated to suppression efforts each year at the expense of other budget categories, such as fuel treatments. This motivates the importance of using available resources in a way that maximizes social welfare, but it is unclear what allocation is considered optimal by relevant stakeholders. This research investigates the preferences of the public for hazardous fuel treatments. The primary objective of this work is to assess how the public would prefer a portion of the USFS wildfire management budget be allocated among fuel reduction activities. A secondary objective is to determine how allocation preferences are affected when budgetary changes are presented as a loss or a gain. To address these questions, surveys were administered to a sample of the public residing in Colorado and Utah. Respondents were asked to complete a budget allocation exercise as the primary mechanism for assessing their preferences. Results indicate that on average, individuals would prefer to allocate a greater percentage of the USFS hazardous fuels budget to prescribed fire treatments than has been spent in previous years. Individuals who own their home allocate more to prescribed fire, on average, but few other characteristics are good predictors of allocation preferences. There is no statistical evidence that the framing of the budget decision affects allocation preferences.

## ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to the many individuals who have supported me throughout my graduate studies. I would like to thank my advisor, Dr. Jordan Suter, for offering constant guidance, encouragement, and support throughout my entire time at Colorado State University, but especially as I completed this thesis. I would like to thank Dr. Dan McCollum and the United States Forest Service for funding this research and offering valuable professional insight in the development of this survey. I also thank my committee members, Dr. Lynne Lewis and Dr. Yu Wei, for offering their time and expertise to improve this research. Thank you to my amazing graduate cohort for their genuine friendship and ability to find fun in every experience. I thank my parents for all they have given in their commitment to the success of my siblings and me; Dr. Maik Kecinski for introducing me to economic research and encouraging me to pursue a graduate degree; and my friends for filling my life with joy. Lastly, I would like to thank my partner, Jimmy, for being my best friend and biggest supporter.

## TABLE OF CONTENTS

ABSTRACT . . . . .	ii
ACKNOWLEDGEMENTS . . . . .	iii
LIST OF TABLES . . . . .	v
LIST OF FIGURES . . . . .	vi
Chapter 1 Introduction . . . . .	1
Chapter 2 Background and Literature Review . . . . .	4
2.1 Hazardous Fuels Treatments . . . . .	4
2.2 Challenges of Management Decisions . . . . .	6
Chapter 3 Methods . . . . .	10
3.1 Survey Sample and Design . . . . .	10
3.2 USFS FACTS Data . . . . .	13
3.3 Proposed Analysis and Hypotheses . . . . .	16
Chapter 4 Data . . . . .	20
Chapter 5 Results . . . . .	23
5.1 Wildfire History and Concern for Future Events . . . . .	23
5.2 Hazardous Fuel Treatments - Familiarity and Acceptance . . . . .	26
5.3 Preferred Budget Allocation . . . . .	27
5.4 Motivations Behind Allocation Preferences . . . . .	29
5.5 Protest Votes . . . . .	38
5.6 Biochar . . . . .	40
Chapter 6 Discussion and Conclusion . . . . .	43

## LIST OF TABLES

3.1	Minimum Detectable Effects (MDE) for different standard deviations and power levels	17
4.1	Summary Statistics by State	20
4.2	Distribution of Respondents by Income Bracket	21
4.3	Wildland–Urban Interface (WUI) Residence by State	21
4.4	Residence Within 5 Miles of a National Forest by State	22
5.1	Indicator For Difference From Status Quo	31
5.2	Average Marginal Effects from Fractional Logit Model on Budget Allocation to Prescribed Fire	32
5.3	Average Marginal Effect from Extended Fractional Logit Model on Budget Allocation to Prescribed Fire	33
5.4	Average Marginal Effects from Fractional Logit Model with OwnHome $\times$ Income Interaction on Budget Allocation to Prescribed Fire	35
5.5	Average Marginal Effects from Fractional Logit Model with WUI Interaction on Budget Allocation to Prescribed Fire	37
5.6	Average Marginal Effects from Fractional Logit Model on Budget Allocation to Prescribed Fire Without Protest Votes	39

## LIST OF FIGURES

3.1	Budget Allocation Exercise . . . . .	11
5.1	How concerned are you about wildfire in the United States? . . . . .	23
5.2	What About Wildfire in the United States Concerns You? . . . . .	24
5.3	In what ways have you personally, or someone close to you, been affected by wildfire in the last 5 years? . . . . .	25
5.4	Hazardous Fuel Treatments: Familiarity vs. Acceptance . . . . .	26
5.5	Public Average Budget Allocation by Treatment Type . . . . .	27
5.6	Stated reasons for allocation preferences . . . . .	29
5.7	Have You Heard of Biochar? . . . . .	41
6.1	Non-Status-Quo Allocation Decisions with Density Contour . . . . .	44

# Chapter 1

## Introduction

In recent decades, the United States has experienced notable increases in the prevalence and severity of annual wildfire events. Changes in temperature and water vapor have left forests more arid (Abatzoglou and Williams, 2016); historic management practices and the resource demands of suppression have allowed the build-up of hazardous fuels (Council, 2014); and the number of residents in the wildland-urban interface (WUI) has increased rapidly in the last few decades (Radeloff et al., 2018). These challenges have brought about the most damaging fires on record, both in terms of acres burned and social and monetary costs (Bayham et al., 2022). Federal wildfire agencies have been recording official data on acres burned and the cost of suppression since 1985. In the first 10 years that the data was recorded (1985-1994), approximately 30.4 million acres burned nationally over the 10-year period, which cost the federal government almost \$4 billion to suppress. The most recent 10 years of the data (2013-2022) reveal a staggering increase, reporting approximately 71.8 million acres burned in the 10-year period, which cost over \$25 billion to suppress.

Wildfire is a necessary natural phenomenon that works to maintain healthy ecosystems, but proper management of wildfire is vital. Although wildfires often occur naturally, human interference has permanently altered historic fire patterns, known as fire regimes (Council, 2014). For much of the 1900s, the USFS practiced anti-fire policies that mandated the immediate suppression of a wildfire at its inception (Service, 2022). This strategy was successful in preventing social and economic losses at the time but altered the prevalence and severity of fires in years to come. Fire regimes that were once maintained by frequent, low-intensity fires now burn much less often, resulting in a build-up of woody residues known as hazardous fuels. The accumulation of hazardous fuels can lead to more severe and widespread wildfire events when they occur. It would be ecologically beneficial for historic fire regimes to be restored to their natural state, but realistically, this may not be a feasible or desired solution given the growth of communities in the

wildland-urban interface (WUI). Alternatively, effective hazardous fuel management options, such as prescribed fire or mechanical treatments, can limit the presence of available fuels in a forest as frequent natural burns used to do (Council, 2014).

This research investigates the preferences of the public for preemptive wildfire mitigation activities known as hazardous fuels treatments. The primary objective of this paper is to assess how the public would prefer a portion of the USFS wildfire management budget be allocated among fuel reduction activities. A secondary objective of the research is to determine how allocation preferences are affected when budgetary information is presented as a loss or a gain. Using a budget allocation exercise administered through a survey, respondents state their preferred level of spending on prescribed fire and mechanical or other non-fire treatments. This work contributes to the understanding of what mix of hazardous fuel treatments the public considers optimal. Additionally, the work seeks to compare these preferences to previous decisions made in the field.

The existing literature suggests that fire managers operate within a complex decision environment and often lack complete information, particularly regarding the preferences of the communities they serve (Archie et al., 2012). As a publicly funded federal agency, the USFS must consider the perceptions of the public in its management decisions. The USFS was created to manage a public good collectively owned and enjoyed by the entire nation, and its mission statement emphasizes “meet[ing] the needs of present and future generations” (United States Forest Service, 2024). Improving the understanding of what mix of fuel treatment options the public prefers, and what factors influence these preferences, will allow the USFS to make more informed management decisions on behalf of the public. Previous literature has evaluated the public’s willingness to pay for specific fuel reduction activities, but has not assessed their preferred mix of treatment options (Loomis and González-Cabán, 2008). Thus, it is not fully understood what members of the public consider optimal, or if these preferences align with previous USFS management decisions.

This paper addresses this gap by answering the following questions: What are the preferences of the public for hazardous fuel treatment options when allocating a public budget, and how does the framing of the budget agenda impact these preferences? To address the research questions,

a between-subjects survey is administered to a sample of the general public. Respondents first answer a series of questions about their personal experiences with wildfire. They then complete a budget allocation exercise in which they are asked to distribute a portion of the publicly funded USFS wildfire management budget between two hazardous fuel treatment options: prescribed fire and mechanical or other non-fire treatments. This exercise was designed to more closely reflect the types of tradeoffs faced by USFS managers in real-world decision-making. Unlike prior studies that often focus on isolated choices, this approach presents participants with a more integrated and realistic budgetary decision.

Two treatments determine the framing of the budgetary decision. Participants in the “gain” treatment are asked to allocate an additional \$100 million across the two management options, relative to previous spending levels. In contrast, those in the “loss” treatment are asked to reduce existing spending by \$100 million by cutting funding from the same two options. The treatment aims to assess how the framing of information as a gain or a loss impacts allocation preferences.

# Chapter 2

## Background and Literature Review

### 2.1 Hazardous Fuels Treatments

The USFS primarily utilizes three strategies for fuel management: prescribed fire, managed wildfire, and mechanical treatments. Prescribed fire describes a method of igniting purposeful, maintained fires to achieve ecological goals. Often touted as the most cost-efficient means of fuel reduction, the USFS has called for the expanded use of prescribed fire to achieve national wildfire management objectives (U.S. Forest Service, 2023). This management strategy emulates low-intensity fires that once naturally cleared forests of hazardous fuels in a way that poses less risk to society.

The utilization of prescribed fire comes with some difficult tradeoffs. While cost-effective and ecologically beneficial, this strategy presents a greater risk to society. The possibility of fire escape, increased presence of smoke, and impact on natural amenities are among the primary concerns of this practice (Bayham et al., 2022). This tradeoff between efficiency and risk is made more challenging by the resource limitations of the USFS. Prescribed fires are carried out by highly trained professionals to mitigate as much potential risk as possible. However, the agency currently faces shortages of personnel with the necessary training to carry out a burn due to a lack of enrollment by new employees and high demand for existing employees in suppression settings (Miller et al., 2020). These personnel shortages can prevent the increased use of this management strategy.

The USFS takes these tradeoffs seriously, as managing risk and prioritizing safety are primary goals of the agency (Council, 2014). However, the agency does not only consider the objective risk they identify, but also how the communities they serve perceive risk. As a federal agency funded by taxpayer dollars, the USFS is responsible for making decisions on behalf of the public. Failing to respond to public preferences could result in pressure to defund the organization or make changes to its objectives and leadership. This is especially relevant in considering the use of prescribed

fire, for which the public has expressed fear and skepticism of its use (Brunson and Evans, 2005). While a growing body of literature has provided evidence of public support for prescribed burns (McCaffrey et al., 2012), opinions vary by location and may change based on experience with wildfire (Brenkert-Smith et al., 2023; Jacobson et al., 2001). The California Department of Public Health found that while Sierra Nevada Foothills residents generally support prescribed fire, many feel anxious when smoke appears and its source is unclear (Hoshiko et al., 2021). Additionally, more vocal actors, such as NGOs and activists, may obscure USFS perceptions of public preferences by advocating for management decisions that do not necessarily align with the opinions of the general public (Brenkert-Smith et al., 2019). These uncertainties can make it very difficult for managers to consider public opinion in their decisions and may lead to a suboptimal use of management strategies.

Similar challenges affect managed wildfire, a fuels management strategy in which wildfire that does not threaten public health or property is permitted to burn to achieve management objectives. Like prescribed fire, managed wildfire offers a lower-cost alternative but a risky one (Council, 2014). Uncertainty about how a fire will grow or move can make this a difficult management decision, as USFS managers wish to avoid undue risk to the communities they serve. Fire managers have reported avoiding this management strategy because they do not wish to be responsible for the unnecessary loss of life or property should the fire get out of hand (Wilson et al., 2011). Although there are inherent risks, the USFS and other federal agencies collaborate to identify locations where managing a wildfire would be feasible before its onset. These agencies can reduce much of the risk that is within their control by choosing locations where a fire is unlikely to threaten life or property (Council, 2014).

Mechanical and other non-fire treatments offer a lower risk option to managers (Council, 2014). These treatments do not directly utilize fire and are often used to reduce or change the arrangement of vegetation that has built up to dangerous levels. Some examples include removing dense strips of trees, thinning brush, pruning low tree branches, and applying herbicides to unwanted vegetation. While these treatments tend to cost more per acre, they offer managers more control and

flexibility over where, when, and how fuels are managed. These treatments can also offer an added economic benefit by providing marketable products such as timber or bio-fuels. One such example is biochar, a carbon-dense product that can be produced by using compact burning machines to process biomass left behind by mechanical treatments (U.S. Forest Service, 2024). Not only does this option produce marketable products that can help offset the cost of management, but it also offers the opportunity to sequester carbon that would otherwise be released through traditional pile burning. The resulting product can also be utilized to restore soil health by redistributing carbon to soils in which it is lacking.

## **2.2 Challenges of Management Decisions**

Although many options exist to reduce hazardous fuels, the current resource demands of wild-fire suppression make it difficult to prioritize these treatments due to constraints faced by the USFS. The majority of acres burned by wildfire annually are on forest and grasslands managed by the USFS (Office, 2022). As a result, managing wildfires has become a significant strain on USFS resources. Suppression spending has averaged \$1.51 billion annually over the past 10 years, which is 53% of the USFS wildfire management budget and 28% of the total USFS budget (Hoover and Lindsay, 2017). This has required the agency to make tradeoffs when choosing where to allocate scarce resources, such as trained personnel and funds (Hoover and Lindsay, 2017). The USFS would prefer to invest more in the management of hazardous fuels because they may mitigate the severity and spread of future fires (Calkin et al., 2014). However, the increasing demands of suppression require a larger portion of the budget to be allocated to this cause each year at the expense of other budget categories (Hoover and Lindsay, 2017). The USFS understands the importance of taking preventative action, but must also ensure enough of the annual budget is allocated to protect the public, firefighters, and forest ecosystems from the active threat of wildfire. Thus, identifying the most efficient allocation of available resources among fuel treatment options would allow the USFS to maximize the social and ecological benefits they generate through these activities.

Identifying the optimal allocation of USFS resources proves very difficult. In the words of The Wildland Fire Leadership Council, wildfire management is “not a scientific optimization problem, but a sociopolitical exercise which science can advise” (Council, 2014). There are various factors at play when deciding which hazardous fuel treatment to utilize. Decision-makers face various objectives, which can sometimes be at odds with one another. Inherent tradeoffs exist between treatment options, primarily between risk and cost. In summary, prescribed fire and managed wildfire are cost-effective options, but present the highest risk. Mechanical and other non-fire treatments are less risky options, but fewer acres can be treated for the same cost. While managers want to treat as many acres as possible with the budget at their disposal, the Forest Service also highly prioritizes public and firefighter safety (Council, 2014). The complexity of wildfire management makes it unfeasible to derive a technically optimal solution, leaving individual managers to determine what they consider the best mix of treatments. However, it remains unclear how these decisions align with public preferences or what mix the public views as ideal.

Given the complexity of the decision space, it is likely that individuals differ in their consideration of what mix of treatments is optimal. Previous literature suggests that when faced with complex decisions embedded with risk or uncertainty, individuals are unlikely to make technically optimal decisions and instead rely on heuristics for decision-making (Tversky and Kahneman, 1974). Some research has provided evidence that these biases may apply to the decisions of fire managers. For instance, managers have been shown to weigh probabilities non-linearly, meaning they may be overly concerned about low-probability events and assume high-probability events as certain (Wibbenmeyer et al., 2013). They have also been shown to discount long-term risks, weight losses more heavily than equivalently sized gains (loss aversion), and often repeat previous managerial decisions due to status quo bias (Wilson et al., 2011). The framing of risk also seems to affect managerial decisions, leading to vastly different resource allocations when outcomes are presented in a neutral vs loss framework (Hand et al., 2015). Less research has been done to evaluate how these biases influence public preferences and how this might affect public perception

of USFS management decisions. Understanding this relationship could be useful in identifying effective ways of informing the public about land management activities.

The USFS presents national goals to guide treatment decisions, but much of the implementation of these directives occurs on a smaller scale, such as within a single national forest. This presents a challenge in which USFS employees are responsible for considering federal objectives in their decisions, but they must also address the unique needs and desires of the community they serve. However, managers have reported a lack of information about community preferences as one of the primary barriers to making management decisions (Archie et al., 2012). In addition to lacking clear information, research has provided evidence that managers' perceptions of public preferences may not be accurate (Wu et al., 2022). Discrepancies between managers' perceptions and reality could lead to management decisions that do not best serve local communities and create tension between the public and federal agencies. To add to these challenges, recent literature provides evidence of significant variance in the acceptability of different fuel management strategies across communities (Brenkert-Smith et al., 2023). These findings suggest it may be difficult to generalize results from public preference research, making it more difficult to inform USFS managers.

Establishing a better understanding of public preferences can aid USFS decision-making. Comparing the management choices made by the USFS to public preferences helps reveal whether the public generally supports current practices or favors a different mix of treatments. However, this research does not aim to suggest that USFS managers should act solely in response to public opinion. Salanié and Treich (2009) describe two types of regulators: populists, who base decisions on the public's perception of risk, and paternalists, who rely on expert knowledge while anticipating how the public may respond to regulation. Populists act directly on public concern, even if those concerns are misaligned with actual risk, whereas paternalists incorporate public perception strategically to enhance policy effectiveness and acceptance. This research aims to improve understanding of the public's preferences for fuel treatments, not to encourage populist decision-making, but to support USFS managers in acting as informed paternalists. By understanding public attitudes, managers can apply their technical expertise while anticipating how the public is likely to interpret

and respond to various mitigation strategies. This balance may enhance both the effectiveness and acceptance of wildfire management decisions.

# Chapter 3

## Methods

A survey was designed and administered through the Qualtrics XM online survey platform to explore the proposed research questions. The survey was administered to a sample of the public in a between-subjects design with two treatment groups. The survey consisted of three sections: questions about wildfire experience, a budget allocation exercise, and demographic questions.

### 3.1 Survey Sample and Design

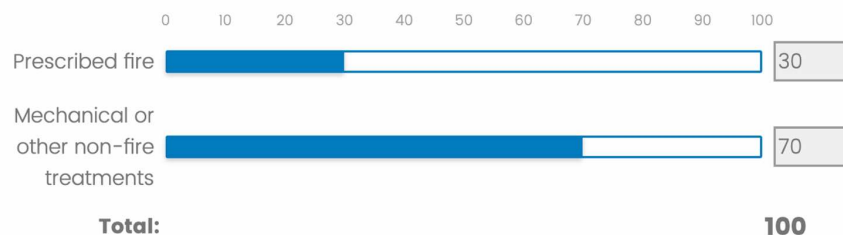
A sample of Colorado and Utah residents was drawn to serve as a proxy for the general public. This population was selected for several reasons. Research funding strictly limited the size of the sample that could be collected, motivating a focus on a specific region. A significant portion of the population in both Colorado and Utah lives in close proximity to national forests, suggesting these residents may have more direct experience with wildfire than the broader U.S. population. The researcher's affiliation with Colorado State University and the USFS Rocky Mountain Research Station further supported this regional focus.

The sample was obtained directly through Qualtrics. Sampling conditions were implemented to enhance the representativeness of the sample relative to the broader population. Respondents were pre-screened to ensure that only Colorado and Utah residents over the age of 18 who consented to participate were included. Additional quotas based on age and state of residence were applied to ensure that the final sample more closely reflected the population distribution of Colorado and Utah.

As previously mentioned, the survey included questions about respondents' experience with wildfire, demographic characteristics, and a budget allocation exercise. Most questions were presented in multiple-choice, "select all that apply," or Likert scale formats, with the exception of the budget allocation exercise.

The budget allocation exercise serves as the primary mechanism for analysis in this study. Participants were presented with information about two commonly used fuel reduction strategies: prescribed fire and mechanical or other non-fire treatments. They received a brief description of each strategy along with a summary of average spending on acres treated with each strategy over the past five years. The intention was to provide participants with enough information to understand the management options available to the USFS and the current state of hazardous fuel management, but not so much as to cause survey fatigue.

After reviewing the provided information, participants were presented with one of two hypothetical scenarios depending on the treatment to which they were assigned. In the “gain” treatment, participants were informed that the USFS will be allocating an additional \$100 million to the hazardous fuel management budget in the following year. They are asked to imagine a scenario in which they are responsible for allocating the additional money between prescribed fire and mechanical treatments. In the “loss” treatment, participants were informed that the USFS will need to reduce its spending on hazardous fuel management by \$100 million in the following year. They are asked to imagine a scenario in which they are responsible for deciding how much money to cut from the prescribed fire and mechanical treatment options to meet the budget reduction requirement.



**Figure 3.1:** Budget Allocation Exercise

Figure 3.1 displays the allocation choice as it was presented to respondents. Respondents were first presented with a status quo allocation that reflected the ratio of USFS spending on prescribed fire and mechanical treatments over a recent five-year period (2019–2023). Participants faced a

tiered choice: first, they decided whether to maintain the status quo allocation or opt for a different one; then, if they chose to deviate from the status quo, they must select a new allocation that reflected their own preferences. The question mechanism did not allow respondents to allocate more than \$100 million between the two management options, requiring them to reduce funding for one option before increasing it for the other. In the gain frame, this meant directly reducing funding in one category in favor of the other. In the loss frame, this meant reducing the amount of funding taken away from a category in favor of cutting funding from the other. This design intentionally presented respondents with a clear tradeoff between the two options.

Immediately following the budget allocation exercise, participants were asked about the choice they made. If they chose to maintain the status quo allocation, they were asked to indicate if this was because they prefer the current allocation, they do not know enough to choose a different allocation, or they trust the USFS to choose the best allocation. All participants were also asked to identify the three most important factors they considered when choosing a budget allocation from a list of potential factors.

This budget allocation exercise was chosen to reflect the decision space faced by USFS managers. This survey method is relatively uncommon in the literature but has been used in similar contexts to assess individuals' valuation of publicly funded services (Blomquist et al., 2003; Korfod, 2010; Han et al., 2022). Previous research on fuel management preferences has typically offered discrete choice sets with specific outcomes, where respondents are often asked about their personal willingness to pay (WTP) for a good or service (Wibbenmeyer et al., 2013; Hand et al., 2015; Dickinson et al., 2020). In this work, respondents are given more flexibility in their allocation decision and are asked to allocate money that is not their own. This design allows participants to experience a decision space more closely related to that of USFS managers and choose the option they identify as optimal without a personal budget constraint. They instead face a public budget constraint, which reflects the limited resources available to the USFS and the responsibility of the organization to allocate government funds on behalf of the population. While simplified, the characteristics of this exercise model the constraints faced by managers.

The gain vs loss treatment was chosen to further assess the effect of behavioral biases on complex decision making. As previously mentioned, risk and uncertainty can drive these biases and lead to inefficient management decisions (Tversky and Kahneman, 1974). Significantly different allocation preferences between the two treatment groups would indicate that the way information is presented to individuals matters in how they evaluate management options. This could have implications in determining how to best present information about management actions to the public.

The current political climate also motivates the included treatment. The administration under President Donald Trump has expressed conflicting intentions for the USFS budget. In his first term as president, Trump was outspoken about the importance of hazardous fuel reduction. He signed Executive Order 13855, which emphasized the importance of active forest management and called for coordination between government entities to identify and implement effective fuel management strategies (Executive Office of the President, 2019). More recently, Trump signed Executive Order 14225, which calls for the immediate expansion of timber production in the United States. The Order calls for the USFS to facilitate sound forest management through the expansion of timber production (Executive Office of the President, 2025). This directive encourages fuel reduction through the removal of timber, but it potentially limits the freedom of the USFS to prioritize other management activities if substantial resources must be committed to this initiative. Budget cuts to federal departments like the USDA and the firing of thousands of USFS employees generate additional uncertainty regarding resources and governing power available to the USFS (Crow, 2025). Thus, it is relevant to evaluate how the preferences of the public may differ when faced with budget increases or decreases.

## **3.2 USFS FACTS Data**

The administered survey collected primary data, which were used for all statistical analyses in this study. Secondary data produced by the USFS were also used to inform the development of the surveys. The USFS Forest Activity Tracking System (FACTS) is an activity tracking application that manages information related to fuel, fire, silviculture, and invasive species (U.S. Forest

Service, 2025). The FACTS Hazardous Fuel Treatment Reduction data tracks all fuel treatments planned, awarded, and/or completed by the USFS. Each point in the dataset represents a fuel treatment project and includes various characteristics of the activity. The USFS utilizes the FACTS data to publish summarized information about fuel treatments on the USFS Hazardous Fuels Treatment Dashboard (hereafter referred to as the Dashboard) (Service, 2024). The Dashboard reports the number of acres treated by prescribed fire, mechanical, and managed wildfire treatments, as well as offers an interactive map of where treatments have been carried out.

To make an informed budget allocation decision, it was necessary to provide participants with information about the current state of hazardous fuels management. The survey asks participants to allocate a budget between prescribed fire and mechanical or other non-fire treatments. It was important for participants to know how the budget is currently allocated between these management options and how many acres of land were treated with those funds. The Dashboard reports some of this, but does not include the relevant cost information needed to inform survey participants. Thus, additional processing of the FACTS data was carried out while using The Dashboard as a guide to ensure consistency with USFS reporting.

The ultimate goal was to use the FACTS data to determine the number of acres treated by prescribed fire and mechanical treatments over the last 5 years and the total cost to treat the land. First, the data had to be sorted into subsets of the categories of interest: prescribed fire and mechanical or other non-fire activities. Hazardous fuel treatments are recorded in the FACTS data with a 4-digit activity code that corresponds to the specific type of treatment completed. These activity codes are detailed, meaning many activity codes make up the broader categories of prescribed fire and mechanical treatments. Although the USFS has sorted the data by activity code into these categories on The Dashboard, they do not report which codes are assigned to each.

Within the FACTS metadata, there are descriptions of each activity code. In many cases, it is clear whether an activity should be designated as a prescribed fire or mechanical treatment, but some activities possess characteristics of both. Activities were initially sorted intuitively based on their code descriptions, with the goal of matching the total acreage in each subset to the acreage

reported on The Dashboard. Several iterations were tested, but an exact match to The Dashboard could not be achieved. In searching for clarity in the literature, it was found that other users of this dataset have also sorted activities into these broader categories, but researchers are not consistent with which activity codes they include (Adams and Charnley, 2018; Interagency Tracking System, 2024). There are also differences in the data from year to year in which activity codes are reported. The limited information on The Dashboard, inconsistencies in the literature, and variance in reported activities across the years required assumptions to be made in the final sorting process. The final breakdown of activity codes was chosen because the number of acres attributed to prescribed fire and mechanical treatments was closer to The Dashboard than any others tested in the iterative process. A link is provided on The Dashboard to email the USFS hazardous fuel staff, but a response was never received after several requests for clarification.

An assumption was also made regarding which individual treatments should be counted in a given year. Three dates are provided for each fuel treatment: the date the project was planned, awarded, and completed. The Dashboard measures all hazardous fuel “accomplishments”, which are treatments planned or contracted to occur. Thus, the date the project was planned was utilized to sort activities by year. Ultimately, the calculated values for acres treated annually by prescribed fire and mechanical activities were not precise due to the assumptions that had to be made. The values presented in the survey reflect a five-year average of the data from years 2019-2023 to account for the imprecision.

After estimating the number of acres treated by prescribed fire and mechanical treatments, work was done to estimate the total cost spent on each treatment over the five years of interest (2019-2023). Cost is recorded in the FACTS data as cost per acre treated in U.S. dollars. With complete data, the total cost for each treatment category could have been calculated by multiplying the cost per acre by the number of treated acres and summing the costs of each project. However, for many of the data points, the cost is reported incorrectly as \$0 or \$1 per acre treated. The missing data prevented a precise calculation of true annual spending on each type of treatment and required the values presented in the survey to be estimated.

To estimate total costs, the prescribed fire and mechanical treatment subsets were first cleaned by removing data points that reported a cost of \$0 or \$1 per acre. A few outliers with unusually high costs were also excluded. The resulting subsets included only data points with valid cost-per-acre values. However, this cleaning process eliminated a significant portion of the data—nearly 2 million acres of treated land—making it unreliable to simply sum the reported costs within each subset. Instead, the cleaned data were used to calculate the average cost per acre for each treatment type. These averages were then multiplied by the total number of acres treated, as identified prior to cleaning, to approximate the true cost of prescribed fire and mechanical treatments over the five-year period.

### **3.3 Proposed Analysis and Hypotheses**

Data collected through the budget allocation exercise were used to address the research questions. Limitations in sample size motivated a power analysis to assess the statistical constraints of the data prior to conducting the analysis.

Prior to survey distribution, it was necessary to develop an agreement with Qualtrics regarding the sample size that would be collected. It was determined that a sample of 700 complete survey responses could be collected, given the available budget for data collection. To assess whether this sample size would support effective statistical analysis, a power analysis was conducted in advance.

The power analysis was completed to assess the minimum detectable effect (MDE) that could be achieved with the fixed public sample size. This MDE was calculated at 80% and 90% power, with a 0.05 significance level and 3 estimates of the standard deviation. The primary statistical analyses utilize the dollar value allocated to prescribed fire to assess the preferences of the public. This value will be a number between 0-100 million dollars.

It is assumed that a notable percentage of responses will be clustered around the provided status quo budget allocation, which represents past USFS spending. Three standard deviations were estimated to evaluate how the MDE might change depending on how much of the data is clustered

around this point and how variable the rest of the data is. Because the true distribution of responses was unknown at the time, several assumptions were made. Specifically, it was assumed that 50% of respondents would allocate the status quo amount of \$30 million to prescribed fire, while the remaining 50% would distribute their allocations uniformly across the remaining values between \$0 and \$100 million, excluding \$30 million. Under these assumptions, the overall mean allocation to prescribed fire would be approximately \$40.1 million. The standard deviation resulting from this mixed distribution was calculated to be approximately 22.77. Standard deviations of 20 and 25 were also tested to provide slightly less and more conservative estimates around the calculated value of 22.7. Table 3.1 displays the results of this power analysis:

**Table 3.1:** Minimum Detectable Effects (MDE) for different standard deviations and power levels

<b>Power Level</b>	<b>SD = 20</b>	<b>SD = 22.7</b>	<b>SD = 25</b>
80% Power	MDE = 4.24	MDE = 4.81	MDE = 5.30
90% Power	MDE = 4.91	MDE = 5.57	MDE = 6.13

The MDE values represent millions of dollars. If the true effect is greater than the MDE values displayed above, there is an 80% or 90% chance (depending on the power level) that this difference will be detected as statistically significant at the 5% level. These results suggest that the statistical analysis should be able to detect meaningful differences in budget allocations. This provides confidence that the forthcoming models will be capable of detecting patterns in the data, should they exist.

To test the stated research questions, two difference-of-means *t*-tests will be conducted. A one-sample *t*-test will be used to determine if each group’s preferences are significantly different from the status quo allocation presented to them during the study. It is probable that a notable percentage of participants will choose to maintain the status quo budget allocation. However, the literature suggests that preferences for fuel treatments can vary greatly depending on location, community characteristics, and risk preferences. The following null hypothesis will be tested:

H1: *There is no statistically significant difference between the mean budget allocation and the status quo allocation in the public sample.*

Next, a *t*-test will be conducted to test the effect of informational framing on the preferences of each group. A statistically significant difference between the mean allocation of each treatment group could indicate that the framing of information has an effect on allocation preferences. The literature provides evidence of the idea that the framing of information as a loss or a gain can influence preferences. It is likely that the presentation of budgetary changes as a gain of \$100 million or a loss of \$100 million will influence the preferences of respondents. The following null hypothesis will be tested:

H2: *There is no statistically significant difference between the mean budget allocation of those assigned to the loss treatment and those assigned to the gain treatment.*

In addition to determining what the allocation preferences of respondents are, it is of interest to understand why they prefer a given allocation. Data collected through survey questions related to respondent characteristics and wildfire experience will be utilized to develop models that test the effect of these factors on allocation decisions. First, a binomial logit model will be estimated to determine characteristics that influence the probability of maintaining the status quo allocation. It is assumed that respondents who possess characteristics that would increase their likelihood of being negatively affected by wildfire will have stronger preferences for forest management and be more likely to deviate from the status quo in favor of their own allocation. One such variable is residence in the wildland-urban interface, where respondents may live in close proximity to wildfire events. Variables that may make individuals more risk-averse, such as living with children, the elderly, or individuals with respiratory illnesses, may also result in stronger preferences and deviation from the status quo.

*H3: Individuals who are at greater risk of being negatively affected by wildfire or possess characteristics that may make them more risk-averse will have stronger allocation preferences and be more likely to deviate from the status quo allocation.*

A fractional logit model will also be estimated to examine how individual characteristics influence the percentage of the budget allocated to prescribed fire. While the model could alternatively be specified using mechanical treatments as the dependent variable, the results would be mathematically equivalent due to the binary nature of the allocation. Because the full budget is divided between these two categories, an increase in one necessarily implies a decrease in the other, meaning the interpretation shifts, but the underlying relationships remain the same. Prescribed fire is a riskier treatment option than mechanical treatments, so it is assumed that individuals who possess characteristics that increase their level of risk or aversion to risk will allocate less to prescribed fire. For instance, those living in the WUI may be less inclined to allocate dollars to prescribed fire because they are at greater risk in the event of a fire escape and are more directly impacted by smoke generated through burning. Those who own their home may also be more risk-averse than renters because they stand to lose the value of their property in the event of a disaster. Additionally, those who state that their home is at risk of wildfire or have vulnerable populations residing in their home may also be less inclined to allocate dollars to prescribed fire.

*H4: Individuals who face greater potential harm from adverse outcomes associated with hazardous fuel treatments, or who exhibit characteristics linked to higher risk aversion, will allocate a smaller share of the public budget to prescribed fire compared to those without these characteristics.*

# Chapter 4

## Data

A total of 700 responses were collected through the public survey. Respondents were evenly divided between two information treatments: gain and loss, with 350 individuals assigned to each group. Within each treatment group, the sample was further stratified by state to reflect population differences between Colorado and Utah, resulting in a 60/40 split. This yielded 420 respondents from Colorado and 280 from Utah, proportionally divided across both treatment groups. The public survey data was cleaned by Qualtrics so that the data included only complete responses. Table 4.1 summarizes respondent characteristics by state.

**Table 4.1:** Summary Statistics by State

<b>Variable</b>	<b>Colorado (N = 420)</b>	<b>Utah (N = 280)</b>
Most common age group	65+ years old (42.1%)	65+ years old (26.2%)
% Female	61.7%	60.9%
% White	87%	82.4%
Most common education level	Bachelor's degree (27.9%)	Some college, no degree (28.3%)
% Own Home	63.4%	54.1%
% With Children in Home	18.9%	29.4%
% With Elderly in Home	49.4%	33.7%
% With Respiratory Issues	17.3%	11.1%
Most common income level	\$25,000–\$49,999 (23.2%)	\$25,000–\$49,999 (26.5%)

Respondents were asked to report their total household income before taxes. They were presented with a multiple-choice question and offered income ranges as answer options. Thus, the data collected is a discrete measure of respondents' income. Table 4.2 displays the percentage of respondents who fall into each income level. Because the data did not offer a continuous measure of income, the upper range of the median income bracket was utilized as the average income in statistical analysis.

**Table 4.2:** Distribution of Respondents by Income Bracket

<b>Income Bracket</b>	<b>Number of Respondents</b>	<b>Percent of Sample</b>
Less than \$25,000	133	19.0%
\$25,000–\$49,999	172	24.6%
\$50,000–\$74,999	135	19.3%
\$75,000–\$99,999	92	13.2%
\$100,000–\$149,999	83	11.9%
\$150,000 or more	84	12.0%

The survey data produced two measures of whether the respondent resides in the WUI. After being provided a definition of the WUI, participants were directly asked if they reside in this area with answer choices “yes”, “no”, and “I am unsure”. Table 4.3 presents the responses to this question by state.

**Table 4.3:** Wildland–Urban Interface (WUI) Residence by State

<b>WUI Response</b>	<b>Number of Respondents</b>	<b>Percent</b>
<b>Colorado</b>		
I am unsure	63	14.9%
No	253	59.8%
Yes	107	25.3%
<b>Utah</b>		
I am unsure	42	15.1%
No	171	61.3%
Yes	66	23.7%

Participants were also asked to provide the ZIP code in which they currently reside. This information was used to construct a geographically derived WUI variable, where any respondent living in a ZIP code whose boundary falls within five miles of a National Forest was classified as residing in the wildland–urban interface. Table 4.4 presents these results. The WUI variable is

of interest in this study because it represents individuals who live in close proximity to areas that may be more directly affected by wildfire events. Residing within 5 miles of a National Forest was determined to be a reasonable proxy for this measure because there is no precise definition of what it means to live in a WUI.

The results presented in Tables 4.3 and 4.4 show that the percentage of participants living in the WUI is much higher when measured by geographic location than what was stated by individuals in the survey. It is possible that those who responded that they are unsure if they live in the WUI are picked up in the geographic measure. It is also true that the geographic measure is imprecise and may include residences that are not truly in the WUI. This discrepancy is interesting because the variable is intended to capture exposure to wildfire risk. The findings suggest that perceived risk, reflected in respondents' self-reported residence in the WUI, does not always align with geographic proximity to wildfire-prone areas. This could be relevant in modeling the effect of WUI on allocation preferences.

**Table 4.4:** Residence Within 5 Miles of a National Forest by State

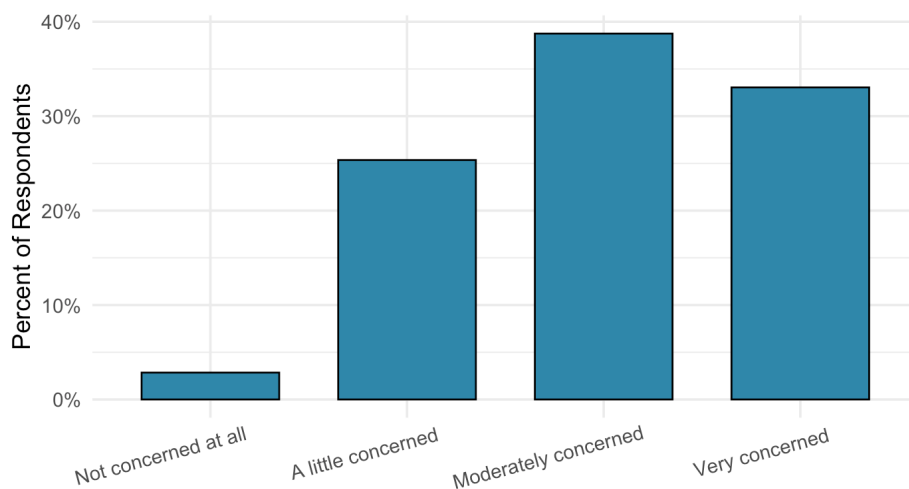
<b>State</b>	<b>Number of Respondents</b>	<b>Percent</b>
<b>Colorado</b>		
No	248	58.6%
Yes	175	41.4%
<b>Utah</b>		
No	32	11.5%
Yes	247	88.5%

# Chapter 5

## Results

### 5.1 Wildfire History and Concern for Future Events

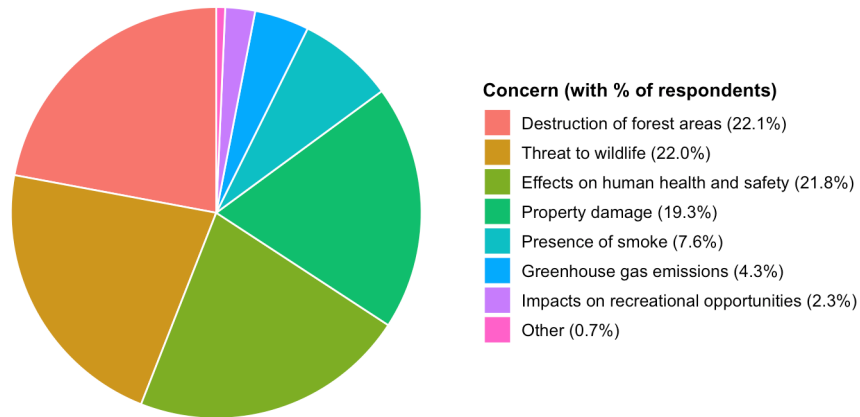
The first part of both surveys inquired about the respondent’s experience with wildfire. These initial questions build a base understanding of how respondents have been impacted by wildfire, which may influence their preferences for hazardous fuel treatments. First, respondents were asked how concerned they are about wildfire in the United States. As expected, most respondents expressed some level of concern, with the majority reporting that they were “moderately concerned”. Only 20 respondents of 700 reported not being concerned at all. Figure 5.1 displays these results.



**Figure 5.1:** How concerned are you about wildfire in the United States?

Next, respondents were asked what about wildfire in the United States concerns them. Respondents were offered a list of concerns to choose from and asked to select their top three. An “other” option with a text entry was also provided. Figure 5.2 displays the percentage of respondents who chose a specific concern. Four concerns were chosen in a similar frequency: destruction of forest areas, threat to wildlife, effects on human health and safety, and property damage. Participants

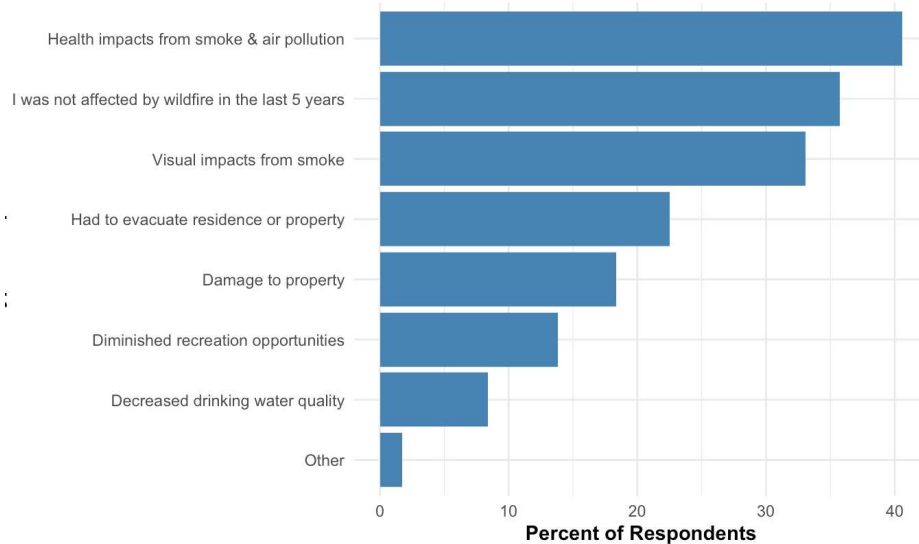
were not as concerned about the presence of smoke, greenhouse gas emissions, or impacts on recreational opportunities. This is not to say that these factors do not concern respondents, but rather, they do not rank among their top concerns.



**Figure 5.2:** What About Wildfire in the United States Concerns You?

Lastly, respondents were asked how they had been impacted by wildfire in the past five years. Again, respondents were offered a list of choices and an “other” option with a space to enter text. Respondents were asked to choose all of the options that applied to them. Figure 5.3 displays these results. Responses indicate a notable range in how individuals have been affected by wildfire in recent years. Two of the most commonly reported impacts were health effects from smoke and air pollution, as well as visual impacts from smoke. This is particularly noteworthy given that concerns related to smoke and greenhouse gas emissions ranked relatively low on participants’ lists of wildfire-related concerns. However, it is not unexpected that many individuals reported being affected by smoke, as wildfire emissions can travel across large geographic areas and impact wide populations simultaneously. Other notable findings include the substantial percentage of respondents who reported being unaffected by wildfire in recent years, as well as those who experienced property damage or were forced to evacuate. One minor issue arose in the analysis of this question specifically. 24 respondents, or about 3.4%, selected that they were not affected by wildfire in the last 5 years, but also selected other options that indicated ways in which they were affected. It

is assumed that respondents who answered this way were not personally impacted by wildfire in the last 5 years, but someone close to them was, so they chose both answer options. Analysis that relied on data from this question was carried out both with and without these 24 respondents, but there was no qualitative difference in the results.



**Figure 5.3:** In what ways have you personally, or someone close to you, been affected by wildfire in the last 5 years?

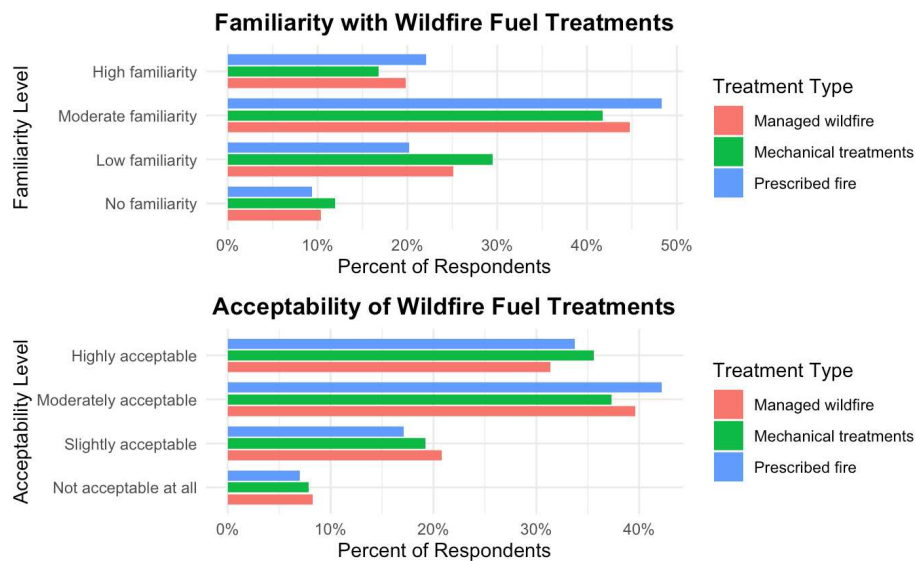
To understand if wildfire experience affects concern for wildfire, a difference of means t-test was conducted to evaluate if those who had been impacted by wildfire in the last 5 years were more likely to report a higher level of concern for wildfire in the United States. The results indicate that the mean level of concern among those who reported being personally affected by wildfire (mean = 3.15) was significantly higher than those who were not impacted (mean = 2.79) on a 4-point scale ( $t = -5.34, df \approx 480, p < 0.001$ ).

These preliminary questions reveal that in general, respondents are concerned about wildfire in the United States. They have been affected by wildfire in a multitude of ways and have various concerns about future fires.

## 5.2 Hazardous Fuel Treatments - Familiarity and Acceptance

Before they were presented with information about hazardous fuel treatments, participants' understanding and acceptance of them were gauged. Participants were asked two Likert scale questions. First, they were asked how familiar they are with prescribed fire, mechanical treatments, and managed wildfire. Then, they were asked how acceptable they find each of these treatment options.

Figure 5.4 compares these responses. Generally, there is no single treatment type that respondents are more familiar with or more accepting of. Participants were slightly more familiar with prescribed fire and managed wildfire, but a majority of participants report moderate or high familiarity with all treatment types: 70.4% for prescribed fire, 64.5% for managed wildfire, and 58.5% for mechanical treatments. Respondents were somewhat more cautious about managed wildfire, with 29.9% indicating that they found this option either slightly acceptable or not acceptable at all. However, the majority of participants found all treatment options to be moderately or highly acceptable: 76% for prescribed fire, 70.1% for managed wildfire, and 72.9% for mechanical treatments. Overall, participants have some familiarity with all three treatment types, and the majority of respondents are accepting of their use.



**Figure 5.4:** Hazardous Fuel Treatments: Familiarity vs. Acceptance

### 5.3 Preferred Budget Allocation

The preferred budget allocation of respondents is the primary outcome of interest in this study. Respondents completed a budget allocation exercise in which they were asked to either allocate an additional \$100 million or reduce spending by \$100 million on prescribed fire and mechanical treatments. They could either choose to maintain a predetermined status quo budget or choose their own allocation. Under the status quo budget, \$30 million is allocated to prescribed fire and \$70 million to mechanical or other non-fire treatments.

Figure 5.5 presents the average budget allocation compared to the status quo allocation. On average, individuals preferred to allocate more of the budget to prescribed fire than the status quo, which reflects previous USFS spending. This preference was nearly identical between the gain and loss treatments. On average, those who received the gain treatment preferred to allocate \$37.6 million to prescribed fire and \$62.4 million to mechanical treatments. Similarly, those who received the loss treatment preferred to allocate \$36.8 million to prescribed fire and \$63.2 million to mechanical treatments, on average.

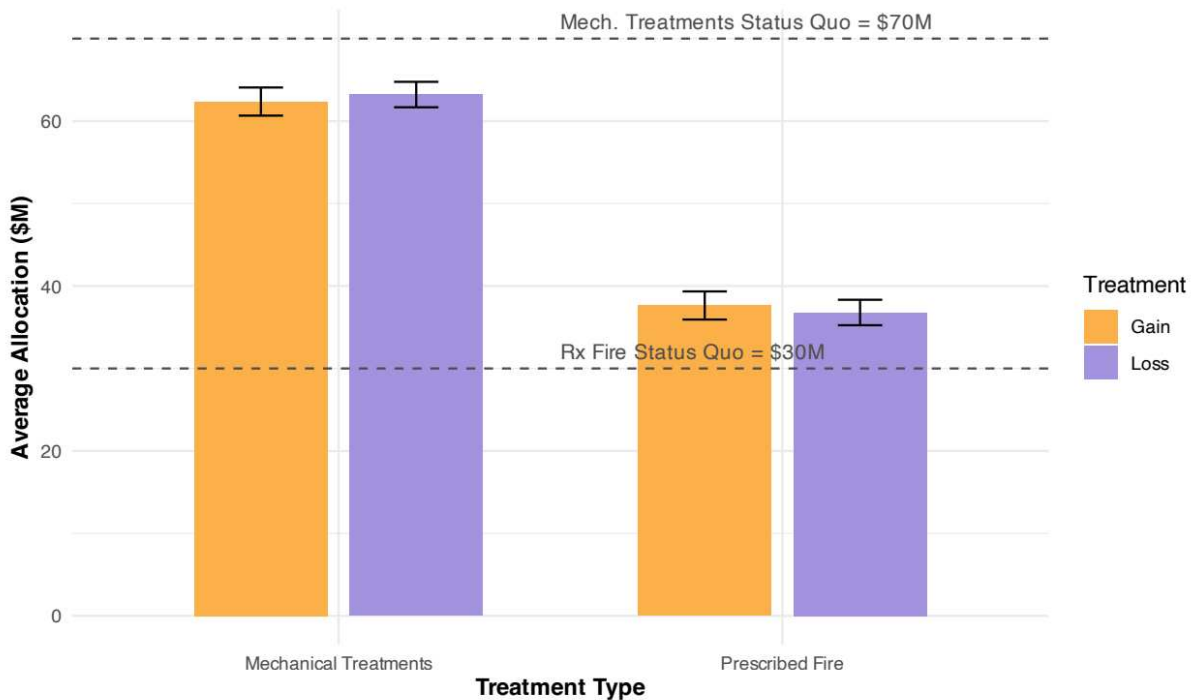


Figure 5.5: Public Average Budget Allocation by Treatment Type

To confirm the visual depiction in Figure 5.5, two difference-of-means  $t$ -tests were conducted. The first  $t$ -test evaluates whether the average preferred allocation across both treatment groups differs significantly from the status quo:

$$H_0: \mu_{PF,Public} = SQ_{PF}$$

$$H_a: \mu_{PF,Public} \neq SQ_{PF}$$

Where  $SQ_{PF}$  and  $SQ_{MT}$  are the status quo dollar values allocated to prescribed fire and mechanical treatments, respectively.

The test indicates that the average allocation to prescribed fire (\$37.2 million) was significantly different from the status quo value of \$30 million ( $t = 12.29$ ,  $df = 699$ ,  $p < 0.001$ ), with a 95% confidence interval of [\$36.06 million, \$38.36 million]. To assess the reliability of these results, they were compared against the minimum detectable effect (MDE) estimated in the power analysis described in Section 3.4. That analysis assumed a standard deviation of 22.7, which proved to be conservative; the actual standard deviation observed in the data was 15.5. This lower variability implies that the study had greater statistical power than originally anticipated, and the true MDE was smaller than initially estimated.

The second  $t$ -test evaluates whether the average preferred allocation differs significantly between the gain and loss treatment groups:

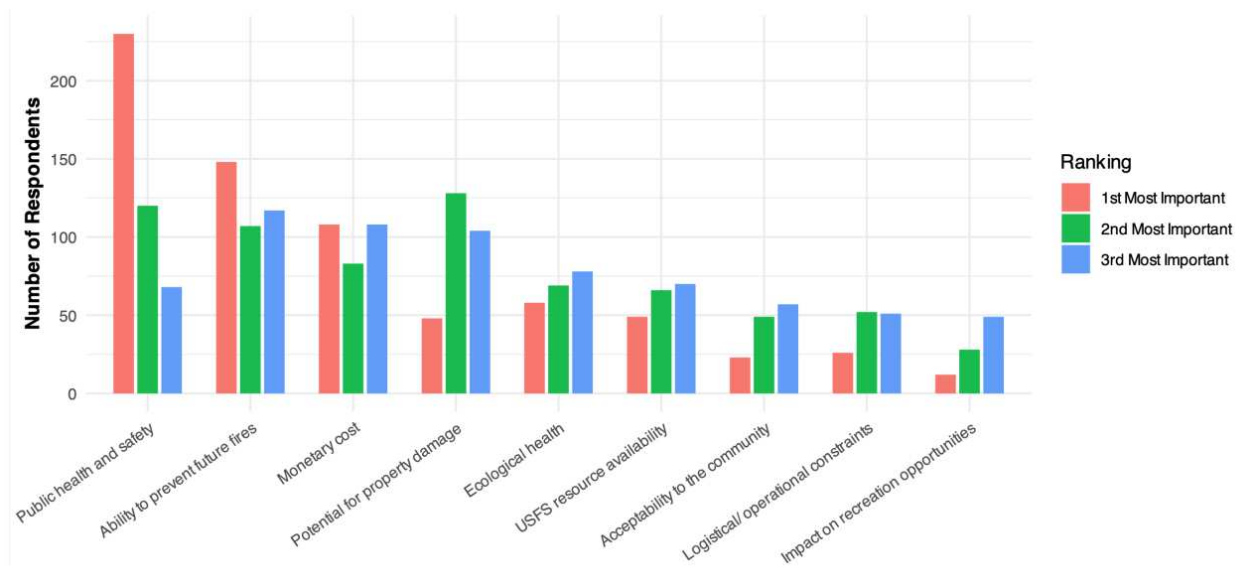
$$H_0: \mu_{PF,Public\_loss} = \mu_{PF,Public\_gain}$$

$$H_a: \mu_{PF,Public\_loss} \neq \mu_{PF,Public\_gain}$$

The test found no statistically significant difference in average allocations to prescribed fire between the gain treatment group (\$37.64 million) and the loss treatment group (\$36.79 million) ( $t = 0.72$ ,  $df = 692.62$ ,  $p = 0.469$ ), with a 95% confidence interval for the difference ranging from [−\$1.45 million to \$3.15 million].

## 5.4 Motivations Behind Allocation Preferences

Perhaps more interesting than what participants prefer is why they prefer a specific allocation. After completing the budget allocation exercise, participants were directly asked about the reason- ing for their allocation decisions. They were asked to select from a list the top three factors they considered when choosing an allocation. Figure 5.6 presents these results.



**Figure 5.6:** Stated reasons for allocation preferences

When considering a budget allocation, participants primarily report being concerned about public health and safety, the ability to prevent future fires, and the monetary cost of treatment. The potential for property damage also seems to be a concern to respondents, but was not often chosen as their top priority.

In addition to directly asking participants about the reason behind their decisions, several models were tested to identify factors that might influence preferences for hazardous fuel treatments. The survey collected relevant information on demographics, housing, and history with wildfire, which may influence an individual's preferences.

These relationships were tested using binomial and fractional logit models. First, a binomial logit model was utilized to identify characteristics that influence an individual's probability of choosing the status quo budget allocation:

$$\begin{aligned} \text{logit}(\text{Pr}(\text{StatusQuo}_i = 1)) = & \beta_0 + \beta_1 \text{OwnHome}_i + \beta_2 \text{WUI}_i \\ & + \beta_3 \text{Children}_i + \beta_4 \text{Elderly}_i + \beta_5 \text{RespIssues}_i + \beta_6 \text{Treatment}_i \end{aligned} \quad (5.1)$$

Where *OwnHome* is a dummy variable equal to 1 if the respondent owns their home and 0 if they rent. *WUI* equals 1 if the respondent lives in the wildland–urban interface, and 0 otherwise. As previously mentioned, two measures of whether participants reside in the WUI were collected. It was decided to utilize participants' stated residence in the WUI as the measure for this variable because ultimately, their preferences are shaped by their perception of where they reside. *Children* is equal to 1 if children under the age of 18 are present in the respondent's household, while *Elderly* equals 1 if adults over the age of 65 live in the household. *RespIssues* is a dummy variable equal to 1 if someone in the household has a respiratory condition such as asthma or COPD. *Treatment* equals 1 if the respondent received the loss-framed information treatment, and 0 if they received the gain-framed treatment.

Table 5.1 presents the average marginal effect of each variable. The results indicate that home ownership significantly decreases the probability of selecting the status quo allocation by approximately 20 percentage points, while an increase by about 10 percentage points is seen among individuals who state that they reside in the WUI. There is a modest effect if children live in the home, increasing the likelihood of choosing the status quo by nearly 9 percentage points.

**Table 5.1:** Indicator For Difference From Status Quo

Variable	AME	SE	z	p-value	95% CI
Children	0.0867	0.0456	1.900	0.0575	[-0.003, 0.176]
Elderly	0.0317	0.0406	0.781	0.4347	[-0.048, 0.111]
OwnHome	-0.1990***	0.0370	-5.375	<0.001	[-0.272, -0.126]
RespIssues	-0.0283	0.0392	-0.722	0.4702	[-0.105, 0.049]
TreatmentLoss	-0.0519	0.0368	-1.411	0.1584	[-0.124, 0.020]
WUI	0.1020**	0.0425	2.399	0.0164	[0.019, 0.185]

Note: \*\*\* $p < 0.001$ , \*\* $p < 0.05$

Next, a series of fractional logit models were used to estimate the effect of individual characteristics on the percent of the budget allocated to prescribed fire. A fractional logit model was chosen because of the bounded nature of the budget allocation exercise. Respondents were asked to allocate a total of \$100 million, allowing each million dollars allocated to be interpreted as one percent of the overall budget. First, a parsimonious model was estimated. The variables included in this model were chosen because they either directly describe an individual’s living situation or they identify potential risk factors that may influence allocation preferences. For instance, it was hypothesized that respondents may feel differently about relatively riskier treatment options, like prescribed fire, if they reside close to a forest in the wildland-urban interface. The following model was estimated:

$$\begin{aligned} \text{logit}(\mathbb{E}[Rx\_Allocation_i]) = & \beta_0 + \beta_1 OwnHome_i + \beta_2 WUI_i + \beta_3 Children_i \\ & + \beta_4 Elderly_i + \beta_5 RespIssues_i + \beta_6 Treatment_i \end{aligned} \quad (5.2)$$

Table 5.2 presents the average marginal effects from the fractional logit model. The results indicate that home ownership is the only statistically significant predictor of allocation preferences. Specif-

ically, owning a home is associated with a 4.4 percentage point increase in the share of the budget allocated to prescribed fire. This suggests that homeowners are more likely to support allocating a greater portion of funds to prescribed burning. No other variables had a statistically significant effect on allocation behavior.

**Table 5.2:** Average Marginal Effects from Fractional Logit Model on Budget Allocation to Prescribed Fire

Variable	AME	SE	z	p-value	95% CI
Children	-0.0055	0.0145	-0.382	0.7027	[-0.0339, 0.0228]
Elderly	-0.0020	0.0128	-0.155	0.8771	[-0.0272, 0.0232]
OwnHome	0.0439***	0.0125	3.505	0.0005	[0.0193, 0.0684]
RespIssues	0.0072	0.0124	0.579	0.5627	[-0.0172, 0.0316]
Treatment	-0.0078	0.0117	-0.668	0.5044	[-0.0306, 0.0151]
WUI	-0.0091	0.0136	-0.671	0.5021	[-0.0358, 0.0175]

Note: \*\*\* $p < 0.001$ .

There were several variables of interest that could be tested using the public survey data. After estimating a parsimonious model of the most relevant variables, additional variables of interest were added to evaluate their significance in influencing allocation preferences. Again, a fractional logit model was estimated:

$$\begin{aligned}
 \text{logit}(\mathbb{E}[RxAllocation_i]) = & \beta_0 + \beta_1 ConcernScore_i + \beta_2 RiskScore_i + \beta_3 OwnHome_i \\
 & + \beta_4 WUI_i + \beta_5 Children_i + \beta_6 Elderly_i + \beta_7 RespIssues_i + \beta_8 State_i \\
 & + \beta_9 Treatment_i + \beta_{10} Income_i
 \end{aligned} \tag{5.3}$$

In addition to the variables included in the base model, variables were included that measure the participant's concern for wildfire events, stated risk to their residence, the state in which they

reside, and their income level. *ConcernScore* is a binary indicator equal to 1 if the respondent expressed any level of concern about wildfire risk, and 0 if they reported being “not concerned at all.” *RiskScore* equals 1 if the respondent believed their home could be at risk in the event of a wildfire, and 0 otherwise. *State* is a binary variable equal to 1 for Colorado residents and 0 for respondents from Utah. *Income* is a simplified binary income bracket, coded as 1 for respondents with annual household incomes of \$75,000 or more, and 0 for those earning less.

**Table 5.3:** Average Marginal Effect from Extended Fractional Logit Model on Budget Allocation to Prescribed Fire

Variable	AME	SE	z	p-value	95% CI
Children	-0.0047	0.0145	-0.321	0.7482	[-0.0331, 0.0238]
ConcernScore	0.0423	0.0361	1.170	0.2418	[-0.0285, 0.1131]
Elderly	-0.0070	0.0130	-0.538	0.5906	[-0.0325, 0.0185]
Income	0.0013	0.0133	0.097	0.9224	[-0.0248, 0.0274]
OwnHome	0.0426***	0.0136	3.124	0.0018	[0.0159, 0.0694]
RespIssues	0.0072	0.0125	0.579	0.5652	[-0.0173, 0.0316]
RiskScore	0.0015	0.0164	0.091	0.9275	[-0.0306, 0.0336]
State	0.0185	0.0122	1.516	0.1295	[-0.0054, 0.0425]
TreatmentLoss	-0.0081	0.0117	-0.698	0.4855	[-0.0311, 0.0148]
WUI	-0.0116	0.0161	-0.720	0.4710	[-0.0431, 0.0199]

Note: \*\*\* $p < 0.001$ . AMEs represent the average change in the predicted allocation to prescribed fire, expressed as a proportion of the total budget.

Table 5.3 presents the results from the extended fractional logit model. The results remain largely the same. Home ownership remains the only statistically significant variable in the model. The direction of some marginal effects aligns with expectations; for instance, respondents with characteristics that may increase risk aversion (e.g., living in the wildland–urban interface or living

with children or elderly individuals) tend to allocate less to prescribed fire relative to mechanical treatments. However, other indicators of risk either had minimal influence or effects in the opposite direction than expected (e.g., living with individuals with respiratory issues or perceiving one’s residence as at risk of wildfire). Many of these estimates are far from statistically significant, making it difficult to draw conclusions about their true effects.

After finding no new significant effects in the extended fractional logit model, a more targeted model was estimated to further assess the relationship of home ownership and allocation preferences. Home ownership is the only consistently significant variable in the model. It is a broad category, so it was of interest to examine whether different types of homeowners expressed differing preferences. To test this, an interaction term between home ownership and income was added to the base model:

$$\begin{aligned} \text{logit}(\mathbb{E}[RxAllocation_i]) = & \beta_0 + \beta_1 OwnHome_i + \beta_2 Income_i + \beta_3 WUI_i + \beta_4 Children_i \\ & + \beta_5 Elderly_i + \beta_6 Resplssues_i + \beta_7 Treatment_i \\ & + \beta_8 (OwnHome_i \times Income_i) \end{aligned} \tag{5.4}$$

Including this interaction term allows for comparison across four groups—low- and high-income renters and homeowners—to assess whether preferences differ by both income level and housing status. Table 5.4 presents the average marginal effects of this model.

**Table 5.4:** Average Marginal Effects from Fractional Logit Model with OwnHome  $\times$  Income Interaction on Budget Allocation to Prescribed Fire

Variable	AME	SE	z	p-value	95% CI
Children	-0.0042	0.0144	-0.2915	0.7707	[-0.0324, 0.0240]
Elderly	-0.0040	0.0128	-0.3123	0.7548	[-0.0291, 0.0211]
Income	0.0167	0.0139	1.2018	0.2294	[-0.0105, 0.0439]
OwnHome	0.0303**	0.0141	2.1495	0.0316	[0.0027, 0.0579]
RespIssues	0.0072	0.0124	0.5781	0.5632	[-0.0171, 0.0314]
TreatmentLoss	-0.0090	0.0116	-0.7772	0.4370	[-0.0318, 0.0138]
WUI	-0.0102	0.0137	-0.7453	0.4561	[-0.0371, 0.0166]
OwnHome:Income (AME)	-0.0872***	0.0315	-2.7656	0.0057	[-0.1490, -0.0254]

*Note:* \*\*\* $p < 0.01$ , \*\* $p < 0.05$ . AMEs represent the average change in the predicted allocation to prescribed fire associated with a one-unit change in each variable.

As seen in the previous model, home ownership is associated with a statistically significant increase in the proportion of the budget allocated to prescribed fire, with homeowners allocating 3.0 percentage points more than renters on average. However, the interaction term is also statistically significant and negative, which indicates that higher-income homeowners allocate less to prescribed fire on average compared to low-income homeowners. Specifically, the marginal effect of home ownership is 8.7 percentage points smaller among high-income respondents than among low-income respondents.

Although self-reported residence in the wildland-urban interface (WUI) significantly influenced whether an individual chose the status quo allocation, it was not a significant predictor of the portion of the budget allocated to prescribed fire. Because this finding contradicted initial expectations, additional analysis was conducted to explore whether other patterns might exist between WUI residence and allocation decisions. As previously discussed, WUI residence can be defined in two ways using the survey data: self-reported (stated) and geographic. After finding no signifi-

cant effect for the stated WUI variable in the prescribed fire allocation model, the regression was re-estimated using the geographic definition. However, the results remained largely unchanged.

While neither WUI definition had a significant effect on prescribed fire allocations in the regression models, the discrepancy between the two WUI definitions was interesting. This inconsistency prompted further investigation to assess whether preferences differed among respondents whose perceptions of WUI residence did not align with their geographic location. To capture these nuanced relationships, an interaction term between stated and geographic WUI was included in the model. This allowed for the identification of preference patterns among those who believe they live in the WUI but do not geographically, those who do live in the WUI geographically but do not identify as such, and those whose stated and geographic WUI statuses are aligned.

$$\begin{aligned} \text{logit}(\mathbb{E}[RxAllocation_i]) = & \beta_0 + \beta_1 OwnHome_i + \beta_2 WUI_i + \beta_3 GeoWUI_i + \beta_4 (WUI_i \times GeoWUI_i) \\ & + \beta_5 Children_i + \beta_6 Elderly_i + \beta_7 RespIssues_i + \beta_8 Treatment_i \end{aligned} \quad (5.5)$$

In the model above, *WUI* is a dummy variable for stated WUI residence, and *GeoWUI* is a dummy variable for living in a geographically defined WUI area. Table 5.5 presents the results. Neither variable was individually significant in predicting prescribed fire allocations. There was a small, positive effect for those who stated they live in the WUI and virtually no effect for those who geographically reside in the WUI. However, the interaction term between these two definitions showed a larger negative effect, although it was not statistically significant. This result suggests that those who both live in the WUI and believe that they live in the WUI may allocate less to prescribed fire than the individual effects would predict.

**Table 5.5:** Average Marginal Effects from Fractional Logit Model with WUI Interaction on Budget Allocation to Prescribed Fire

<b>Factor</b>	<b>AME</b>	<b>SE</b>	<b>z</b>	<b>p-value</b>	<b>Lower CI</b>	<b>Upper CI</b>
Children	-0.0075	0.0145	-0.513	0.6080	-0.0359	0.0210
Elderly	-0.0026	0.0129	-0.199	0.8427	-0.0278	0.0227
GeoWUI	-0.0003	0.0136	-0.018	0.9853	-0.0269	0.0264
OwnHome	0.0440	0.0125	3.516	0.0004	0.0195	0.0685
RespIssues	0.0072	0.0124	0.576	0.5644	-0.0172	0.0315
Treatment	-0.0075	0.0116	-0.642	0.5210	-0.0303	0.0154
WUI	0.0186	0.0239	0.777	0.4369	-0.0283	0.0654
WUI × GeoWUI	-0.0393	0.0292	-1.347	0.1780	-0.0966	0.0179

These findings highlight the importance of distinguishing between perceived and actual risk when evaluating public support for wildfire mitigation. This idea has been explored by the Wildfire Research Team (WiRē), who found significant differences between perceived and actual wildfire risk (Meldrum et al., 2019). Their work presents evidence that residents’ self-assessments of parcel-level vulnerability often diverge from professional evaluations. This mismatch somewhat parallels the distinction in this study between self-reported and geographic WUI residence. Future work could further investigate the difference identified between stated and geographic residence in the WUI to better understand how this discrepancy in perceived vs actual residence location may affect wildfire mitigation preferences.

Lastly, a model was estimated to assess whether participants’ stated reasons for their budget allocation decisions were associated with the amount they allocated to prescribed fire. A fractional logit model was used, with the proportion of the budget allocated to prescribed fire as the dependent variable. The primary independent variables were a set of dummy variables representing each response option to the “Top Reason for Budget Allocation” question, with “Ability to prevent

future fires" specified as the reference category. Although respondents were asked to identify their top three reasons in ranked order, this model considered only their first-choice response.

None of the coefficients estimated in this model were statistically significant, but some were interesting in their direction and magnitude. For instance, those who stated that their top reason was "Acceptability to the community" allocated 4.8 percentage points less to prescribed fire compared to those who chose the reference reason. This could indicate that participants perceive their community as being less accepting of prescribed fire than mechanical treatments. Those who prioritized "Public health and safety" were also less likely to allocate to prescribed fire than those who chose the reference reason. This could indicate that these individuals are concerned with the excess smoke generated by prescribed fires or the inherent risk associated with this practice.

## **5.5 Protest Votes**

Respondents who chose to maintain the status quo allocation were presented with an additional question to assess the reason for their choice. Of these responses, about 39% of people indicated that they chose the status quo because they did not have enough information to choose an allocation, 35% stated that they do not have a strong preference and trust the decisions of the USFS, and 26% did have a preference and considered the current allocation to be best. One concern is that those who stated they did not have enough information to choose an allocation are essentially protest votes because they refused to state their true preferences. These individuals made up about 20% of all respondents to the survey, which made it important to evaluate whether they skewed the statistical analysis presented above. For robustness, a secondary analysis was carried out that leaves out these responses.

It is possible that those considered "protest" voters altered the results identified through regression analysis because their survey response does not truly reflect their preferences. To evaluate if this was the case, many of the regression models were re-estimated using only data from individuals who indicated a clear budget allocation preference. Table 8 provides results for the parsimonious fractional logit model.

**Table 5.6:** Average Marginal Effects from Fractional Logit Model on Budget Allocation to Prescribed Fire Without Protest Votes

<b>Variable</b>	<b>AME</b>	<b>SE</b>	<b>z</b>	<b>p-value</b>	<b>95% CI</b>
Children	-0.0036	0.0180	-0.1972	0.8437	[-0.0389, 0.0318]
Elderly	-0.0012	0.0159	-0.0778	0.9380	[-0.0324, 0.0299]
OwnHome	0.0427**	0.0157	2.7121	0.0067	[0.0118, 0.0735]
RespIssues	0.0113	0.0153	0.7418	0.4582	[-0.0186, 0.0412]
TreatmentLoss	-0.0075	0.0143	-0.5238	0.6004	[-0.0354, 0.0205]
WUI	-0.0113	0.0166	-0.6838	0.4941	[-0.0438, 0.0211]

*Note:* \*\* $p < 0.01$ . All AMEs represent marginal effects on the proportion of budget allocated to prescribed fire.

The results of the model are nearly identical whether the protest votes are included or excluded. This suggests that these responses did not meaningfully skew the statistical analysis. This finding is somewhat surprising, given that respondents selecting this option made up a substantial fraction of the sample. To further assess the impact of these responses, each of the other regression models presented above was re-estimated using the restricted dataset without the “protest” votes. In each case, the results remained largely unchanged.

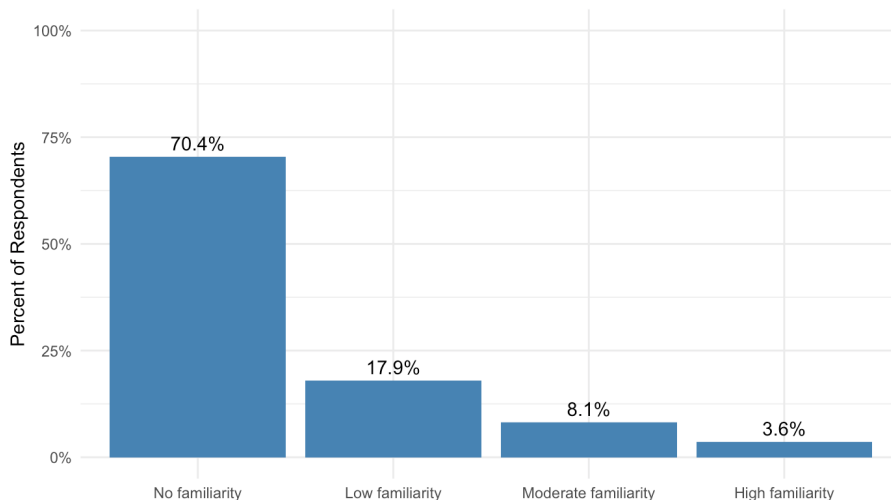
These findings suggest that respondents who indicated they did not have enough information to choose an allocation were likely not engaging in protest behavior, but rather expressing genuine uncertainty or a lack of expertise. In this context, their responses appear to reflect valid, though uncertain, preferences, rather than an objection to the allocation task itself. This interpretation is supported by the final question in the survey, which asked respondents whether they were interested in learning more about hazardous fuel management options. Among those who said they did not have enough information to make an allocation decision, only about 30% expressed interest in learning more. This suggests that most were not explicitly protesting the allocation task, but were instead either uninterested or apathetic toward the decision. In effect, this group appears to prefer deferring the complex decision of budget allocation to USFS professionals, rather than participating directly in it.

## 5.6 Biochar

In recent years, the USFS has advanced research and pilot programs focused on biochar production as an innovative hazardous fuels reduction strategy. Biochar is a highly stable, carbon-rich material produced by burning woody biomass under conditions of limited or no oxygen (Neukirch, 2022). This process differs from conventional disposal methods, such as open pile burning or mechanical removal, which emit significant greenhouse gases and can damage underlying soil.

Emerging technologies, such as mobile air curtain burners like the CharBoss, enable onsite conversion of forest residues into biochar, offering a more controlled, lower-emission alternative to slash pile burns. Beyond reducing fuel loads, biochar production supports long-term carbon sequestration by holding carbon in the soil for hundreds, if not thousands, of years. It can also be used as a soil amendment to enhance water retention and improve nutrient levels in the soil (Neukirch, 2022). This benefit presents an economic opportunity in which waste removed from National Forest land can be sold commercially in agriculture, horticulture, or similar industries. This opportunity to generate value from waste could be utilized to fund additional management activities.

To contribute to the growing body of research on biochar, the survey included questions near the end assessing participants' familiarity with, prior use of, and opinions about biochar. Respondents were first presented with information about biochar and asked to indicate their level of familiarity with the practice. Figure 5.7 displays the results.



**Figure 5.7: Have You Heard of Biochar?**

The results indicate that very few respondents were familiar with biochar. This is not too surprising, as biochar production is a relatively recent development in wildfire management. However, this lack of familiarity is important in considering the marketability of biochar products. Should the USFS be interested in generating additional revenue from biochar sales, they could expand their market by better informing the public of its benefits. Respondents were also asked if they would ever use biochar, and were presented with several answer options in a “choose all that apply” format. Only about 5.9% of respondents indicated that they had used biochar in the past, and most would use it again. Among the majority of respondents, who indicated that they had not used biochar before, most would consider using it in the future under certain conditions. Most (39.7%) would use biochar if they had more information about it, some stated biochar must be inexpensive (29.8%), and some require easy access to biochar (23.1%). Only 18.8% of the sample would not consider using biochar at all. These responses offer some evidence that marketing biochar to the public could be successful should they have enough information about the product.

Lastly, to relate the biochar questions to respondent preferences for hazardous fuel treatments, they were asked if the USFS should invest more in biochar production, even if this removes funding from other areas. Most respondents found this decision to be too difficult, with 48.1% indicating that they are not sure. This is unsurprising given the lack of familiarity with biochar and the level

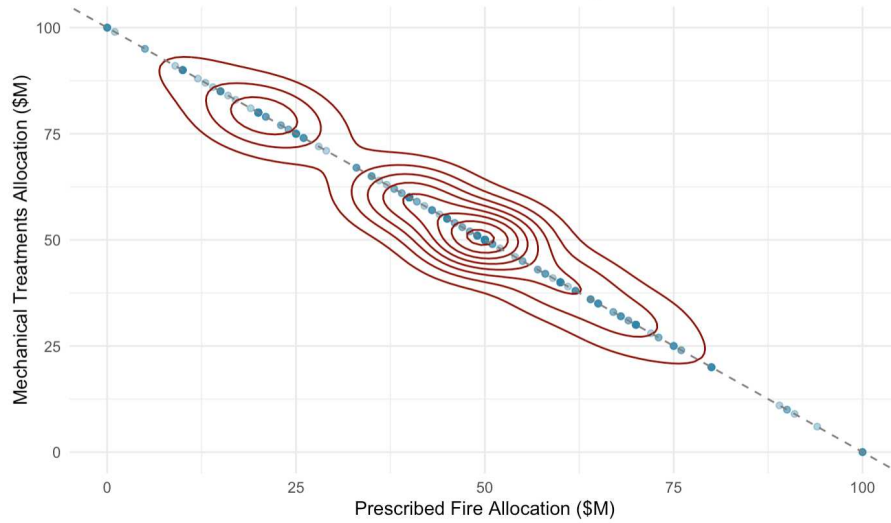
of uncertainty in the budget allocation responses. Generally, the results suggest that the public requires additional information about biochar to make decisions about its production and use.

## Chapter 6

### Discussion and Conclusion

The goal of this research was to identify public preferences for hazardous fuel treatments when allocating a public budget. Results indicate that, on average, members of the public prefer to allocate a greater portion of the USFS hazardous fuel treatment budget to prescribed fire than has typically been spent in recent years. Similarly, they prefer to allocate less to mechanical treatments relative to historical spending. A secondary goal was to assess the effect of presenting budgetary choices as a loss or a gain on allocation preferences. Preferences were consistent across treatment groups, suggesting that the framing of the budget decision did not significantly influence respondent choices. These results may suggest that, unlike in other economic contexts discussed in the literature, individuals do not rely on behavioral heuristics when evaluating hazardous fuel treatment decisions. It is also possible that individuals do rely on behavioral heuristics when making hazardous fuel treatment decisions in real-world contexts, but the framing treatment used in this study may not have been salient enough to elicit those effects in a survey setting.

Although conclusions can be drawn regarding the average response of individuals, it is also true that there was a notable spread in allocation preferences. About 52% of public respondents chose to maintain the status quo allocation. Among the other 48%, there were allocations at the extremes—\$0 or \$100 million to one category—as well as many choices in between. This spread is consistent with other findings in the literature that suggest significant variance in public acceptance for treatment options (Brenkert-Smith et al., 2023). Figure 6.1 plots the allocation decisions of participants who deviated from the status quo. The red contour lines highlight where the data is most dense. The mean allocation among respondents who did not choose the status quo lies much closer to an even split between the two management options, with a mean allocation of \$45 million to prescribed fire and \$55 million to mechanical treatments.



**Figure 6.1:** Non-Status-Quo Allocation Decisions with Density Contour

Given the variability in the data and the modest sample size, it is unsurprising that it was difficult to estimate a model that adequately explained allocation decisions. Nevertheless, several meaningful patterns emerged. Home ownership was consistently a significant predictor across all models. This finding is unsurprising, as an individual’s home is often their most valuable asset. Homeowners may perceive greater potential losses in the event of a disaster and, as a result, may approach risk differently than renters. What was unexpected in this result is the direction in which home ownership affected preferences. It was hypothesized that individuals with characteristics that may increase their aversion to risk would allocate less on average to prescribed fire, which is a riskier treatment option. However, the opposite was true among homeowners. It is possible that homeowners feel more inclined to mitigate long-term risk, as investment in a home is often a lifetime commitment, and choose to allocate additional funds to the more cost-effective treatment option.

It was interesting to see how home ownership and income jointly impact preferences for hazardous fuels treatments, even though it was not initially considered during model development. There could be several reasons for this result. It is possible that those with below-average income have less financial reserves outside of their home compared to those with above-average income.

In this case, these individuals stand to lose a greater fraction of their assets if their home were to be damaged by wildfire. They may be motivated to allocate a greater portion of the budget to prescribed fire because it is more efficient and could potentially reduce long-term fire risk to their home. Initially, it was considered that high-income homeowners may be more likely to reside in the wildland-urban interface because there is value in living near natural amenities, and thus, these residences may be worth more. However, there is no statistical evidence that individuals living in the WUI are more likely to be high-income earners.

Another notable set of findings relates to whether individuals reside in the wildland-urban interface. Residence in the WUI was a significant predictor of whether respondents chose to maintain the status quo allocation, but it had no statistically significant effect on the amount allocated to prescribed fire. It was assumed that this would be a meaningful factor because individuals living in close proximity to wildfire-prone areas and hazardous fuel treatments may be more directly affected. This idea motivated the hypothesis that individuals residing in the WUI would have stronger preferences regarding forest management and would be more likely to deviate from the status quo allocation. However, evidence suggests the opposite effect. It was also hypothesized that these individuals would be less likely to allocate dollars to prescribed fire because they are at greater risk in the event of fire escape and are more directly affected by the smoke produced through burning. In practice, the evidence suggests that residence in the WUI is not a significant predictor of dollars allocated to prescribed fire.

It is possible that the way in which WUI was measured makes this variable unreliable. It was ultimately decided to use the stated WUI measure in constructing this variable because respondent perception of the location of their residence likely has a greater impact on their allocation preferences. However, the notable percentage of respondents who were unsure of whether or not they reside in the WUI makes this measurement imprecise. The geographically derived WUI measure is also an imperfect representation of the location of an individual's residence. For instance, the majority of Utah respondents reside within 5 miles of a National Forest because of the location of

Utah's major population areas, but not all of these residents truly live within the WUI. The models were estimated using both measures, but the results were qualitatively similar.

This research was conducted with the intention of informing USFS decision-makers. Previous literature suggests that USFS managers do not have a clear understanding of public preferences, and that managerial preferences are variable and could be biased. Generally, it is difficult to identify clear recommendations for hazardous fuel management from the results of this study. The results corroborate findings in the literature, which suggest that preferences for hazardous fuel treatments are highly variable, making it difficult to identify a course of action that is deemed optimal by all relevant stakeholders. However, there are still takeaways that USFS managers may consider. First, over half of all respondents chose to maintain the status quo budget allocation. As stated previously, about 39% of people indicated that this was because they did not have enough information to choose an allocation. These results could suggest that if the USFS wishes to rely more on public input, individuals may need to receive more information about treatment options. This also suggests that the majority of people either agree with the Forest Service's allocation or trust the agency to make a decision on their behalf, which might motivate maintaining the status quo.

The findings suggest some ideas for additional areas of inquiry to ascertain a more concrete understanding of public preferences for hazardous fuel treatments. The scope of this study was limited in that minimal data were collected from one geographic region. A more rigorous survey that samples a larger portion of the United States population might identify more detailed patterns in public preferences that could inform decision-making. For instance, regional differences in preferences could be utilized to identify the best course of action for a specific geographic location, such as in an individual National Forest. A larger sample would also improve the statistical power of estimated models and could be used to identify relationships that went undetected in this study.

The findings also motivate adjustments to the budget allocation exercise and informational treatment in future work. Although it is possible that there was no significant difference between the two treatment groups because participants were truly unbiased in their allocation decisions, the

ample available literature would suggest that it is more likely that the survey mechanism failed to elicit these biases. For example, the way the informational treatments were framed may not have elicited a salient difference in the choice faced by participants in each treatment. One option to make the difference between the two treatments more salient could be to present the starting value on the survey's allocation figure differently for each treatment. For instance, instead of presenting both treatment groups with the status quo budget allocation, the sliders could start at \$0 or \$100 million dollars, for the gain and loss treatments, respectively, to make it clearer that they are allocating or removing funds from the treatment options. It would also be interesting to provide an estimate of the number of acres that could be treated by each management option with a given budget allocation. This value was initially intended to be included in the survey to make the tradeoff between risk and cost more salient, but the imprecision of the cost data and significant variability in cost for different management activities prevented the calculation of such an estimate.

An additional extension of this analysis could involve comparing the collected survey data to recorded USFS FACTS data. Survey respondents were shown national averages for acres treated by each management option and the associated treatment costs, even though the sample consisted solely of Colorado and Utah residents. It would be valuable to assess whether FACTS data from Colorado and Utah aligns with these national averages, and how participant responses compare to the regional data specifically.

It is the intention of the researchers to expand upon this study by surveying USFS employees in a similar manner. Just as public preferences for wildfire management are not well understood, there is limited insight into how individual fire managers evaluate tradeoffs when making decisions in the field. While some research has examined how managers weigh different suppression strategies (Calkin et al., 2012), there remains a gap in understanding their preferences for various hazardous fuel treatment methods. Assessing these preferences will allow for comparison across decision-makers to evaluate whether tradeoffs are weighed consistently or if substantial variation exists in the preferred treatment mix. This data will also enable direct comparison between the preferences

of USFS personnel and those of the public. While this study provides some insight for wildfire management decisions, it can be strengthened by the outlined opportunities for future work.

# Bibliography

- Abatzoglou, J. T. and Williams, A. P. (2016). Impact of anthropogenic climate change on wildfire across western us forests. *Proceedings of the National Academy of sciences*, 113(42):11770–11775.
- Adams, M. D. and Charnley, S. (2018). Environmental justice and us forest service hazardous fuels reduction: A spatial method for impact assessment of federal resource management actions. *Applied Geography*, 90:257–271.
- Archie, K. M., Dilling, L., Milford, J. B., and Pampel, F. C. (2012). Climate change and western public lands: a survey of us federal land managers on the status of adaptation efforts. *Ecology and Society*, 17(4).
- Bayham, J., Yoder, J. K., Champ, P. A., and Calkin, D. E. (2022). The economics of wildfire in the united states. *Annual Review of Resource Economics*, 14(1):379–401.
- Blomquist, G. C., Newsome, M. A., and Stone, D. B. (2003). Measuring principals’ values for environmental budget management: an exploratory study. *Journal of Environmental Management*, 68(1):83–93.
- Brenkert-Smith, H., Goolsby, J. B., Champ, P. A., Meldrum, J. R., Donovan, C., Wagner, C., Barth, C. M., Forester, C., and Wittenbrink, S. (2023). The devil is in the details: Variation in public acceptance of fuels treatments across western fire-prone communities. *Western Economics Forum*, 22(2):5–23.
- Brenkert-Smith, H., Jahn, J. L., Vance, E. A., and Ahumada, J. (2019). Resistance and representation in a wildland–urban interface fuels treatment conflict: The case of the forsythe ii project in the arapaho-roosevelt national forest. *Fire*, 3(1):2.
- Brunson, M. W. and Evans, J. (2005). Badly burned? effects of an escaped prescribed burn on social acceptability of wildland fuels treatments. *Journal of Forestry*, 103(3):134–138.

- Calkin, D. E., Cohen, J. D., Finney, M. A., and Thompson, M. P. (2014). How risk management can prevent future wildfire disasters in the wildland-urban interface. *Proceedings of the National Academy of Sciences*, 111(2):746–751.
- Calkin, D. E., Venn, T., Wibbenmeyer, M., and Thompson, M. P. (2012). Estimating us federal wildland fire managers' preferences toward competing strategic suppression objectives. *International Journal of Wildland Fire*, 22(2):212–222.
- Council, T. W. F. L. (2014). The final phase in the development of the national cohesive wildland fire management strategy.
- Crow, I. (2025). Wide u.s. forest service layoffs leave projects delayed. *Fire & Safety Journal Americas*. Accessed: 2025-05-04.
- Dickinson, K. L., Brenkert-Smith, H., Madonia, G., and Flores, N. E. (2020). Risk interdependency, social norms, and wildfire mitigation: a choice experiment. *Natural Hazards*, 103:1327–1354.
- Executive Office of the President (2019). Promoting active management of america's forests, rangelands, and other federal lands to improve conditions and reduce wildfire risk. *Federal Register*, Vol. 84, No. 4. Executive Order 13855, Accessed: 2025-05-04.
- Executive Office of the President (2025). Immediate expansion of american timber production. <https://www.whitehouse.gov/presidential-actions/2025/03/immediate-expansion-of-american-timber-production/>. Accessed: 2025-05-04.
- Han, T., Zhao, G., and Wang, J. (2022). Residents' budget preference, private willingness to pay, and budget resource allocation satisfaction based on the analysis of the survey data of j city. *Discrete Dynamics in Nature and Society*, 2022(1):7561210.
- Hand, M. S., Wibbenmeyer, M. J., Calkin, D. E., and Thompson, M. P. (2015). Risk preferences, probability weighting, and strategy tradeoffs in wildfire management. *Risk analysis*, 35(10):1876–1891.

- Hoover, K. and Lindsay, B. R. (2017). *Wildfire suppression spending: Background, issues, and legislation in the 115th Congress*. Congressional Research Service.
- Hoshiko, S., Mello, A., Jones, C., and Prudhomme, J. (2021). Public health impact of prescribed fire: report on listening sessions with community members, el dorado and nevada counties, california. *CA: Environmental Health Investigations Branch, Center for Healthy Communities, California Department of Public Health*.
- Interagency Tracking System (2024). Interagency tracking system. Accessed: 2024-11-11.
- Jacobson, S. K., Monroe, M. C., and Marynowski, S. (2001). Fire at the wildland interface: the influence of experience and mass media on public knowledge, attitudes, and behavioral intentions. *Wildlife Society Bulletin*, pages 929–937.
- Koford, B. C. (2010). Public budget choices and private willingness to pay. *Public Budgeting & Finance*, 30(2):47–68.
- Loomis, J. B. and González-Cabán, A. (2008). Contingent valuation of fuel hazard reduction treatments. *The Economics of Forest Disturbances*, pages 229–243.
- McCaffrey, S., Toman, E., Stidham, M., and Shindler, B. (2012). Social science research related to wildfire management: an overview of recent findings and future research needs. *International Journal of Wildland Fire*, 22(1):15–24.
- Meldrum, J. R., Brenkert-Smith, H., Champ, P., Gomez, J., Falk, L., and Barth, C. (2019). Interactions between resident risk perceptions and wildfire risk mitigation: evidence from simultaneous equations modeling. *Fire*, 2(3):46.
- Miller, R. K., Field, C. B., and Mach, K. J. (2020). Barriers and enablers for prescribed burns for wildfire management in california. *Nature Sustainability*, 3(2):101–109.
- Neukirch, A. (2022). Biochar basics: an a-to-z guide to biochar production, use, and benefits.

Office, C. B. (2022). Wildfires. <https://www.cbo.gov/publication/58212>: :text=In Accessed: 2024-10-09.

Radeloff, V. C., Helmers, D. P., Kramer, H. A., Mockrin, M. H., Alexandre, P. M., Bar-Massada, A., Butsic, V., Hawbaker, T. J., Martinuzzi, S., Syphard, A. D., et al. (2018). Rapid growth of the us wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences*, 115(13):3314–3319.

Salanié, F. and Treich, N. (2009). Regulation in happyville. *The Economic Journal*, 119(537):665–679.

Service, U. F. (2022). Confronting the wildfire crisis: A strategy for protecting communities and improving resilliance in american forests.

Service, U. S. F. (2024). Usfs arcgis dashboard for wildfire data. <https://usfs.maps.arcgis.com/apps/dashboards/95470eec0ef1424eb1e74369b3519677>. Accessed: 2024-11-10.

Tversky, A. and Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *science*, 185(4157):1124–1131.

United States Forest Service (2024). Meet the forest service. Accessed: 2024-12-11.

U.S. Forest Service (2023). National prescribed fire strategy. Accessed: 2024-05-11.

U.S. Forest Service (2024). Biochar and the bioeconomy. Accessed: 2024-11-11.

U.S. Forest Service (2025). Enterprise data warehouse (edw) datasets. Accessed: 2025-05-04.

Wibbenmeyer, M. J., Hand, M. S., Calkin, D. E., Venn, T. J., and Thompson, M. P. (2013). Risk preferences in strategic wildfire decision making: a choice experiment with us wildfire managers. *Risk analysis*, 33(6):1021–1037.

Wilson, R. S., Winter, P. L., Maguire, L. A., and Ascher, T. (2011). Managing wildfire events: Risk-based decision making among a group of federal fire managers. *Risk Analysis: An International Journal*, 31(5):805–818.

Wu, H., Miller, Z. D., Wang, R., Zipp, K. Y., Newman, P., Shr, Y.-H., Dems, C. L., Taylor, A., Kaye, M. W., and Smithwick, E. A. (2022). Public and manager perceptions about prescribed fire in the mid-atlantic, united states. *Journal of environmental management*, 322:116100.