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CONFRONTING THE WILDFIRE CRISIS: UNDERSTANDING EQUITY AND DECISION-MAKING IN WILDFIRE MANAGEMENT STRATEGIES

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CONFRONTING THE WILDFIRE CRISIS: UNDERSTANDING EQUITY AND
DECISION-MAKING IN WILDFIRE MANAGEMENT STRATEGIES

By

Katherine Huerta Sanchez

A REPORT

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

In Environmental and Energy Policy

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This report has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Environmental and Energy Policy.

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Author Contribution Statement

The project's inception is attributed to Dr. Richelle Winkler and Dr. Miranda Mockrin. The author confirms sole responsibility for the following: data collection, analysis, interpretation of results, and report preparation.

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Abstract

This study investigates how fuel managers incorporate equity and social vulnerability considerations into wildfire fuel reduction treatments on National Forest land and explores the resulting impact on the implementation of wildfire risk reduction policies. Through interviews, managers revealed differing perspectives on prioritizing social vulnerability characteristics and challenges such as insufficient information and resources to inform equitable fuel treatment decisions. These findings illuminate the complexities of integrating considerations of social vulnerability into decision-making processes for wildfire management at the wildland-urban interface, suggesting potential divergence from nationally supported policies aimed at equitably implementing wildfire risk reduction measures. The study findings underscore the importance of addressing challenges associated with access to information and building capacity to enhance the equity and effectiveness of manager's fuel reduction decision-making.

1 Introduction

Implementing fuel treatments is an essential aspect of forest land management to which the United States Forest Service (USFS) dedicates significant attention. Treatments such as mechanical thinning and prescribed fire are designed and applied using the best available science and local expertise to help increase forest health and resilience, promote wildland habitats, and minimize wildfire risk (Weseman, 2022). The responsibility of implementing these treatments and other wildfire mitigation strategies falls under the purview of thousands of fuel managers entrusted with oversight of high-risk National Forest (NF) lands. Fuels managers, which include positions such as fuel planners, prescribed fire and fuel specialists, and other NF managers who make decisions about and implement hazardous fuel reduction treatments, are particularly important factors in determining how federal programs are implemented.

Due to the increasing wildfire threats stemming from the effects of climate change and the continued oppression and exclusion of disadvantaged communities, it is imperative that managers undertake and implement efficient, sustainable, and equitable actions to safeguard neighboring communities, particularly vulnerable populations. Understanding what drives decisions about where to do fuel treatments, including the various policies and practical considerations that managers must balance. These insights can serve as a foundation for shaping future policies, enhancing community resilience, and fostering a more equitable response to the growing threat of wildfires.

The work in this project is a smaller subset of a larger project that seeks to co-produce knowledge and practices that facilitate wildfire adaptation and resilience across land ownership types and jurisdictions. In relation to this overarching research purpose, this study aims to understand the factors influencing fuel managers' decision-making in implementing wildfire mitigation strategies on NF land, particularly within the wildland-urban interface (WUI), defined as "areas where human development intersects with undeveloped natural landscapes" (FS-1187f 2023, pg. 3). The overarching goal in understanding these factors is to unravel the ways in which considerations of equity and social vulnerability contribute to the overall decision-making framework in wildfire management. To achieve this objective, the following research questions are addressed:

1. *How do fuel managers make decisions about where to conduct fuel treatments?*
2. *How are fuel managers influenced by existing policies, regulations, and guidelines when making decisions about wildfire risk reduction strategies?*
3. *How do fuel managers coordinate with other agencies and organizations when they are planning fuel treatments, and how might this work to include or exclude socially vulnerable groups?*
4. *In what ways do fuel managers consider characteristics of nearby residents (e.g. social vulnerability, density, or amount of housing) as a factor in their decision-making about fuel treatments and other wildfire mitigation strategies?*

Using findings from the interviews, this project aims to bridge any disconnect there may be between federal investments and grounded reality. The listed RQ's will be used to

supplement the overarching question of how managers address social vulnerability and equity in their wildfire mitigation efforts. Ultimately, this study aims to contribute valuable insights to the field of wildfire management, with the hope of fostering communities that are both more equitable and resilient in response to the persistent threat of wildfires.

1.1 Equity and US Wildfire Policy

The effects of early nineteenth-century US policy, combined with climate change, have significantly contributed to the catastrophic wildfires we are battling in the country today. Historically, Native Americans recognized the ecological benefit behind the contained use of fire and used it to enhance the health of plants and animals (Roos 2021; Manke, 2018). However, a 1911 federal policy strayed from these traditions and instead promoted a “war on wildfire” along with disadvantageous practices that dictated against the use of fire in keeping landscapes open. While the fire exclusion stance is no longer in practice, having been a long-standing policy failure and eventually being abandoned by the Forest Service in the late 70s, its effects have long remained, resulting in “dangerous excess fuel loads” (Haaland and Vilsack 2022) that have reached crisis proportions (FS-1187a 2022). The failure of the wildfire exclusion policy and its resulting excess fuel loads provide important lessons about the significance of inclusivity and engaging diverse communities in decision-making processes. Attempts to rectify the inadvertent excess fuel loads were heightened in recent years.

In recognition of the threats posed by wildfires in the context of this policy failure and a changing global climate, efforts to mitigate the possibilities of future disasters were taken in 2022 by the U.S. Department of Agriculture Forest Service with the Wildfire Crisis Strategy (WCS). This strategy entails a cohesive approach aimed at restoring healthy, fire-resilient forests while simultaneously addressing wildfire risks to nearby infrastructure and communities. It involves collaborative efforts across various jurisdictions to recruit and train a needed workforce capacity and identify equitable and science-based locations for fuel/forest health treatments (FS-1187b 2022). Supported by the Bipartisan Infrastructure Law and Inflation Reduction Act, the WCS received a remarkable \$7 billion in funding for the United States Department of Agriculture, Department of Interior, and National Oceanic Atmospheric Administration efforts centered around equitable mitigation and response to wildfires (White House 2023).

Around the same time that the WCS emerged, the Biden Administration also increased federal investments dedicated to advancing equity-based initiatives aligned with the principles of environmental justice. Defined as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies” (GSA, 2021) the concept of environmental justice has slowly been integrated into the American policymaking system since the 1990s. Executive Order on Environmental Justice (E.O. 12898) brought forth by the Clinton Administration reaffirmed its nature in the United States regulatory process for the first time in 1994 (Martinez et. al 2023). The order establishes environmental justice (EJ) as multifaceted in addressing both the implementation side, its pros and cons of distribution effects, and its procedural side, such as equal opportunities and participation in policymaking. More recent initiatives from the Biden Administration include E.O. 13985, which strives to embed values of equity and inclusion by having its workforce reflect the diversity of the country with employees from all segments of society (Biden 2021). The 2023 Equity Action Plan “directs EPA and other federal agencies to further advance equity and embed

environmental justice and external civil rights in a whole-of-government approach” (EPA, 2022). Finally, the historic Justice40 commitment signed days into the Biden Administration promised that 40% of federal investments will flow into disadvantaged communities in areas that cover climate change, remediation/reduction of legacy pollution, training and workforce development, and more (The White House 2021). The relationship between environmental justice and equity in policy is demonstrated through efforts to enhance the accessibility and inclusivity of environmental policymaking, ensure fairness in the administration of EPA and other agency programs, and promote equity in the distribution and effects of environmental hazards. On paper, the initiatives and policies the two administrations established set out to solidify fair services and responses to socially vulnerable populations, but the inherent need for these legalities reveal a disconnect.

Facing the threat of wildfires, it's reasonable to assert that everyone and everything in proximity to the risk is vulnerable to the impact of smoke and flames. However, a subset of the population, deemed socially vulnerable, feel these effects more acutely than others. Some groups frequently highlighted in literature are low-income individuals, the elderly, people with disabilities, and minority populations (including language barriers) (Sadegh, 2023; Modaresi Rad et al., 2023). In reference to the overarching project, research done by members of the project team found similar characteristics that contributed to this study's understanding of vulnerability. Within this work, project team members within the broader study identified how lower-income individuals may have fewer resources or time to prepare for wildfires, and elderly individuals are more vulnerable due to the potential health and physical limitations. Further, transient and houseless populations are more vulnerable due to difficulties in communicating and locating in case of emergency, as well as possible unfamiliarity with the area. Social vulnerability extends beyond the aforementioned groups, encompassing a wide range of factors that can be complicated further by a combination of them. The link between social conditions and a person's vulnerability to wildfire (Lambrou et al., pg. 3) then amplifies the importance of considering the concept and the groups it encapsulates when directing resources. As social vulnerability heightens the impact of wildfires, these groups face significant challenges in preparing for, responding to, and recovering from disasters. Given the threats that vulnerable groups face with the wildfire crisis and other underlying barriers that prevent proper wildfire mitigation, the consideration needed for these populations bleeds into the role of USFS fuel managers.

The men and women across the country who fill the role of fuel managers shoulder significant responsibility in their line of work, especially during the wildfire season. One of their many duties involves coordinating and carrying out hazardous fuel reduction treatments. These treatments, such as mechanical thinning and prescribed burning, are beneficial because they can enhance forest health and minimize loss to wildfire; however, there are cons to treatments, such as with smoke cover from prescribed burns. The positive and negative impacts of hazardous fuels treatment provide an interesting perspective on how social vulnerability and equity is integrated in that decision-making process. In the project's literature review of how fuel managers consider social vulnerability in hazardous fuel reduction decisions, an article on the EJ implications of

fuel management underscored how “managers generally did not consider demographic characteristics of nearby populations when planning projects, focusing instead on biophysical factors” (Adams & Charnley, 2020, pg. 25). While the article acknowledged that this finding stemmed from a lack of EJ knowledge, was variable among forest remoteness, and not widespread, this gap in decision-making can have major implications as WUI and climate developments progress. The insights from this article serve as a valuable reference, as project work intends to centralize discussions of social vulnerability in hazardous fuel reduction decision-making. This will help enrich dialogue on equitable decision-making on the ground level during the wildfire crisis.

1.2 The Wildfire Crisis

As we navigate through the complexities of our modern world, we are confronted with the pressing need to address the escalating frequency of wildfires on a global scale. In the year 2021 alone, an astonishing 9.3 million hectares of global tree cover was burnt (MacCarthy et al 2023), making it one of the most catastrophic years for forest fires. The following year reported an equally devastating burn amount of 6.3 million hectares, and in 2023 the record Canadian burns (Popovich 2023) and tragic Hawaiian fires (Hassan et. al 2023) continue to burden society with the realities of an increasingly more fire-prone environment.

Along with the worsening climate, the US's long-held wildfire suppression policy has resulted in decades of untouched growth accumulating on national forest land, increasing the risk of wildfire (Busenberg 2004). The two elements in combination heighten the necessity for various wildfire mitigation strategies, as the resulting frequency of large-scale wildfires, longer burn durations, and an extended fire season (Westerling 2006) pose a significant risk to communities living in the country's wildland urban interface (WUI). The WUI has seen a steady influx over the years, driven by a growing number of individuals opting to relocate to the edges of our national forests for a more rural lifestyle. The rapid growth of the WUI has seen numbers jump 40% as more and more residents opt to live in these newly built areas, contributing to the wildfire crisis (Radeloff et. al 2018). Decades of built homes and communities in the fire-prone western landscape result in around 70,000 communities being under the threat of a disaster, especially adjacent to national forests (USDA 2022).

In response to these risks, in 2022, the USFS published a 10-year Wildfire Crisis Strategy (WCS) detailing plans for wildfire mitigation efforts on federal lands and emphasized support efforts towards vulnerable communities in WUI areas. This strategy allocates significant funding for existing authorities that work in wildfire mitigation, such as the Joint Chiefs' Landscape Restoration Partnership Program, the Collaborative Forest Landscape Restoration Program, and the Community Wildfire Defense Grants (FS-1187b 2022). Along with focusing on vulnerable communities, a central portion of the WCS is its analysis of western firesheds and their priority level as highlighted by their ignition risk. Firesheds—products of the long-standing fire suppression policy failure—are defined as “landscapes of about 250,000 acres in which an ignition can spread and expose communities to wildfire” (FS-1187a, 2022, pg. 3). These priority landscapes, housing high-risk firesheds, indicate where mitigation efforts should be concentrated; however, it is worthwhile to note that this aspect is not the only factor used in consideration when assessing priority level.

As WUI areas continue to develop rising encounters with “homeless adult groups and transient retirees (living in RVs)” (Cervený & Baur, 2019, pg. 151), amplify the need for recognizing the unrecognized with socially vulnerable populations in wildfire mitigation decision-making. In states like California, Oregon, and Washington, there is a rise in highly vulnerable populations in the WUI being exposed to wildfires, which will continue to intensify with an aging population (Modaresi Rad et al., 2023). The 2018 California

Paradise fire, dubbed Camp Fire, for example, saw the most deaths in some of the most vulnerable residents - namely the elderly (Newberry, 2019). This tragic event serves as an example that the threats of the changing climate are devastating and that social vulnerability in the WUI can increase the catastrophic loss of wildfires. The fear is that houseless and other underserved communities living within WUI will be overshadowed in favor of the privileged that also reside in such areas (Wigtil 2016). The growing necessity for society to coexist with wildfire ignites an understandable concern surrounding the integrity of new mitigation efforts as historical prejudices may reaffirm questions of equity in how these actions are implemented. Lack of knowledge, prejudice, or the simple non-consideration for demographics the literature expressed (Adams & Charnley, 2020, pg. 25) can have profound consequences, as it can lead to the oversight of areas or communities when it comes to receiving crucial help and resources. The possible gaps then in EJ policy and how equitable the impact from hazardous fuel treatments is then the concern of the matter.

Despite the presence of federally backed non-discriminatory policies and equity directives, the actual on-the-ground reality may not always reflect those ideals. Whether it's time, knowledge, resources, or conflicting cooperation efforts, a manager's decision-making model bears some responsibility in the prevention of significant loss of life and structural damage, so project efforts are necessary for striving towards an equity-based response. In alignment with this concern, this report explores the fuel treatment decision-making process of USFS fuel managers. In documenting the variabilities surrounding knowledge, resources, coordination efforts, and time, this report intends to shed light on the specifics and degrees to which fuel managers consider social vulnerability in the implementation of new national mitigation strategies.

2 Impact and Importance

The findings of this project hold several implications for informing wildfire management practices and future policies. By exploring how on-the-ground NF managers integrate or overlook equity concerns in their fuel treatments, decision-making can offer insights into the nuanced ways in which social vulnerability is taken into account. These insights can be considered in the following ways:

1. **Informs Decision-Making:** Acknowledging managers' grasp and integration of equity, along with the challenges they encounter in doing so, offers crucial insights into the drivers shaping the development and execution of wildfire mitigation tactics. Differing views or even experiences with socially vulnerable populations can influence a manager's approach to land management. This knowledge can contribute to a more informed decision-making model among fire and forest managers.
2. **Equity in Wildfire Mitigation:** Learning how decisions incorporate equity, or the lack thereof, can lead to a better understanding of the potential disparities in the distribution and impact of wildfire mitigation efforts. This insight is crucial for ensuring that vulnerable communities are not disproportionately affected and that mitigation strategies are justly implemented. These ideals are not only necessary in preventing further wildfire destruction but also aligning with the overarching environmental justice policies.
3. **Policy Improvement:** The interviews can provide valuable insights into the interplay between equity considerations and decision-making processes. Leveraging this knowledge can lead to more effective wildfire management policies, strategically crafted to address equity issues. This understanding can be pivotal for enhancing the effectiveness of wildfire management policies by ensuring they address equity concerns more comprehensively.
4. **Enhanced Community Resilience:** The rapid expansion of the WUI highlights the critical imperative to prioritize and safeguard communities. While the project does not claim to provide definitive answers, its findings can serve as valuable insights in crafting strategies aimed at bolstering community resilience against wildfires. Such strategies may involve enhanced communication networks and a robust public wildfire prevention outreach.

In summary, the project's significance extends beyond academia to practical use in policymaking. Its aim is to use the findings to improve wildfire management in line with equity initiatives endorsed by the government, benefiting both the environment and vulnerable communities. By incorporating these insights into policy, we can create a more equitable approach to wildfire management, tackling environmental issues and social disparities simultaneously. This integration of research and policy can enhance resilience in vulnerable areas, promoting environmental sustainability and social equity.

Ultimately, this project serves as a crucial link between policy makers and fuel managers and their role in implementing effective and equitable wildfire mitigation strategies.

3 Methods

The work in this project is part of a larger study that was conducted by fellow project members exploring vulnerability in WUI areas. This study includes inquiries about wildfire management and their considerations for the socially vulnerable. These inquiries are outlined by the project's RQs as:

1. *How do fuel managers make decisions about where to conduct fuel treatments and other wildfire risk reduction strategies?*
2. *How are fuel managers influenced by existing policies, regulations, and guidelines when making decisions about wildfire risk reduction strategies?*
3. *How do fuel managers coordinate with other agencies and organizations when they are planning fuel treatments, and how might this work to include or exclude socially vulnerable groups?*
4. *In what ways do fuel managers consider social vulnerability as a factor in their decision-making about fuel treatments and other wildfire mitigation strategies?*

In alignment with the RQs, a set of ten open-ended interview questions (see Appendix A) was formulated aiming to expand upon managers' decision-making processes, the factors influencing their choices, and the extent to which equity considerations play a role in the implementation of wildfire mitigation strategies. The semi-structured interview protocol was approved by the Michigan Technological University's Institutional Review Board (IRB Net # 2112347-1). The interview format's flexibility allows researchers to easily expand or generate any questions needed for detail using prompts previously identified in the research process (Jacob and Furgerson, 2012); as exemplified in the interview protocol (Appendix A). Before contacting potential participants, I, along with fellow project members, completed the CITI Program Certificate (#55619879) as required by Michigan Tech to be able to conduct the social/behavioral research this project entails.

The following sections on participation selection and qualitative analysis outline the steps taken to initiate the data collection and analysis process, which spanned approximately five months.

Participation Selection

The initial phase of the selection process acknowledged the West and Southeast regions of the United States as the primary focal points. These regions were identified due to their heightened susceptibility to wildfires and ongoing implementation of fuel treatments (Schoennagel et al., 2017; Holifield, 2023). With this geographical focus, NFs from the regions were identified and selected using data from USFS map service program that detailed forest's hazardous fuel treatments and its proximity to socially vulnerable neighborhoods (MapServer, 2023). In addition, attention was also paid to the extent of land that forest land managers were capable of treating, prioritizing those with higher fuel treatment coverage. Using these factors, NFs in California, Arizona, Nevada, Montana, Oregon, Texas, Oklahoma, South Carolina, Georgia, Florida, and Kentucky were identified. From the selected areas, 11 NF managers were identified using publicly

available information that detailed some involvement with fuels reduction decision-making. Examples of some of these sources include NF websites, news articles, Facebook posts, land management approval documents, and simple internet searches of job titles (fuel planners, prescribed fire and fuel specialists, etc.) at chosen forests. Once identified managers were reached out via their public contact information and subsequently interviewed. The remaining three national-level managers interviewed were not chosen based on the same dataset but instead selected using public information that detailed national-level involvement with hazardous fuel treatments. Participants were interviewed in an online meeting format, which was recorded with the knowledge and consent of the involved parties. Recordings were stored on a password-protected computer and were deleted within one week after being transcribed and anonymized. Transcriptions, identified by their NF state and interview date, were generated using the automated Zoom software. These transcriptions were then cross-checked with video recordings, and minor editing was performed as necessary.

Qualitative Analysis

Interviews and their corresponding transcripts were analyzed and coded incrementally using NVivo, a software tailored for qualitative analysis. In addition to the transcripts serving as the primary source of data, several wildfire management policy documents were incorporated into the data analysis process to complement the insights provided by managers. These documents include the 1995 Fire Management Policy, the 2009 Guidance for Implementation Wildland Fire Management, and the 2023 USFS Fuels Technician Guide. NVivo software was used to catalog data into various categories, or codes, which address the RQs. The project team collaborated to develop an initial codebook based on previous work and anticipated themes in fuel manager responses. As more interviews were conducted and insights gathered, the codebook evolved and expanded to encompass a broader range of concepts and themes. Researchers continuously incorporated new insights from the interviews into the software until coders indicated data reaching saturation, defined as “matter of identifying redundancy in the data” (Saunders et al., 2017, pg. 4). In NVivo, the broad concepts (e.g. fire season) are labeled as parent codes and related subtopics that spawn from the parents are known as child codes (e.g. fire frequency, increasing fire conditions). Codes such as the examples given were analyzed and tagged in the interview transcripts by two members of the project team. One member was directly involved with the data collection process while the other was more removed. The two coders met on a weekly basis and compared completed transcripts. Cross-coding done by project members, as well as the project’s approach to coding was done to ensure inter-coder reliability (Cofie et al., 2022), which was also discussed in weekly meetings with the full project team. Continuous coding comparison throughout meetings were also done to ensure coders were both in agreement of how codes should be applied. I then used a thematic analysis approach, “a method for identifying, analyzing and reporting patterns (themes) within data” (Braun & Clarke, 2006, pg. 79), to analyze the coded transcripts.

4 Limitations

Due to the project's semi-structured interview format, this research is heavily reliant on the information participants provide. To ensure robust interview data, the project team curated open-ended questions that align with the RQ's and further refined these interview questions to ensure clarity and understanding among project participants. Additionally, prompting questions were prepared beforehand to assist participants in responding to project questions. Examples of this prompting can be seen in multiple questions throughout the project's interview protocol. As an example, the first question asked participants:

How would you briefly describe your role with the Forest Service and how long you've been doing this?

While certain managers might perceive this question as an occasion to delve into the various responsibilities and intricacies of their role, others may simply provide a concise and superficial response that addresses the question directly. While any response is appreciated, in qualitative research, detailed answers are preferable. Prompting questions meant to garner more detail to the question include:

What are your primary work activities or responsibilities?

What is your role in relation to planning for fuel treatments or other wildfire risk reduction strategies?

These prompting questions provide a foundation for participants to formulate their responses. Prompting was also a useful tool for participants to think of related ideas or experiences to include in their response that they may not have thought of in their initial understanding of the question. This addition to the project's interview protocol was a necessary decision added to help address the limitations that come with interviewing participants.

Another aspect of the project design that might be seen as a limitation is the small participant pool. This decision, while negating abilities to make statistical generalizations, does not impede the logic of the project as its focus is on depth rather than extent (Small, 2009). In concept-generating research, the small number of participants can be advantageous as intensive engagement with respondents can enhance validity and reliability as well as lead to rich and meaningful insights (Crouch & McKenzie, 2006). The decision to focus on the depth of fuels managers responses will aid in the conceptualization and thematic analysis of interview findings.

5 Findings

Themes and common ideas were identified from the data analysis and are summarized under their respective research question below. The overarching question of how fuel managers address equity, or lack thereof, will be explored and expanded upon following the findings from each RQ. Findings in the form of direct quotes are provided to illustrate major themes and will supplement this overarching concern of equity.

1. *How do fuel managers make decisions about where to conduct fuel treatments and other wildfire risk reduction strategies?*

The interviewed managers noted that while the responsibility for the fuel treatment decision-making process does not solely rest on their shoulders (as some processes require supervisory approval), their expertise is still essential for navigating the complex interplay of the decision-making process. In response to this RQ managers reported balancing a number of considerations, common factors included various ecological considerations, legal requirements, forest plans, commitments to past investments, stakeholder/partner expectations, and a commitment to “values at risk”. While a majority of how managers make decisions is inherently based on the regulatory process (which will be expanded more in RQ two) the concept of “values at risk” stands out as an important all-encompassing factor of what is considered when managers make wildfire risk reduction decisions. These considerations are weighed within the context of a small work force and limited resource allocation pool, which was mentioned as a major constraining factor.

Defined as “ecologic, social, economic assets, and resources that could be impacted by a hazard or threat” (ORM, 2020) the concept of “values at risk” was strongly emphasized throughout the interviews revealing a thoughtful examination of the concept. Encompassing the safeguarding of multiple factors including watersheds, airsheds, timber, and public/private property, the concept speaks to a majority of the concerns managers are used to incorporating. The following excerpts provide more foundation of the concept:

“Homes, businesses, community infrastructure, you know it could be the railroad, it could be communication sites. There's a lot of infrastructure out, on or adjacent to the National Forest that's, you know, more than just people's houses or businesses or municipal watersheds; that's another value at risk that we plan treatments for. Yeah, water is definitely a value, water quality.”

“You could go, what are the values at risk on the forest services property? Obviously timber, watersheds, wildlife, range. There's, you know, an endless list. What about our neighbors? So private land values at risk. Do we have people living out in the woods very close to the forest? So those are values at risk; access and egress into areas where we would have potential fire can we-. If we have something happen over here can we get to it easily to keep it small? Or is access

going to be an issue, or you know, some of that is again part of why we put projects where we do.”

While the aforementioned factors such as timber, watershed, airsheds, and structures near the WUI are integral aspects of “values at risk,” managers consistently prioritized the safety and value of life in neighboring communities as well as for their own workforce. This sentiment was reflected by managers' emphasis on the importance of the concept and supported by internal agency publications. The standalone importance of ‘life and safety’ was added as an additional theme. Examples of this sentiment include:

“So what I'm looking for with the community defense projects; anywhere on my district where the forest touches a community, that we can provide protection around those are usually a priority, just public life and public safety, you know.”

“Number one is always going to be life period. We can't make more people. I can plant more trees. So life and property and you know, so life there's not much more to say about it that's number one, period.”

“The safety of firefighters and the public is the number one priority when planning and implementing projects/treatments” [2023 Fuels Technician Guide].

After the importance of “life and safety” and “values at risk” are assessed, managers are then impacted by evident constraints of the regulatory landscape. While pertinent to how managers make wildfire risk reduction decisions, the nuanced approach in ensuring regulatory compliance speaks more to the influence of the regulatory process, which is addressed in RQ two. However the strategic balance managers need to consider in their decision-making is heightened in regard to another big factor, which is collaboration.

Project managers interviewed across the nation reported working with a variety of state partners and foresters, Tribal nations, NGOs, and local police and fire departments to work together in the name of wildfire risk mitigation strategies. Some participants even emphasized how collaboration is necessary to fulfill their roles and progress in land management activities as partners can also bring in more funding and more firefighting force. Internal publications reflect this theme of collaboration as they actively encourage managers to engage and collaborate on fuel reduction treatments.

“When developing projects, fuel managers should engage partners and the public at as many formal and informal levels as possible” [2023 Fuels Technician Guide].

Internal publications also outlined various methods for managers to collaborate, such as participating in local government meetings, engaging in door-to-door outreach, attending fire chief's meetings, and utilizing public advertisements. Throughout the interviews the theme was a core necessity that managers shared in their responses, enough so that its effects intermingle with this project's other RQs. With this emphasis of collaboration,

regular consultations with local tribes and community engagement initiatives like the Community Wildfire Protection Plan (CWPP) were highlighted as an inclusive shift in managers' decision-making process that differed from years past. This sentiment, while not expressed by many, was highlighted as an "evolving procedure" when brought up by managers with longer standing careers. This theme indirectly speaks to how managers decide where to do fuel treatments as evolving procedures will ultimately dictate the how and where fuel treatments will be allocated.

"So I would have to say that in the early portion of my career collaboration we were still very much agency siloed right? So state partners would only work with State partners. Feds would only work with other Feds, and Tribal nations were kinda out lingering by themselves using BIA as their conduit. Where we are now as a country, if you will, in terms of how we work with and collaborate with partners, has shifted significantly in the last 10 years. So we finally kind of realized, I think, circa, 2000 fire doesn't care about administrative boundaries, doesn't care who owns the land and doesn't care where you live. And so when we kind of embrace that reality that we cannot stay within our agency silos and that whose money is paying for it as a beside some point we kind of awoke to the reality that we have to constantly collaborate, whether it's with our private neighbors like individual, you know, unique people. And or if it's state agencies, Tribal nations. And then we created the communities at risk. So under the Community Wildfire Protection Plan, we basically engaged and emboldened the communities to tell us where they feel like their risks are.....because we manage land. We don't manage people and finances right? So we factored in the private side of that conversation"

"We've become more focused on areas of risk. Like the communities of risk developed back under the National Fire plan, I think, Clinton started that which... I was one of the first hires after that national fire plan. But you know the community's at risk and ...communities that are threatened... with wildfire that came into play in the policy of the law ...I say, when the fire plan came in around the 2000 somewhere in there. Then I think around 2008- 2010ish, we really kind of started focusing more and it had something to do with our forest land and resource plan, you know, identifying the WUI has a priority as well"

The notion of "evolving procedures" transcends collaboration considerations and encompasses practical applications of identifying fuel treatment areas. This is particularly pertinent in the relatively recent prioritization of wildland-urban interface (WUI) regions. This commitment to treat WUI areas and protect (especially in the case of smoke cover) facilities like hospitals, nursing homes, and residential treatment facilities in those areas highlight the broader societal impacts of these strategies and the considerations made when making fuel treatment decisions. These considerations coupled with the allocation of funding and resources along with prioritization of historically treated areas adds another layer of complexity to decision-making. The interviews suggest that funding/personnel availability and project prioritization contribute to the strategic allocation of resources, reflecting a pragmatic approach to achieving both ecological and

societal objectives within the WUI. The challenge therein lies in optimizing limited personnel and resources that address all of the considerations explored above.

In summary, other than the regulatory landscape, managers decide where to conduct fuel treatments using collaboration considerations, various “values at risk,” WUI and invested area prioritizations, and the emergence of “life and safety,” which is considered paramount. These considerations are further complicated by the funding and resource constraints that were commonly expressed by managers throughout the interviews. It is important to take into account these considerations managers are facing when deciding where to do fuel treatment as its impacts will directly affect priority WUI areas and, consequently, the vulnerable populations residing within them, a notion that will be expanded at the end of this section in response to the broader consideration of how managers consider equity.

2. *How are fuel managers influenced by existing policies, regulations, and guidelines when making decisions about wildfire risk reduction strategies?*

The legal context, understandably, has a profound influence on decisions, necessitating compliance with agency, national, and state-specific regulations as well as coordination with state, Tribal, and NGO partners to work across jurisdictional boundaries. The intricate balance between ecological conservation objectives and legal obligations becomes apparent in the meticulous planning required for permits and permissions, especially concerning endangered species, cultural heritage, and potential impacts on air quality. Exemplified by state-level guidelines such as federal forest plans and smoke management guidelines, as well as nationally mandated procedures such as the National Environmental Policy Act (NEPA), these necessary constraints significantly influence manager’s decision-making processes. Finding harmony between these conservation goals and legal mandates requires thorough planning and careful consideration; examples of these necessary legalities are listed below.

“And then the big one here in South Carolina for us is South Carolina's smoke management guidelines. We have to call the State to get a smoke permit because of the air shed. You can look that up online if you want to know more about South Carolina guidelines, but it's pretty restrictive and what that does is to make sure you've got good wind and good dispersion to get your smoke up and out and so you're not creating public issues. Obviously, we're trying to avoid hospitals, chicken [farms], nursing homes. And those are the larger main ones, but any kind of anything that you might know. We got a couple of line [WUI] owners that are sensitive to smoke. So we wanna make sure the ones that we know about, we try to make sure we're burning with that smoke that carries it the other direction.”

“So when it comes to NEPA or we'll say, specifically prescribed burning, we have to look at all of the different programs [that] have provided input so obviously, if we're burning for hazardous fuels, we still don't want to look at doing silvicultural damage to our trees or anything like that. There's a lot of archaeological sites and heritage sites within our burn unit. So we talk with our archaeologists and find out

if that site has to be fire-excluded, or if we can burn over the top of it because they're non-consumable. We work with our hydrologist to make sure that none of the streams and tributaries are going to be affected negatively. So there's I guess it's just a collaborative process that all the programs talk about in order to proceed with the NEPA”

“Some areas are very difficult to burn, because, like, say, on the Osceola National Forest, I-10, runs through the forest the southern part of the National Forest and so if you're trying to burn just north of I-10 in the right now, in the winter chances are most of our winds come from the north. You'd be blowing smoke on the interstate. They wouldn't even get a permit from the State to be able to do that. And so those kind of smoke sensitive areas drive what can be accomplished”

The difficulties expressed by managers, as seen with South Carolina's smoke management guidelines, NEPA regulations, and state permit approvals, are only the start of the manager's regulatory considerations. In addition to legal compliance, managers are influenced by decision-making tools such as Qualitative Wildfire Risk Assessment (QWRA) and land resource management plans when making decisions about treatments. These tools highlight an influence that is separate from other regulatory processes such as NEPA. Although the QWRA isn't as binding and is primarily intended to guide the process, land resource management plans hold greater sway in decision-making, as highlighted by the excerpt:

“and then a big, probably the biggest one for us, or the one I pay most close attention to is our land resource management plan. So we have a forest plan that covers the entire Flathead National Forest, and you have to ensure that whatever project you're proposing complies with, you know your land and resource management plan, or if it doesn't that you disclose that and then do a site specific amendment to your plan”

While a major component of the hazardous fuel treatment planning process is ensuring those internal processes for permits, land management plans, NEPA approvals, and risk assessments, the impact of existing policies extends beyond mere legal compliance. The core theme of collaboration and its guidelines with Tribal nations and the public speak to the hazardous fuel treatment planning process, as well as the nuanced navigation of diverse regulatory landscapes. Forest managers must actively collaborate with various stakeholders, including state governments, non-governmental agencies, and Tribal/local communities, to progress land management efforts. Some of the collaboration guidelines expressed and codified in the Fuels Technician Guide include the National Fire Plan, the Healthy Forests Restoration Act, the Collaborative Forest Landscape Restoration Program, and the National Cohesive Wildland Fire Management Strategy. This collaborative effort is particularly evident during the public comment period of the NEPA, emphasizing the influence and importance of inclusive decision-making processes. However, aligning all these factors can become very challenging especially given the pressing matters of the wildfire crisis. Project managers towards the West were, not surprisingly, more in agreement of the burdening effects of the evolving fire season

while managers towards the East didn't hold as strong of sentiments. However, a majority of the managers expressed how impacts of these evolving fire seasons would, in turn, impact the scheduling of hazardous fuel treatments and the allocation of staff responsible for implementing these crucial measures.

“That is the biggest challenge for us internally is all these processes. Take more of your day, and it takes more people to accomplish, and it takes away from the actual doing of the things. So, it either means more work hours, or it means more people or both..... But that's a challenge. That's a challenge for us. And the public probably already sees that. And they're going to see it more. Is it just takes us longer to accomplish projects in general nationwide”

“Well, we need to write contracts. We need to, you know, have folks that can administer the contracts. And at that point we didn't have those things in place. So here, 2 to 3 years on, we're finally getting things in place that were asked of us way back when so it's not an inch. The government's a big, unwieldy thing that moves slowly sometimes, and that's where it's hard, where money doesn't solve all problems. You need adequate infrastructure to deal with that and do the work in the woods”

Managers understand that their decisions are heavily influenced by the extended waiting periods it takes to navigate the policies, regulations and guidelines required in their wildfire risk reduction decisions. Bureaucratic obstacles such as those encountered with the time it takes for the state permitting process, private contractor approvals, and NEPA planning are only part of the equation. The resources needed to allocate and retain staff to these processes is another aspect that influences decision-making.

“The biggest challenge is time and attrition. And what I mean by attrition would be that we get started on projects. And then as I mentioned before, there's a lot of players that go into getting anything accomplished. So you have somebody that is involved, and then they leave the agency or take a different position, things like that. You kind of have to start over with the next individual that comes in that expertise area. So it's hard to get through one project without hitting a speed bump like that”

Recruitment and retention were common barriers mentioned throughout the interviews. Along with an array of legal complexities and resource constraints, the fuel treatment planning process introduce time-consuming but necessary procedures that will influence, and often hinder managers decision-making. The need for streamlined procedures becomes evident in these challenges, emphasizing the importance of efficient collaboration and sufficient staff to overcome bureaucratic impediments.

Despite lengthy legal procedures and monetary/staff resource trouble, the collaboration between partners and the personal relationships made in these interactions emerge as the linchpin, attributing to about 80% of the decision process according to one national-level forest manager. The involvement of diverse stakeholders, including non-governmental

organizations like The Nature Conservancy, highlights the intricate balancing act required to address the multifaceted considerations of fuel treatment plans. As the decision-making process is inherently tied to relationships, fuel managers must become “part politician, part people person,” according to one local-level manager, in order to navigate the complex terrain necessary to address wildfire risk reduction strategies effectively. The theme of "personal relationships" emerged as a pivotal aspect within the bureaucratic process, playing a key role in enhancing and advancing wildfire mitigation strategies across agency disciplines. Additionally, it fostered collaboration and engagement with external and community stakeholders, which was also used to symbolize a positive bond with the community, as signified by the excerpts below.

“The relationships that we have with our community makes or breaks...should make or break our operation and so we've got to do everything we can to make sure they're at the table and that we understand all the considerations that need to go into planning. It fuels treatment and that goes into coordinating with these communities”

“If you continue to impact those places [sensitive communities] you're just not, you're not being a good neighbor, and you're not a good steward. And those people rightly such, most people if they have to deal with it for a day or so [smoke cover], they understand. And that's common. But if you're continually putting people in any kind of home play whatsoever, yeah, yeah, you're not doing should be trying to do a little better job. You don't want your community mad at you if you can help it”

“So when we get in there and start looking at that, if you combine the relationship you have with the people, your forest, the land. And then some of those tools you start to create a, a, a system, you know, a system, a model. It's that mental model that we can start using. But otherwise, prior to that, a lot of it was just conversations with your Rangers. Whoever shouted the loudest in a meeting drove the product”

The personal relationship theme is noteworthy here to mention as these findings speak to overall considerations of equity. When managers rely on personal relationships to support collaborative decision making, they are exacerbating exclusion of the most socially vulnerable groups (the homeless, isolated elderly populations, and people with different socio-economic positions or racial/ethnic identities, and language competencies), who are not likely to have personal relationships with management professionals. Transient populations that have been increasingly encountered in national forests are left out of these conversations and relationship development. The unequal decision-making field thus leaves transient and other socially vulnerable populations who might not have the time or means to cultivate relationships with professionals and engage with coordination efforts, out of the conversation, which is expanded more in the discussion of findings below.

Overall, managers cited multiple factors influencing their risk reduction decisions including cross-boundary collaboration mandates, permit approvals, land management resource plans, lengthy waiting periods, decision-making tools like NEPA and QWRA, staffing concerns, and notably, the importance of personal relationships. Analyzing the data to answer this RQ brought to light the crucial role of personal relationships, demonstrating their importance in a collaborative environment. In the final section, we'll further explore how these considerations intertwine with broader issues of equity and social vulnerability, enriching our understanding of how these matters are brought into decision-making.

3. *How do fuel managers coordinate with other agencies and organizations when they are planning fuel treatments, and how might this work to include or exclude socially vulnerable groups?*

Collaboration among forest managers and their various partners is a common theme that is constantly upheld and prided upon throughout the interviews as a core theme. Managers described that, in contrast to years past, shifts in collaboration see that managers engage with Indigenous communities and bring them into the conversation when doing maintenance work in the forest. Executive Order 13175, for example, Consultation and Coordination with Indian Tribal Governments, issued in 2000 was an inclusionary shift in collaboration seen for some longer standing fuels managers. The emphasis on partnerships is codified in internal agency publications encouraging managers to fully understand the components of the collaborative process such as “assessing risk, developing common goals, building relationships and trust, sharing information, acknowledging interdependence, and pooling resources and public outreach” [Fuels Technician Guide]. How this collaboration unfolds varies widely, but the success of coordination endeavors is credited to the cultivation and sustenance of professional relationships between the partners.

“How do those partnerships work?”

That's extremely complicated. Mostly. It's you know, knowing people and having worked with them in the past is what really strengthens [the relationship]. We work together and make sure that we're collaborating, not just when an event occurs, but you know, pre-season postseason.”

Managers on both the national and local level emphasized how relationships with their land, community, and partners have had some role in their hazardous fuel treatment planning. This collaboration is not limited by administrative boundaries, recognizing the importance of cross-agency and cross-cultural partnerships. While many of these cooperation efforts have to do with resource allocation needs and agency guidelines, personal relationships have a role in continuing and fostering those partnerships.

Efforts for inclusivity have grown, going beyond agency boundaries. This includes broader collaborations with private neighbors, state agencies, NGOs, and Tribal nations. One notable step that has been taken to tackle economic disparities involves forests working to help secure agreements for reduced-fee fuel work on WUI private lands.

“There's also other ways that we can burn private property if the landowners are open to it. It's something called a Wyden agreement, and it's a tool where...if the land owner's open to it benefits us because we don't have to put in additional [fire] lines. We can enter into an agreement with them and burn their land when we burn ours”

“We do work with our volunteer fire departments, and they are obviously a lot more into those communities. And that's where we're seeing some of those grants going is to the volunteer fire departments to implement those treatment methods and then the State also. So [state department of forestry], we work hand in hand with them pretty well. They focus a lot more on, I guess the private land side of things for the fuels reduction side on private land. And then we focus more on the Federal Forest Service side around those communities”

Despite the opportunities provided by the Wyden agreement and related wildfire mitigation grants for the WUI populations to engage in wildfire mitigation efforts, there are still limitations that persist in reaching everyone, as suggested by one manager. This personal experience highlighted how the match requirements for grant funding acted as a barrier, preventing two elderly and retired Montana residents living on a fixed income from implementing wildfire reduction treatments on their property. Other examples from participants highlighted how the transient, houseless, or even the exhausted working class may not want or be able to make time to participate in wildfire reduction information sessions, NEPA meetings, or other planning activities associated with fuel treatments. These decision-making dynamics can possibly favor those with more influence or vested interests, potentially marginalizing less engaged stakeholders and vulnerable individuals, creating an unequal playing field.

“We would like to think we have vested interests in an equal manner. Right? But there are always organizations that are always gonna have a heavier sway. So the 5 nonprofits that are the heaviest players within the Forest Service, you know, Nature Conservancy, Trout Unlimited, Rocky Mountain Elk Foundations. You know, those are the big waxes. Those guys have not only a lot of political swag with them, but they also carry funds and capability. And so they have, probably a more prevalent presence in those discussions. Then a small town or a smaller operation, even though maybe has similar interest, doesn't have that capability to enter the conversations, if it's at a local level. I think that the other part that gets swayed in there to some extent is just whose voice has the, not the loudest, but who has the most traction.”

Within this unbalanced decision-making arena, some managers expressed concerns about a communication gap, particularly in reaching populations who are not active on social media platforms during treatments (to warn of smoke cover) or wildfires. This barrier in communication outreach, while small, does hold some broader implications in the inclusivity of those harder to reach populations and how that will translate for high-risk WUI areas. Other regions echo this sentiment, emphasizing the challenges posed by a lack of local knowledge.

“But there's a learning curve, and sometimes it's a difficult learning curve. And so we have this pool of fire folks that are coming from all over the country and getting you know, continuously. There's turnover, and they're getting mixed and matched in different ways. You get different personalities, of course. So you just don't have the consistency of a core group of local people who really, you know, have been doing this for a generation kind of thing. And I think that is a huge challenge that makes actually applying fire on the ground very difficult”

The concern local-level managers have in trying to retain and recruit professionals with long-standing knowledge of their forests is an elemental one, as this lapse in environmental knowledge can translate into bad land management decisions. The difficulty also lies with the relationships new managers must work hard to cultivate and instill both within the forest team and with its surrounding community. This underscores the importance of having individuals who are familiar with the intricacies of their respective regions in terms of both local ecological and social dynamics.

In conclusion, effective coordination between managers and external partners hinges on the cultivation of professional relationships. While efforts to be inclusive in fuel treatment planning, such as with grant programs on WUI private lands and cross-boundary partnerships, are underway, challenges persist. These include the inability of some populations to be present and knowledgeable of fuel treatment decision-making. The inadvertent communication gaps with socially vulnerable populations and the limited local knowledge within the manager's workforce contribute to a level of exclusion experienced by these vulnerable groups. In essence, the existing practices and procedures, despite aiming for inclusivity and full collaboration, exhibit inherent gaps that may widen alongside the expansion of the WUI.

4. *In what ways do managers consider social vulnerability as a factor in their decision-making about fuel treatments and other wildfire mitigation strategies?*

Although the predominant emphasis in the decision-making process for fuel treatments lies in biophysical data, there are instances where managers reported experiential vulnerability factors that exert influence in these decisions. In Arizona, for instance, considerations were extended to a community situated near the forest. Residents, whose health had been impacted by the events of 9/11, relocated to the area with the assurance of receiving clean air. While vocal, these communities are factored into planning, with efforts to minimize smoke impact through strategic timing and location of burns. Similar considerations were given to a Florida residential treatment facility for individuals with

PTSD, where the forest actively worked and communicated with the facility in advance to minimize smoke exposure. Oklahoma cited similar considerations, arranging a hotel stay for an individual with COPD to avoid the smoke cover that was affecting the area for a few days.

Smoke exposure is the overarching theme in consideration of nearby vulnerable residents. Managers must obtain smoke permits to ensure proper dispersion and prevent public issues, particularly near sensitive areas like hospitals, nursing homes, and even chicken farms. Although smoke has consistently played a role in the treatment process, this concern became particularly heightened during the COVID-19 pandemic. One forest, for instance, gave an example of having to have daily coordination with a neighboring hospital to safeguard it from potential air quality issues during emergencies. Despite these instances of vulnerability being considered, there are differing perspectives on the importance of considering the social vulnerability characteristics of residents, as illustrated in the examples below.

“If we had a checkbox and said, every time you do this you need to go through that. We would have a checklist a mile long, because what you would end up starting to see is the creeping of special interest groups or ideas coming in there. So the broader category of environmental justice isn't. I'm not saying it's a negative thing. What I'm just saying is we shouldn't allow it to be the overshadowing value for what we do because we have to rank something, and if we start looking at life, liberty, and the pursuit of happiness, then you know that's kind of the order”

“Yeah. I mean, it takes in a whole gamut of different factors and then it's basically like running a model. You have all these inputs into the model that you know, fuel, fuel, topography, percent slope, weather patterns, potential fire behavior. I remember a quote the other day that like fire behavior modeling is more complex than rocket science. Because there's a lot of input into that decision matrix about what areas to treat, or how to prioritize treatments. And I just don't recall like social vulnerability, you know, being fed into that model”

Although the significance of incorporating vulnerability characteristics was emphasized, concerns were raised that solely prioritizing based on demographics might overlook critical components of land management. The mile long “checklist” and the complexity of the decision matrix highlighted in the aforementioned quotations speak to the number of factors managers must consider before engaging topics of social vulnerability. The caution then in over prioritizing social vulnerability characteristics, was an interesting perspective that about half the project managers, local and national, across the country expressed in their interviews and was subsequently categorized as “diminished vulnerability.” Examples of this theme in conversations are as follows:

“So I feel like, if we were to hone in only on demographics, or use demographics as a decision tool, if you will, in terms of how we prioritize or where we go and

why we're going there. It would potentially derail or disservice potentially another component that's part of land management”

“All of these different values swirling together is a really challenging environment to work in. And you know, every stakeholder groups that have a particular.. focus. You got the wildlife folks that are really what they are focused on. There's folks that are looking at jobs in the community, vulnerability of communities and populations and smoke sensitivity. All of these things are important. And so the challenge is, how do you blend them at the right you know- weigh them appropriately. We can't pick one of these things and make it the most important without, you know, seeing a detriment to all the others. And so that's really the challenge is trying to weigh the importance of all these values appropriately”

The “diminished vulnerability” theme was an interesting insight and when it arose in conversations mainly arose in the context of uncertainty surrounding the use of social vulnerability to inform decision making. While managers were given examples of how vulnerability may look/translate in the WUI (like how lower income populations have a harder time responding, preparing, and recovering from wildfires), the hesitation in using this information in fuel treatment planning mainly stemmed from a lack of knowledge on how to weigh vulnerability concerns amongst all the other factors that managers consider. The lack of information available to managers concerning these populations also factors into the uncertainty of using demographic information.

In addition to this perspective, another commonly held viewpoint among project managers is the concept of "dismissed vulnerability." In response to initial mitigation measures and active wildfires, managers expressed how vulnerability characteristics fade into insignificance when confronted with the reality of wildfire's indiscriminate fury. These sentiments are expressed through the following excerpts:

“So we tend to look at adjacent private lands or adjacent whatever kind of just unbiased we're like doesn't really matter so much on the social vulnerability aspect of it. I think we would. We would do the same work kind of regardless of who lives next door. What their social class is, you know, cause, we just know it's gonna be a long time before we get back to this area. So we just need to do the treatment now and try to treat all of it. But I wouldn't say we prioritize project areas or treatments over whether you know anyone's social status or vulnerability to wildfire”

“all those social classes [are] intermixed within...a mile of land adjacent to the national forest. You could have every social class and every different type of situation sprinkled into that area so it's not like we're picking and choosing. We're just like, hey, we're gonna treat this entire area”

“So no matter what. I'm gonna just tell you that the demographics to us overall it doesn't matter. If we can get to fire, and we can put it out quickly as possible. That's what we're that's what we're trying to do, no matter what”

The “dismissed vulnerability” theme is another insight that local and national-level managers shared alike. Fuel manager's outright dismissal of vulnerability in favor of prioritizing wildfire risk protection for everyone may seem noble in theory. However, as discussed in this report, these needs are not always met equitably, such as with transient/houseless populations being properly integrated/considered in decision-making. Another example is mentioned in the text, “If we can get to fire, and we can put it out quickly as possible. That's what we're trying to do, no matter what.” The ability to effectively reach and respond to fires can indeed be socially differentiated based on factors such as access to resources and infrastructure. Vulnerable communities, which often face barriers such as limited transportation, inadequate communication networks, or insufficient resources, may experience delays or challenges in fire response compared to more advantaged areas. In short, the most socially advantaged are most likely to live in places with the best infrastructure to support rapid response, while the most socially vulnerable are more likely to live in places where infrastructure is also vulnerable. While this comment was in the context of fire response, similar sentiments where vulnerability is dismissed were expressed in the context of hazardous fuel treatment planning. The limitations expressed in the “diminished” interviews were highlighted once again by managers for this theme of “dismissed vulnerability.” Some of these limitations include the constantly fluctuating nature of the WUI population, and both themes highlighted how there was a lack of available information to supplement understanding of local vulnerable groups. This sentiment is exemplified below:

“The vulnerability with you know, we're trying to manage a program where we're picking a spot on a map to do treatment and treat that vegetation. But if the vulnerabilities of the populations that have an interest in that spot on the map is kind of moving, moving around. It's a little bit tricky. So you know. Certainly, it's a factor that we want to pay attention to and be aware of and have it inform our decisions. But it's also a really tough one in terms of, you know, you might say, Okay, this is gonna have the biggest impact on a vulnerable population. When you make that first choice in year one. But by year 4 or 5 conditions might have changed. And now the vulnerabilities are not on that piece of ground. They moved on someplace else. So it's a challenge for sure. But it's definitely information that we're looking at to inform our decisions”

The need for a balanced framework that integrates biophysical data with social data, stands out as an option to supplement this information gap. An example of this could help address the comfort of managers who may only be familiar with the biophysical landscape of their forests and the lack of material data necessary to address vulnerability in WUI areas. While the exact formula of this balance exceeds this report's capabilities, the importance of considering social vulnerability becomes even more evident when addressing houseless populations, a pressing issue for forests with extensive WUI areas. As urbanization continues to encroach upon natural landscapes, proactive measures must

be taken to anticipate and mitigate the challenges posed by houseless populations in NF areas.

“We have kind of houseless issues on a large swaths of the forest services. We are so intermixed, WUI-wise. I know we have a current planning decision that got signed last year at the southside of Bend that is incredibly political and very fraught with a lot of houselessness problems. And that's kind of an epicenter for fire risk. And not only from human starts in that area coming out, but the work that we need to do. To mitigate those risks requires folks to not be in those places. And that's where we have a lot of houseless camps and things of that nature. So that's kind of an ongoing issue. And that's certainly not isolated in one spot. Basically, every community we have up and down highway 97 corridor kind of connects all our communities in North South sort of way. And basically every community adjacent to our district has some sort of houseless area within the urban interface, in a spot that also conflicts with current or ongoing treatments. So that's definitely something we're thinking about”

In closing, the ways in which managers reported social vulnerability as a factor in their decision-making were mainly short-term coordination and accommodations with institutions and residents in response to concerns of smoke cover. Furthermore, the rise of intermixed WUI areas (Radeloff et. al 2018) pose concerns for houseless populations and how they might factor into wildfire mitigation decision-making. Other findings from this RQ emphasized themes of “diminished vulnerability,” highlighting concerns about vulnerability characteristics' importance in decision-making environments, while “dismissed vulnerability” surfaced as managers emphasized indiscriminate vulnerability to wildfire, disregarding specific characteristics; an interesting insight that the next paragraph will delve more into.

Integration of Findings

The four listed RQ's allude to the extent to which fuel managers take into account social vulnerability and equity when making decisions regarding wildfire land management. Among the various considerations that were explored, themes that garnered the most interest included “values at risk,” “life and safety,” personal relationships, and the central tenet of collaboration. These considerations, however, are hindered by the lack of available information on how and where to actually approach and engage with socially vulnerable groups. Encroaching WUI areas, and data that affirms homeless and non-recreational camping in all nine USFS regions (Cervený & Baur, 2019) overlaid with a fire-prone landscape speak to the necessity of ensuring fuel treatments are equitable and inclusive throughout decision-making.

Engaging with neighboring WUI communities is a responsibility that NF managers will have to continuously adapt to as more and more of these areas develop. With this new development, the significance of cultivating personal, yet professional, relationships with the socially vulnerable in these areas becomes evident, representing an integral component of this new sense of collaboration. While formal guidelines and

recommendations are integrated and institutionalized in collaboration mandates, the role of personal relationships has a way of contradicting those formal rules/requirements. The challenge lies in how less vested individuals, transient or homeless populations, and other vulnerable groups—who lack the time, resources, or social capital to engage—struggle to fully integrate themselves into these relationships and thus cannot fully participate in environmental policymaking. While findings admit that the continuously evolving WUI and vulnerable populations are challenging aspects to fully engage, efforts must be made to improve communication so that reliance on personal connections does not create another dimension of exclusion, with significant impacts for vulnerable groups.

The other aspect of this disconnect comes with the “diminished” and “dismissed vulnerability” themes. Neglecting social vulnerability concerns in favor of maintaining an unbiased perspective or overlooking its significance altogether are common viewpoints seen throughout the interviews. These findings, overlaid with the understanding that managers generally didn’t consider nearby population demographics (Adams & Charnley, 2020, pg. 25) suggest that fuel managers’ approach to engagement and knowledge of these groups must be improved upon.

In aligning with equity policies, “life and safety” themes, and plain consideration for people's livelihood, addressing the information and communication disparities is crucial to building the individual analytical capacity (Wu et al., 2018, pg. 6) of managers. Educating about and integrating socially vulnerable data with familiar scientific-oriented perspectives and frameworks is necessary for overcoming existing disparities. Redefining the “values at risk” theme to include and highlight some of these dimensions of social vulnerability for specific populations may be a way to start prompting genuine inclusivity in the decision-making process.

6 Conclusions

This study found that fuel managers must undergo a multifaceted decision-making process when making hazardous treatment decisions spanning economic, ecological, legal, and collaborative considerations. Fuel managers navigate balancing these factors in the context of an increasingly more fire-prone landscape, matched with minimal financial and workforce support; these constraints further complicate the work of managers from being able to create and ultimately implement equitable treatment decision-making.

Examples from various NF's demonstrate efforts to address the needs of vulnerable communities, such as minimizing smoke exposure for residents with health conditions and coordinating with facilities serving populations with specific vulnerabilities. However, despite efforts at the individual level to address social vulnerability, FS fuel managers grapple with challenges in implementing these considerations uniformly across practices. Differing perspectives on the prioritization of social vulnerability characteristics, coupled with a lack of comprehensive information to support such efforts, pose significant obstacles. Furthermore, while homelessness is more prevalent in the West, similar concerns have been expressed in the East, highlighting the pressing need for proactive and collaborative solutions, particularly in WUI areas. Nonetheless, the agency remains committed to protecting both natural resources and the well-being of all community members in wildfire-prone regions. Addressing these challenges will require collaborative efforts, robust information gathering, and nuanced approaches to integrate social vulnerability considerations effectively into wildfire mitigation strategies. By doing so, the Forest Service can strive towards a more inclusive and resilient approach to their fuel treatment decision-making process. Surface-level recommendations for improvement sit above the fuel manager level but could vary from advisory boards, manager training, improved data collection, and robust national wildfire education outreach and public advertisement that are central to bridging these inclusivity gaps. These insights can serve as a foundation for further exploration of the pivotal role of personal relationships in managers' collaborative efforts and shed light on how partnerships may facilitate effective and high-quality decision-making. Overall, the study's findings help bridge the gap between research and policy, with insights for promoting equitable decision-making in wildfire management strategies.

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A Appendix

Interview Protocol for Researchers

I am conducting interviews to better understand decision-making for hazardous fuels reduction treatments. I would like to learn how managers decide where to do treatments, and the various factors that go into the planning process, including ecological, economic, social, and policy considerations.

1. First, I'd like to hear more about your job. How would you briefly describe your role with the Forest Service and how long you've been doing this?

PROMPT: What are your primary work activities or responsibilities?

PROMPT: What is your role in relation to planning for fuel treatments or other wildfire risk reduction strategies?

MAYBE PROMPT: How long in this role/location?

2. How does your team make decisions about where to focus fuel treatment efforts? What sorts of things do you consider?
 - a. Do you focus your treatment efforts near where people live? How so? Or why not?
 - b. Are there specific regulations, policies, or guidelines that you must follow, or that you should follow?

PROMPT: Does your agency currently have fuel treatments that are being planned or worked on?

3. Are you and your team collaborating with any community partners on wildfire risk reduction efforts? Who? How does that partnership work?

PROMPT: Can you share a story or example about how this works?

PROMPT: Which organizations collaborate with most/priority/most effort?

4. There has been increasing attention to the idea that some people are more vulnerable than others in the case of wildfire. I mean elderly people may have a harder time evacuating or may be more susceptible to smoke-related health risks. Or lower-income people may have fewer resources to harden their homes, or to recover in the face of wildfire losses or work stoppages. Or people without a car would be less able to evacuate. The basic idea is that some people are better able

to respond than others, and that can be related to demographic characteristics like age, income, education, race, or language. Is this kind of differential vulnerability something that your team considers when planning for fuel treatments?

- a. Why or why not?
- b. Can you tell me about how that works?

POSSIBLE PROMPT: That's really interesting. Why do you think that's the case?

- c. Does the Justice40 declaration impact how you think about this? How so or not?

PROMPT FURTHER: Can you share a story or example that illustrates how these factors may have influenced the decision-making of fuel treatment's locations?

5. How important is it for managers to take this kind of demographic information that might impact people's vulnerability to fire into account in making decisions about fuel treatments?
 - a. What other factors do you have to consider?
 - b. What would need to be different in order for you to be able to consider these factors more?
6. What limits or constraints impact the Forest Service fuel treatment planning process whether related to resources, policies, public perception, information, or anything else?

PROMPT: Are there liability constraints you consider in fuel treatment locations?

PROMPT: How does a longer fire season impact?

PROMPT: In your experience has private landowners hinder or enabled fuel treatment?

7. * If low on time may skip: How has the Forest Service approach to fuel treatments evolved over time, and what factors have driven these adaptations?

PROMPT: How would you say the procedure has evolved?

8. Looking ahead, what challenges or opportunities do you see in making sure the people who need the most help from fuel treatments can get them?

9. What additional information does your organization need to better help people live with and cope with wildfire?

10. Is there anything else you think it's **important** for me to know?

Thank you for taking the time out of your busy schedule to talk with me. We appreciate the effort you made to be a part of our study and sincerely thank you. Once our project is complete would you be interested in receiving the final product? If you think of anything else later that you'd like to share, please give me a call or send an email.