THESIS

GOVERNANCE APPROACHES FOR SCALE MISMATCHES IN PRE-WILDFIRE PLANNING AND POST-WILDFIRE RESPONSE AND RECOVERY

Submitted by

William Cole Buettner

Department of Forest and Rangeland Stewardship

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Master's Committee:

Advisor: Courtney Schultz

Tony Cheng
Ryan Scott

ABSTRACT

GOVERNANCE APPROACHES FOR SCALE MISMATCHES IN PRE-WILDFIRE PLANNING AND POST-WILDFIRE RESPONSE AND RECOVERY

Wildfires in the western United States have become an increasingly complex management challenge. Increased fire extent and severity, longer fire seasons, housing development in the wildland-urban interface, jurisdictional complexities, and interactions between fire and other disturbances combine to exacerbate risks to different critical values. Managers have recognized the need for greater pre-wildfire planning by reducing wildfire risk through fuel treatments and contingency planning in anticipation of fire. Less explored, however, are how managers are responding to changing environmental conditions after wildfires and planning for long-term recovery efforts. Challenges in pre-wildfire planning and post-wildfire response and recovery share similar scalar mismatches that frustrate effective governance. Scale is the spatial, temporal, and functional dimensions used to measure and study any phenomenon, and mismatches arise from challenges within relationships between ecological and social systems. In this thesis, I explore different scale mismatches in pre-wildfire and post-wildfire management to derive an understanding of potential adaptation options in complex management systems.

This thesis consists of five standalone chapters. The first chapter introduces the two primary studies and reviews relevant literature related to wildfire governance and tools used to facilitate adaptive management approaches. The second chapter is a peer-reviewed manuscript that investigates the use of Potential Wildfire Operational Delineations (PODs) for fire and fuel

management. In collaboration with the Colorado Forest Restoration Institute, we filled gaps in PODs research by investigating how PODs are being utilized in non-incident management contexts to align forest and fire planning objectives with incident response tactics. We found that PODs help validate fuel treatment plans and support communication among agency staff, and with private landowners and collaborators. Challenges included lack of technical knowledge and skills, unclear leadership direction, potential misalignment with other forest management goals, and community and agency buy-in to using PODs. Recommendations from interviewees were to address knowledge gaps and capacity challenges. In our paper, we offer insights into how PODs are being utilized within our case studies and align these findings with the diffusion of innovation literature. This second chapter of my thesis has already been published in the *International Journal of Wildland Fire* as a Research Note.

The third chapter, intended for a practitioner audience, explores the governance approaches to post-wildfire policies and programs following the Hermit's Peak-Calf Canyon Fire response and recovery efforts. Interviewees shared program and policy challenges, adding that policies did not incorporate local contexts, had prolonged treatment timelines, and federal staff were uneducated on program nuances. Facilitators of success were the Monsoon Taskforce and Lines of Effort Framework created by New Mexico State Agencies to allow for greater communication, coordination, and collaboration. Interviewees recommended an increase in workforce capacity and education, as well as legislative changes. The fourth chapter, intended for a peer-reviewed journal, aligns adaptive governance theory and literature on boundary organizations with the governance approaches following the Hermits Peak Calf Canyon Wildfire. I found that adaptive governance arrangements are occurring in New Mexico and that boundary organizations are playing a significant role by facilitating information transfer and addressing

knowledge gaps. In chapter five, I share concluding thoughts for both studies and suggestions for further inquiry and policy guidance.

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CHAPTER 1 - INTRODUCTION

Wildfires in the western United States have become an increasingly complex management challenge (Schultz et al. 2019a). Increased fire extent and severity, longer fire seasons, housing development in the wildland-urban interface (WUI), and interactions between fire and other disturbances combine to exacerbate risks to different values. (Holden et al. 2018; Jolly et al. 2015; Radeloff et al. 2018). These challenges have driven the development of decision support tools for pre-wildfire planning, including the PODs framework, by which fire managers and cooperators co-identify potentially suitable control lines (e.g., roads, rivers, ridges, streams, and or fuel transitions) on the landscape with the highest likelihood of containing wildfire (Thompson et al. 2020; Greiner et al. 2020). Potential Wildfire Operational Delineations (PODs) were developed as a pre-season planning tool to promote safe and effective fire response in an attempt to bridge across the temporal and geographic scale mismatches, and mitigate short-term risks, while bearing in mind long-term fire and forest management goals across multiple jurisdictions. To date, there has been little research on how PODs are being utilized in non-incident management contexts to align forest and wildfire planning objectives. The goal of this study was to understand how actors are adopting and adapting the PODs framework to inform non-incident management. We investigated three cases, the San Juan National Forest, the San Isabel National Forest, and the Washington Department of Natural Resources. Interviews were conducted by researchers at the Colorado Forest Restoration Institute. In collaboration with them, I analyzed the data and led the writing of a product for publication. This work was pending publication at the time of my proposal writing and was not intended to be a primary focus for this

thesis, instead, it offers perspectives on how scale mismatches are addressed in pre-wildfire operations and planning. This product is stand-alone and can be found in Chapter 2.

Post-wildfire response and recovery reveal ignorance of scale-related issues when short-term solutions (e.g., mulching) aggregate into long-term problems (e.g. increased fire risk or invasive species presence). Social-ecological mismatch occurs when the effects of wildfire across agency jurisdictions do not align. Lastly, short-term incentives to manage immediate hazards may overlook or exacerbate longer-term concerns or problems. Beyond community-based reports and government assessments, to date and to my knowledge, there are no peer-reviewed studies that have investigated the policies that govern post-wildfire response and recovery at the federal level or the governance approaches used to navigate scale-related challenges involving multiple jurisdictions and long time-frames. To fill this gap, I investigated the governance approaches, facilitators, challenges, and recommendations for response and recovery efforts following the Hermit's Peak-Calf Canyon Wildfire in northern New Mexico.

Fires affect ecosystems and people across jurisdictional boundaries, at different temporal scales, and at geographic scales too large for any one actor to manage. After a wildfire, short-term challenges like hydrophobic soils and vegetation loss create optimal conditions for sediment movement and flooding (Wine et al. 2018). This can result in water quality impairment and recurrent damage to critical infrastructure, like water facilities, roads, and bridges. Watershed conditions remain dynamic for upward of a decade. In addition, climate change-related conditions, like hot droughts and severe rainfall, when they occur in tandem with fires, result in major hydrological changes, landscape-scale ecosystem changes, and shifts in species compositions. (Millar & Stephenson 2015). Wildfires act as a catalyst for forest ecosystem change, and climate change is limiting regeneration and making it less likely forests will recover

to pre-wildfire conditions (Stevens-Ruman and Morgan 2019). In addition to ecological effects, wildfires cause economic challenges that can persist for more than a decade after the initial event (Hjerpe et al. 2023). California alone reported billions of dollars in structural loss from wildfires in 2017 and 2018 (Buechi et al. 2021). Headwaters Economics (2018) found that nearly half of the total costs of wildfire recovery are paid at the local level, by homeowners, businesses, and state and local government agencies. Post-fire flooding and debris flows damage critical infrastructure, including drinking water infrastructure (Jones et al. 2022; Hjerpe et al. 2023). Wildfires also affect livelihoods and local economies when tourism, industry (e.g., timber harvesting), and ecosystem services are negatively impacted (Vukomanovic and Steelman 2019; Otrachshenko and Nunes 2022; Thomas et al. 2017).

Local and state entities must respond to ecological and economic challenges after a wildfire and often do not have the resources to address either short- or long-term recovery needs. Furthermore, local and state governments often do not conduct contingency plans for disasters at the scale of today's large fires (i.e., 100,000+ acres). Once state resources are depleted, federal response and recovery policies become available after a formal disaster declaration (see *Policy Overview below*). This process, when initiated, triggers a menu of programs designed to help communities recover (McCarthy 2010). It is, however, the responsibility of the state to have systems for funding distribution and provide local, contextual information (e.g., community characteristics or needs) to federal entities. Federal post-wildfire response and recovery policies are administered by four core agencies: the US Forest Service (USFS), the Natural Resource Conservation Service (NRCS), and the Farm Service Agency (FSA), all with the Department of Agriculture, and the Federal Emergency Management Agency (FEMA), housed within the U.S.

Department of Homeland Security. Each program typically is managed independently of others within the post-wildfire space.

Scale mismatches are inherent across wildfire management broadly and create challenges for communities and management regions as they adapt to meet national climate-driven strategies. Scale refers to the spatial, temporal, and functional dimensions used to measure and study any phenomenon, while fit can be described as the integration of human and ecosystem dimensions in social-ecological systems (Cash et al. 2006; Folke et al. 2007; Schultz et al. 2019a). Scale-fit mismatch manifests as different challenges across management regimes. Mismatches include ignorance of scale-related issues, social-ecological mismatch, and tensions between short- and long-term risks and benefits (Cash et al. 2006).

At the time of proposal writing, I intended to use theory in adaptive governance and policy design as a solution to address scale mismatches. Adaptive governance is increasingly promoted as an approach to coordinate resource management regimes in the face of complex and uncertain environmental challenges (Chaffin et al. 2014). Literature on adaptive governance is expansive, but a primary focus is on addressing scale-fit mismatches by allowing objectives to be tailored to local contexts, promoting flexible problem-solving, and fostering social learning (Schultz et al. 2019b). Tailoring objectives requires rules that establish modes for engagement while still maintaining open solutions. This provides flexibility in prioritization of project areas, identifying which stakeholders to include, and the mix of implementation actions. A lack of clear administrative and technical support and reluctance for government officials to delegate responsibility are factors that lead to failures in AG (DeCaro et al. 2017). I noted that within post-wildfire response and recovery governance and policies were not adaptive and did not allow for flexibility or objectives tailored to complex contexts. Instead, rigid policy design is assumed

to be adequate for local contexts, regardless of factors like available capacities, level of urbanization, jurisdictional complexity, or forest and watershed structure and function. I anticipated that this critique of post-fire policy would emerge in my study and that recommendations for new policies would align with many of the "design principles" for AG (DeCaro et al. 2017). However, to my surprise, factors that facilitated response and recovery aligned with the sensitizing concepts of adaptive governance. This alignment is further discussed in Chapter 4.

I also considered theory in policy design and intended to use it as a way to operationalize adaptive governance in practice. Policy design refers to the process of identifying public policy goals, determining tools to achieve those goals, and calibrating them to succeed across different levels of governance (vonHedemann et al. 2020). Policy design is used to invoke behavioral changes and requires that all levels of policy aims, objectives, and goals are coherent, that implementation preferences and tools are consistent, and that tools are congruent and convergent (Howlett 2009; Howlett 2019). Often multiple policy tools are needed to achieve a goal across space and time, and all policy tools have inherent assumptions about how and why they will work in practice and to change the behavior of different actors. Failures occur when the assumptions needed for effective policy design are not met. Ultimately, the data did not reflect the principles of policy design and thus did not prompt further use in my study. A better fit for policy design would be a project centered around the analysis and deconstruction of the Wildfire Management and Mitigation Commission's recommendations (WFMMC 2023) to determine how they would work together to create more post-wildfire opportunities (see vonHedemann et al. 2020).

In this thesis, I utilized a pragmatic research orientation with qualitative methods to understand the challenges, opportunities, and recommendations across both areas of study. Pragmatism emphasizes the research problem and question and is not committed to any one methodological approach to understanding the problem (Creswell and Creswell 2018). I used an exploratory case study approach to show how PODs are utilized in a non-incident management context and how post-wildfire policies are being navigated. Across both studies, I conducted 22 and analyzed 36 interviews. This data is not intended to be generalizable, but rather contextualized to specific environments that can provide insights for policymakers and future research. More detail on my methods is included in each chapter, with the detail required for a peer-reviewed publication found in the methods sections of chapters 2 and 4. Additionally, interview guides and codebooks can be found in Appendix A and B, respectively.

My research topics are components of broader research projects within the Public Lands Policy Group and the Colorado Forest Restoration Institute. The Public Lands Policy Group and the Colorado Forest Restoration Institute have conducted ongoing research on the use of Risk Management Assistance (RMA) tools and the use of PODs over the past half-decade (Griener et al. 2020; Schultz et al. 2021; Thompson et al. 2022; Beeton et al. 2022). This preliminary research is important given increased funding for PODs in recent legislation and the possibility of broader adoption of fuels treatment planning in the future. My post-wildfire work is part of a larger research effort to determine how post-wildfire programs and policies are used broadly across the West. This research highlights the importance of state and local-level disaster readiness and how local contexts influence implementation effectiveness. To date, the Public Lands Policy Group has investigated case studies in Colorado and Washington. My thesis consists of four chapters: Chapter 1, an introduction; Chapter 2, a manuscript on the use of

PODs; Chapter 3, a manuscript in preparation for a practitioner audience based on my post-wildfire research; Chapter 4, a manuscript in preparation for a peer-reviewed journal based on my post-fire research; and Chapter 5, a conclusion on study limitations and future research directions.

CHAPTER 2 – USING PODS TO INTEGRATE FIRE AND FUELS PLANNING

Summary

Background: Potential Wildfire Operational Delineations (PODs) were developed as a pre-season planning tool to promote safe and effective fire response. Past research on PODs has identified uses in an incident management context. There has been little research on how PODs are being utilized in non-incident management contexts to align forest and wildfire planning objectives.

Aims: We sought to understand how actors are adopting and adapting the PODs framework to inform non-incident management, and identify facilitators, barriers, and recommendations.

Methods: We investigated three cases, the San Juan National Forest, the San Isabel National Forest, and the Washington Department of Natural Resources, through 13 semi-structured, key informant interviews.

Key results: We found that PODs were helpful for validating fuels treatment plans and supporting communication among agency staff, and with private landowners and collaborators. Challenges included lack of technical knowledge and skills, unclear leadership direction, potential misalignment with other forest management goals, and community and agency buy-in to using PODs. Interviewee recommendations aimed to address knowledge gaps and capacity challenges.

Conclusions: We offer insights into how PODs are being utilized within our case studies and align these findings with diffusion of innovation literature.

Implications: This preliminary research is important given increased funding for PODs in recent legislation and the possibility of broader adoption for fuels treatment planning in the future.

Introduction

U.S. wildfire management is an increasingly complex management challenge (Schultz et al. 2019a). Changes in increased fire activity and fire season length, development in the wildland-urban interface, and interactions between fire and other disturbances (Jolly et al. 2015; Holden et al. 2018; Radeloff et al. 2018) have driven the development of decision support tools such as Potential Wildfire Operational Delineations (PODs) (Greiner et al. 2020). This framework allows managers and cooperators to co-identify in the pre-season potentially suitable control lines (e.g., roads, rivers, ridges, streams, and or fuel transitions) on the landscape with the highest likelihood of containing wildfire (Dunn 2017; Thompson et al. 2020). While PODs have been developed on over forty National Forests and surrounding landscapes (USFS 2021), to date, research has only focused on the use of PODs during incident management (Thompson et al. 2016; O'Connor and Calkin 2019; Caggiano et al. 2020; Stratton 2020). Several federal and state agencies have expanded the framework for cross-boundary planning and prioritization of mitigation and restoration treatments to integrate fuels treatment placement with consideration of wildfire management goals.

In this study, we explored how actors adopted and adapted the PODs framework to inform non-incident management, and identified facilitators, barriers, and recommendations. This is a timely issue; the Infrastructure Investments and Jobs Act (IIJA; 8 U.S.C. § 40803.C.7) provided $100 million in funding to the Secretaries of Interior and Agriculture for PODs planning and workforce, $500 million for developing or improving Potential Control Locations (PCLs), and created a new Categorical Exclusion (CE) under the National Environmental Policy Act (NEPA) for fuel breaks along potential control lines (EMC and FAM 2022). Our interviews were conducted before the IIJA was passed; previous authorities for CEs were created through

rulemaking and under laws like the Healthy Forest Restoration Act (HFRA; 16 U.S. Code § 6591d). The implicit goal of IIJA funds is to implement fuel breaks and treatments that will facilitate holding fire at PCLs (POD boundaries) and expansion of managed of fire within POD polygons to meet land management objectives (Thompson et al. 2022).

To inform our study, we considered factors that influence the adoption and diffusion of innovations, which depend on innovations' alignment with institutions at multiple levels (Lemos 2008; Table 2.1). Diffusion of innovations "refers to the spread of abstract ideas and concepts, technical information, and actual practices within a social system, where the spread denotes flow or movement from a source to an adopter, typically via communication and influence (Rodgers 1995)" (Wejnert et al. 2002, p 297). The theoretical framework proposed by Lemos (2008) is a simplified model adapted from Wejnert et al. (2002) and Rodgers (1995) and outlines institutional characteristics needed for an innovation to fit.

In Table 2.1, the first column denotes three levels of institutions. At the individual level, local actor priorities, relationships, knowledge, risk tolerance, past experiences with similar innovations, and how they view the innovation as salient, credible, and legitimate affect rates of adoption (Cash et al. 2003; Lemos 2008). At the organizational level, organizational mission, culture or set of incentives around risk-taking, decision-making authority associated with organizational roles, and capacity can influence innovation diffusion, as can performance assessment incentives, leadership commitment, clarity of communication regarding purpose of or support for PODs, potential integration with existing systems, and adequate staff and technical capacity to support the use of innovations (Fernandez and Rainey 2006). The broader institutional environment also matters with regard to the complexity of a problem, built infrastructure, and other institutional arrangements (e.g., policies, jurisdictional authorities, and

direction from political leaders). Others have noted that innovation should also be: provided at appropriate spatial scales to inform decision-making, at the appropriate time in a decision-making process to inform those decisions, accessible (i.e., available, appropriate format, and easy to interpret), and usable within the confines of existing technological capacity (Cash et al. 2003; Dilling and Lemos 2011; Lemos 2008). Across each level, access to knowledge, communication, and perception of "fit" between knowledge and decisions affect manager's willingness to innovate (Lemos 2008).

Methods

We conducted 13 semi-structured key informant interviews with 14 individuals (one interview was with two people) during Fall 2021. We explored how agencies were using the PODs framework in non-incident management contexts in three places by three land management units: the San Juan National Forest (SJNF) in western Colorado, the San Isabel National Forest (SINF) in southern Colorado, and the Washington Department of Natural Resources (WADNR) in eastern Washington. Interviewees held positions in fire and fuels management or forest planning and coordination. Interviews were structured to determine how agencies developed and used PODs, and to garner personal insights on barriers to PODs function and implementation. Most interviewees were championing PODs development on their State or National Forest and were creating blueprints for future development. We used purposive sampling to target informants with intimate knowledge of how PODs were developed and used for non-incident management, and we identified additional interviewees through snowball sampling (Bernard 2017). Interviews were conducted according to an approved human subjects research protocol, and were recorded, transcribed, and coded using thematic analysis (Braun and Clarke 2012; Ryan and Bernard 2003). Our sample size was relatively small. However, it was

appropriate for these exploratory case studies to document early adoption and adaptation of PODs in a new, and potentially innovative, context. Our findings are not meant to be generalizable to a broader context, but to understand early stages of innovation and inform future work. Results are organized by each research question and represent integrated findings across all three cases unless explicitly stated.

Results

How did managers use PODs to inform non-incident management?

PODs were being utilized in three distinct and unique ways to achieve Forest-wide goals across each case study. The SJNF adopted PODs as a forest-wide framework to inform prescribed fire planning and implementation, wildfire decision-making, and cross-boundary prioritization. This was achieved through a "nested PODs" concept, where PODs were created at multiple scales (Box 2.1). Collaboration with the Rocky Mountain Restoration Initiative (RMRI) was meant to increase the pace and scale of treatments in southwest Colorado and to create cross-boundary PODs. On the second unit, the SINF incorporated their PODs framework into the Wet Mountains Wildfire Potential Control Lines project, a proposed vegetation management project CE under the HFRA authority. The project aimed to create opportunities for firefighters to safely engage wildfire during an incident, reintroduce fire on the landscape, decrease the threat of catastrophic wildfire, and achieve landscape-scale outcomes. Limited resources for this project led to small, targeted treatments that were intended to affect fire behavior at a landscape scale. The WADNR adopted PODs to address planning and dual benefit needs outlined by two state policies that required a minimum of 200,000 acres to be assessed for forest health treatments every two years with treatments required to have dual benefits for both forest health and wildfire response. WADNR took an all-lands approach where assessments were made across

state, federal, and private lands. More information on when and how PODs were operationalized in each case can be found in Box 2.1.

What are the facilitators, barriers, and recommendations for PODs use?

Most interviewees discussed how PODs were an intuitive way for validating and prioritizing treatment locations. For example, SJNF interviewees said using PODs and PCLs to designate units for prescribed fire helped ensure the best possible features were being utilized for delineating control boundaries. Others discussed how PODs encouraged agency staff to continue off-season dialogue about treatments, which they said can be useful for justifying the need and approach to fire management in these ecosystems. Interviewees with WADNR discussed how PODs helped align the goals of wildfire management and forest health, which are often perceived as conflicting goals pursued by different groups of actors.

Most interviewees discussed how PODs have been used to facilitate communication externally with partners and private landowners to help support management discussions and to gain buy-in. Interviewees from the SINF case mentioned how PODs have acted as a springboard for dialog about future treatments and mentioned that the collaborative process of developing PODs helped gain buy-in for the project goal. WADNR interviewees said PODs helped communicate to landowners the purpose and need for treatment, including for example why certain parcels are a higher priority for treatment than others and the need for co-managing risk across boundaries.

Almost all interviewees mentioned a lack of capacity to complete treatments or to further advance PODs planning. Specifically, interviewees mentioned capacity barriers of access to funding, access to personnel, and technical knowledge on PODs. Most interviewees in management roles said there is a lack of available technical expertise that is needed to develop

and maintain PODs and a lack of common knowledge around PODs within agencies and with partners. Interviewees shared instances where USFS personnel lacked the knowledge to transfer PCLs into GIS platforms. One interviewee mentioned that a lack of general knowledge around PODs is slowing down development.

Most interviewees mentioned a lack of agency leadership direction, intent, alignment, and buy-in as being a challenge to PODs, although this was not to say there are no champions helping facilitate development and implementation. However, many interviewees discussed how a lack of direction to utilize PODs has led to hesitancy among agency staff to use PODs when planning treatments. For example, some interviewees said certain staff members want large or flexible POD delineations, so they do not feel locked into doing something if it is not the right treatment strategy. Some interviewees wondered how PODs would be further developed. One interviewee said some management units develop PODs and then do nothing with them, especially when they are viewed as just another new and temporary tool for planning. Interviewees shared instances where top-down processes have overturned decisions and dictated how and when treatments are implemented despite what the pre-vetted PODs lines indicated.

The most common recommendation from interviewees was aimed at addressing the knowledge gap between PODs experts, regular users, and outside collaborators. One interviewee recommended having more media outlets, like videos or a story map, that could help with PODs education and outreach. This would aid when engaging with local landowners or other jurisdictions. Another interviewee thought that having agency personnel devoted to PODs analytics would be helpful instead of leaving that role to PODs developers or research institutions. Interviewees recommended there be more leadership direction supporting PODs from USFS regional offices and states, although they agreed PODs should be developed and

implemented at the local unit level to capture local needs and adaptations. One interviewee discussed that regional direction (i.e., from the USFS Regional Office) would help provide a level of standardization when it comes to high-level PODs dialogue and presentations, to ensure consistency as PODs expand beyond western landscapes. Interviewees also recommended that, at the local level, innovations to PODs need to be communicated by forest leadership in an effective way to ensure field-level staff members have a common understanding of their purpose and utility. Interviewees recommended engaging with partners early and often, along with establishing a dialogue with partners to help gain buy-in and enhance collaborative processes. In addition, there is a need for information sharing and support, continued investment to increase staffing capacity, and further funding for a PODs user group, as a sort of network of practice. Interviewees wanted to know the different contexts that PODs can be utilized for non-incident management, as this has been relatively unexplored and research and outreach to date, has been primarily geared towards its utility in incident management contexts.

Discussion/Conclusion

This article assessed how PODs are being utilized in a non-incident management context and how managers are adapting the framework to achieve state and federal goals. We spoke with three units that were early adopters of this innovation (i.e., using PODs outside of the incident management context). Using the diffusion of innovation theory we discussed above, we explore herein PODs as an institutional innovation and the factors that supported early adoption of PODs for non-incident management (Lemos 2008; Table 2.1). We note that our findings were consistent with the theoretical literature, and that understanding them in this context is helpful for contextualizing current practice and future recommendations.

At the individual level, theory indicates that innovations will be adopted if they are accessible, fit with manager's priorities, and are salient, credible, and legitimate (Cash et al. 2003; Lemos 2008). Most interviewees said PODs summarize the relevant information needed to help validate decision-making, identify priority areas, facilitate communication, and adaptability to achieve forest-wide goals. Manager's and local stakeholder's priorities such as cross-boundary planning, communication, and treatment prioritization were incorporated into PODs delineations. PODs have also been shown to integrate climate mitigation and adaptation approaches into preseason prioritization (Thompson et al. 2022). Thus, PODs were salient and fit with manager needs, and their credibility and legitimacy were implicit in interviewee comments that PODs helped justify decisions. Others have also found that PODs are salient and legitimate when local knowledge and stakeholder engagement occur, especially when this diffuses into fire management decisions (Greiner et al. 2020; Thompson et al. 2022). PODs are a spatial fire planning framework and decision support tools; the analytics mean little if not situated within local contexts and decision processes.

At the organizational level characteristics that affect innovations are problem-framing or provision of rationale for use by leadership, a culture or set of incentives that support risk-taking, and adequate capacity and funding (Lemos 2008). Indeed, we found that leadership direction, intent, and buy-in to new practices are vital for PODs use (Table 2.1). A lack of leadership direction from both the local and regional levels, and a lack of capacity in funding, personnel, and technical knowledge will limit long-term planning with PODs (Greiner 2020; Fernandez and Charnley 2006). To encourage broader use, some interviewees discussed a need for standardizing PODs at the regional level. However, there were also concerns about PODs utility if they are mandated, because their use requires local buy-in and tailoring. The development of PODs

requires planning, internal communication, and coordination with partners, which ultimately requires adequate funding, personnel, and technical capacity. Limited staff capacity is a persistent challenge across US Forest Service and State management entities (Schultz et al. 2019a), and it was mentioned by our interviewees as a factor affecting use. To support PODs use, there needs to be a general understanding of the concept, how they intend to be used, the capacity to develop and maintain them, and ways to convey this information to partners and the public (Greiner et al. 2020). If POD use expands there will be a greater need for expert knowledge and collaborative partner understanding (Thompson et al. 2022). Despite challenges, PODs can be leveraged to find impactful solutions with limited capacity, as was done on the SINF (Box 2.1), by proposing small but targeted treatment areas with landscape-scale impacts. Various needs for capacity and knowledge of PODs would help expand fit at the organizational level and promote greater diffusion of PODs use outside of incident management as an innovation, if this remains a goal.

Other organizational factors affecting the diffusion of innovation are compatibility with existing decision-making requirements and integration with other support systems (Fernandez and Rainey 2006; Lemos 2008). PODs must align with decision-making options and requirements under NEPA, HFRA, and other treatment frameworks in order to fit organizational structure. Interviewees explained how PODs are integrated with existing federal and state policy (Box 2.1). Likewise, other support systems like the Risk Management Assistance (RMA) dashboard, Wildland Fire Decision Support System (WFDSS), and Interagency Fuel Treatment Decision Support System (IFTDSS) are commonly utilized to inform management decisions within incident and non-incident management contexts (Thompson et al. 2022). Our interviews did not capture the integration of PODs with other existing support systems; though a growing

body of literature supports this connection by exploring how the proactive, collaborative, and spatial components of PODs provide additional value to existing support systems (Nobel and Paveglio 2020; Schultz et al. 2021; Thompson et al. 2022; Beeton et al. 2020; Rapp et al. 2020).

At the broader institutional level, innovations are more likely to be adopted when they fit within larger social and political goals and policy design paradigms. Interest in PODs is likely being driven in part by management challenges in the Western U.S. and funding support under the IIJA. Our interviews were carried out in 2021, before the IIJAs enactment, and there has since been more direction and support from the Washington Office (USFS 2022a; USFS 2022b; Moore 2022; EMC and FAM 2022). Federal strategies such as the National Cohesive Wildfire Management Strategy have emphasized the need for collaborative, spatial, pre-wildfire planning (Colavito 2021). Likewise, the Wildfire Mitigation and Management Commission report recommended Congress and agencies further develop and utilize pre-wildfire response planning methodologies, like PODs, to align wildfire management and mitigation through an interdisciplinary and collaborative approach (WFMMC 2023).

PODs offer a unique way to approach pre-fire planning and integrate plans for land management with consideration of using fuel treatments not just to mitigate local fire behavior but also strategically during wildfire incident management. Interviewees discussed how PODs are changing the way they approach fire, saying that past strategies for fuel treatment are not working as well anymore in the face of larger fire sizes and more communities at risk. Others explored these changing dynamics by showing how PODs offer a framework to integrate fire management across preparedness and response (Thompson et al. 2022). Our cases also showed that PODs can be used as a boundary object to communicate and link treatments across jurisdictions and levels of governance. As such, they offer a potentially more integrated approach

to land and fire management, although their utility and efficacy are still inconsistent and remain to be demonstrated more broadly (Colavito 2021). The recommendations for further PODs development, including increased capacity, clear leadership direction, greater buy-in, continued investment, and flexibility to adapt for context-specific uses must be addressed at the organizational and broader institutional level. Nonetheless, their fit within the broader institutional environment of social and political concern and investment in forest management to address large fires may facilitate their ongoing adoption

Box 2.1: How PODs were operationalized to achieve agency goals

San Juan National Forest: Informing Prescribed Fire and Cross-Boundary Prioritization

The SJNF used PODs as a forest-wide framework to help inform prescribed fire, wildfire decision-making, and in collaboration with the Rocky Mountain Restoration Initiative (RMRI). In 2019, they deployed a nested PODs approach, where already-developed burn units were situated within a forest-wide PODs network. Collaboration with RMRI aligned prescribed fire and timber projects to areas within high-priority PODs. The SJNF developed an automated decision-support tool that integrated PODs and could be used to develop burn plans, identify burn windows based on the conditions and timing of past prescribed fires, and help characterize fire behavior, resource allocation, and contingency planning/decision-making if a prescribed fire were to escape to an adjacent POD. In this vein, the SJNF integrated fire mitigation and response by aligning tools for both purposes. This approach allowed for POD boundaries to be strengthened through fuel breaks. POD boundaries and PCLs were evaluated on the percent likelihood of containing a specific fire, based on historic burn data.

San Isabel National Forest: Potential Control Lines & Landscape-Scale Outcomes

The Wet Mountain Wildfire PCLs: A Proposed Vegetation Management Project was developed in 2019 to facilitate opportunities for firefighters to safely engage wildfire and to reintroduce fire back onto the landscape. Treatments were prioritized along PCLs, POD boundaries, in areas with high fuel loadings, high insect and disease mortality, limited access, and a number of high-value resources and assets. Prioritization was based on egress and ingress routes and the number of high value areas adjacent to the project area. The treatments totaled to less than 3,000 acres and 400 feet wide on either side of a PCL, making it categorically excluded from full NEPA review under the HFRA.

Washington DN: Forest Health Assessments & Treatment Framework

In 2020, PODs were adopted to address planning and dual benefits outlined by two state policies specific to eastern Washington. The *20-Year Forest Health Strategic Plan* required that a minimum of 200,000 acres needed to be assessed every two years. House Bill 1784 required forest treatments to support dual benefits for both forest health and wildfire response. The WADNR prioritized treatments along PCLs (e.g., shaded fuel breaks) based on layers relevant to wildfire response benefit (e.g., homes, infrastructure, drinking water, crown fire potential), these are places where fire operations may focus efforts to reduce loss to highly valued resources and assets. Treatment areas were prioritized within PODs based on factors affecting forest health (e.g., drought vulnerability, fire risk, forest structure). The KITTI Application (Keep IT or Tweak It) was a new collaborative online GIS platform that was created specifically to allow any user to add, refine, or delete PODs or PCLs based on what they were seeing in the field. The creation of KITTI provided a designated place where personnel could easily work from and provide feedback even if they lacked GIS skills. This aimed to address technical capacity challenges, however, was not utilized for fire operations.

Table 2.1. Adoption of innovation framework (Lemos 2008) with characteristics that affect innovations and recommendations from our findings at three levels of institution.

Level of Institution	Characteristics that Affect Innovation from Literature	Characteristics that Affect Innovation from our Findings	Recommendations from Findings
Individual Level	Manager -Priorities -Relationships -Knowledge -Individual risk tolerance -Past Experiences and how they view an innovation as salient, credible, and legitimate (Cash et al. 2003).	-Alignment with forest and fire management goals -Support of treatment prioritization -Communication tool -Cross-boundary collaboration tool - Accessibility to relevant information	-More media outlets for PODs education and outreach -Personnel devoted PODs analytics within agency
Organization Level	-Culture of risk -Decision-making autonomy -Capacity in staffing, technical knowledge, and funding -Compatibility with Existing Processes -Leadership direction, alignment, and intent -Organizational Mission	-Personnel - Fit within decision-making requirements (e.g., NEPA, HFRA, treatment framework, landscape-level prescribed fire program) -Technical capacity -Knowledge/awareness -Buy-in to a new practice -Leadership direction, alignment, and intent	-Communication and outreach -Clear direction and leadership -Two-way learning between analysts and developers -Increase investments in analytical capacity - Greater Regional Office direction
Broader Institutional Environment	-Complexity/nature of the social and ecological environment -Jurisdictional authority -Institutional arrangements and policy design	-Enabling legislation (HB 1784; IIJA) -Fire management challenges – changing approach to pre-fire planning with better alignment of forest management goals	- Continued investment and support

CHAPTER 3 – CHALLENGES AND OPPORTUNITIES IN POST-WILDFIRE RESPONSE AND RECOVERY: A CASE STUDY FROM THE HERMIT'S PEAK-CALF CANYON WILDFIRE

Executive Summary

Wildfires in the western United States have become an increasingly complex management challenge, as effects are distributed across jurisdictional boundaries and occur at different temporal scales. In 2022, two escaped prescribed fires merged and became the Hermit's Peak-Calf Canyon Wildfire (HPCC) burning over 300,000 acres and becoming the largest fire in New Mexico state history. Utilizing qualitative methods, we interviewed 22 individuals with intimate knowledge of the HPCC post-wildfire response and recovery efforts, and who held positions across local, state, and federal agencies, to obtain detailed perspectives on the efficacy of post-wildfire programs. Our objectives were threefold:

1. Understand the major challenges that communities face in post-wildfire response and recovery in terms of effects on livelihoods and landscapes and how these were addressed through policy and governance.
2. Identify factors that allow organizations and agencies to navigate response and recovery policies.
3. Inform future policy changes to facilitate more effective post-wildfire response.

Key Findings

Interviewees perceived that FEMA Individual Assistance programs lacked the flexibility to address local contexts, resulting in low eligibility for program participation. Interviewees said FEMA would not provide temporary housing units to individuals who did not previously have sewer, water, or electricity connections, despite many rural New Mexican communities using

alternatives like outhouses, river water, and solar or hydroelectric power. Strict policy guidelines contributed to low Individual Assistance eligibility, and interviewees perceived additional disincentives to participate because of funding available through the Assistance Act.

Interviewees perceived that FEMA Public Assistance programs had prolonged reimbursement and treatment timelines, and variable post-wildfire knowledge among federal employees. FEMA Public Assistance programs are based on reimbursements to applicants (state and local governments); the agency does not guarantee which projects will receive funding and subsequent reimbursement, creating challenges for quick project implementation, given uncertainty about reimbursement. Interviewees said there is variable post-wildfire knowledge among FEMA staff; interviewees thought staff in Region 6 (New Mexico, Texas, Oklahoma, Arkansas, and Louisiana) did not have institutional knowledge of post-wildfire contexts, especially compared to other regions (e.g., Region 9 and 10).

Interviewees discussed challenges with the Hermit's Peak Assistance Act, including slow funding disbursement, an unfamiliar claim process and were not certain how it would be implemented effectively. The Hermit's Peak Assistance Act provided $4 billion in supplemental funding to settle damages or loss to property, businesses, critical infrastructure, economic loss, and physical or emotional damage. FEMA was tasked with creating a Claims Office to distribute the funding appropriated through the Act. Most interviewees said the disbursement of funding was slow because of the delayed establishment of the Claims Office and regulations. Interviewees already had familiarity with the Torts Claims process, the use of which could have reduced confusion across levels of governance and the public on how claims are processed. Most interviewees said they wanted the Hermit's Peak Assistance Act to provide funding that can be

implemented across jurisdictional boundaries, but instead provided payouts for claim settlements.

Most interviewees discussed challenges associated with the Stafford Act's policy guidelines, particularly the fact that disasters that result from wildfires, like subsequent floods, are not covered by initial disaster recommendations. The most common challenge mentioned was that cascading events (disasters that result from a post-wildfire environment) are not eligible for funding through the initial disaster declaration and must either go through a separate disaster declaration or be funded by the state. Many cascading events did not meet disaster thresholds, despite communities needing assistance.

The Monsoon Taskforce and the Lines of Effort Framework were coordination and collaboration frameworks that helped establish a sense of familiarity among actors, create channels for communication, and reduce information overload (Box 3.1). The Monsoon Taskforce was created to provide a platform for daily updates where agencies could share progress on project planning, expected field conditions, and immediate emergency tasks. The Lines of Effort was an adaptation of the FEMA Interagency Recovery Coordination Framework; through this effort, actors organized according to the seven identified efforts (watershed mitigation, housing, community development, water quality, economic development, historic and cultural resources, and health and social services) to distribute resources efficiently and encourage collaboration among actors.

Recommendations

The following is a synthesis of the key recommendations our interviewees offered regarding post-wildfire response and recovery policies and frameworks:

- Increase workforce capacity, specifically at the state and local level, to better manage contract procurements, land assessments, project implementation, and community engagement.
- Improve/create federal and state education on programs and ecological considerations around post-wildfire response and recovery.
- Develop and implement a navigator concept (i.e., a post-wildfire caseworker) to connect individuals and agencies with expert post-wildfire knowledge as they traverse response and recovery programs and policies.
- Create funding that can be implemented across boundaries and allow for a holistic post-wildfire approach.

Common Acronyms

FEMA	Federal Emergency Management Agency
NRCS	Natural Resource Conservation Service
USFS	United States Forest Service
FSA	Farm Service Agency
USACE	U.S. Army Corps of Engineers
BAER	Burned Area Emergency Response
EWPP	Emergency Watershed Protection Program
EFRP	Emergency Forest Restoration Program
FMAG	Fire Management Assistance Grants
IRC	Interagency Recovery Coordination
HPCC	Hermit's Peak-Calf Canyon Fire
EMNRD	Energy, Minerals and Natural Resources Department
DHSEM	Department of Homeland Security and Emergency Management

Project Overview and Background

Post-fire response and recovery is an increasingly important topic in the wake of more catastrophic, extensive, and frequent fires in the US West. In 2022, the Hermit's Peak-Calf Canyon (HPCC) Fire burned more than 340,000 acres in northern New Mexico (InciWeb 2022). Both fires started on the Santa Fe National Forest. The Hermit's Peak Fire started from the Las Dispensas prescribed fire, and the Calf Canyon Fire started from a dormant pile burn that was conducted in January 2022. The two fires merged and resulted in the largest wildfire in New Mexico state history, burning approximately 200,000 acres of private lands (58% of the fire footprint), 141,000 acres of Federal lands (41%), and 745 acres of state land (.02%) (NMFRI 2022). Over 150 homes and 900 structures (barns, sheds, etc.) were lost to the fire (NMFRI 2022). The cause of the HPCC fire and the damage that occurred reinforced New Mexican distrust towards the federal government (see Box 3.1). In addition to the rekindled national debate over the future use of prescribed fire (USFS 2022), practitioner and community experiences with HPCC post-wildfire effects and challenges have contributed to the discussion on how communities and governments approach response and recovery (Haffey 2023, WFMMC 2023).

We researched federal post-wildfire policies, programs, and governance approaches after the Hermit's Peak-Calf Canyon Wildfire. Examining this fire offered unique and important perspectives on how rural communities respond and recover from wildfires. This work is part of a larger research effort to understand the major challenges to post-wildfire policies, potential recommendations, and governance approaches across the West. Our objectives were to:

1. Understand the major challenges that communities face in post-wildfire response and recovery in terms of effects on livelihoods and landscapes and how these were addressed through policy and governance.
2. Identify factors that allow organizations and agencies to navigate response and recovery policies.
3. Inform future policy changes to facilitate more effective post-wildfire response.

Box 3.1. Historical context on the New Mexico and Federal Government Relationships
The Treaty of Guadalupe Hidalgo, which ended the war between the United States and Mexico, was intended to recognize the existing property rights of the Hispanic landowners. However, during the land grant adjudication processes community land from these grants was declared public domain, eventually becoming part of the San Juan, Rio Grande, Carson, and Santa Fe National Forests (USFS, 2020). The descendants of the original rightsholders still live in the surrounding area and claim rights to the land that once belonged to their ancestors. In addition, within New Mexico's boundaries are the Jicarilla Apache Nation and 19 Pueblos and their trust lands, and the unceded ancestral lands, much of which is now considered US public land, of these and other Tribes.

From a wildfire perspective, New Mexico has already experienced catastrophic fires because of federal prescribed fire. The Cerro Grande Fire of 2000 also started from a prescribed burn in Bandelier National Monument and moved into Los Alamos, Santa Clara Pueblo, and San Ildefonso Pueblo, destroying over 280 homes and 40 laboratory buildings (Gabbert 2010). Recovery cost exceeded $1 billion dollars and was prolonged for over a decade after the initial event (Gabbert 2010). Shortly thereafter in 2011, the Las Conchas Fire, which also started in Bandelier National Monument, affected more rural and Indigenous communities but received less federal attention. Centuries of broken treaties and agreements have contributed to federal distrust in many New Mexican communities, and past federally caused fires contribute to the difficulty in rectifying the harm caused by the HPCC fire.

Wildfires affect ecosystems and people across jurisdictional boundaries, at different temporal scales (e.g., sometimes over hours or days, and other times over multi-year timeframes), and at spatial scales too large for any one actor to manage. After a wildfire, hydrophobic soils and vegetation loss create optimal conditions for sediment movement and flooding (Wine et al. 2018). This can result in water quality impairment and recurrent damage to

critical infrastructure, like water facilities, roads, and bridges. Watershed conditions remain dynamic for upward of a decade. In addition, climate change-driven weather (e.g., hot droughts and severe rainfall) compounds the effects of fires resulting in changes to hydrology and other ecosystem processes, as well as shifts in ecological composition and structure. (Millar & Stephenson 2015). Compounding events are making it less likely forests will recover to pre-wildfire conditions (Stevens-Ruman and Morgan 2019).

Federal post-wildfire response and recovery policies are administered by four main agencies: the US Forest Service (USFS), the Natural Resource Conservation Service (NRCS), the Farm Service Agency (FSA), and the Federal Emergency Management Agency (FEMA). The USFS administers two programs, the Burned Area Emergency Response (BAER) program, which allows emergency soil stabilization actions, and the Burned Area Rehabilitation (BAR) program, which allows infrastructure repair and restoration work to be conducted. The NRCS administers the Emergency Watershed Protection (EWP) program on private lands that require watershed stabilization. Likewise, the FSA works on private lands that were previously forested before the fire via the Emergency Forest Restoration Program (EFRP). None of the USDA programs require a disaster declaration to be activated. Additional information on each USDA program, jurisdictional limitations, implementation timeframes, and allowable treatments can be found in Table 3.1.

The primary FEMA programs are the Individual Assistance, Public Assistance, and Fire Management Assistance Grants (FMAG), each governed through provisions of the Stafford Act. With exception to FMAG programs, FEMA programs are triggered when the Governor of the affected state declares a disaster and has taken appropriate response actions under state law. The state must also be able and committed to distributing funding to alleviate the effects of the

disaster and comply with all cost-share requirements. Once U.S. Presidential approval is given for disaster relief, FEMA will begin conducting damage assessments across public and private property to determine the total funding awarded. In addition, FEMA was tasked with creating a Claims Office to distribute funding appropriated in the Hermit's Peak-Calf Canyon Assistance Act. The supplemental funding totaled approximately $4 billion to settle damages or loss to property, businesses, critical infrastructure, economic loss, and physical or emotional damage. Additional information on FEMA programs can be found in Table 3.2.

Post-wildfire response and recovery is a state-led and federally supported effort that requires coordination and collaboration at each level of governance. Communities are expected to respond to changing conditions during and after the emotional and physical trauma of a wildfire and often lack the financial resources to address short- and long-term recovery needs. Local-level actors (municipalities, county offices, and conservation districts) are responsible for addressing damage to transportation infrastructure and water filtration systems and managing evacuation. State-level actors help local governments and individuals address ecological or community-level challenges, identify potential policy shortcomings, advocate for waivers or exemptions, and coordinate post-wildfire efforts. Local and state-level actors can be sponsors for federal programs, making them responsible for contract procurement, land assessments, community coordination, and sometimes treatment implementation. Federal-level actors support the state during the response and recovery process. Federal agencies, like FEMA, the USFS Tiger Teams, and the U.S. Army Corps of Engineers (USACE), deploy internal disaster experts who can identify opportunities, expedite recovery, and increase workforce capacity. Non-governmental organizations (e.g., collaborative groups, watershed coalitions, research institutes,

or legal counselors) fill critical gaps that inevitably form across government efforts. The core group of organizations relevant to the HPCC fire can be found in Table 3.3.

Table 3.1: Summary of USDA post-wildfire programs, jurisdictional limitations, implementation timeframes, and allowable treatments.

Program	Jurisdictional Focus	Funding Mechanism	Operational Timeframes	Role in Post-fire Response and Recovery Process
USFS Burned Area Emergency Response (BAER)	Federally managed land and Tribal trust lands (i.e., reservations).	Agency wildfire suppression budgets.	Within one year of incident containment.	Emergency stabilization and treatments on federal lands to protect and prevent further degradation of natural and cultural resources threatened by post-fire conditions, assess post-burn soil, plant, habitat, and hydrologic conditions, and prepare integrated plans to respond to threats.
USFS Burned Area Rehabilitation (BAR)	Federally managed land and Tribal trust lands (i.e., reservations).	USDA – Competitively awarded from Bipartisan Infrastructure Law	Within three years of incident containment.	Recovery of burned landscapes unlikely to recover without human intervention, including mitigation of invasive species threats, soil disturbance, reseeding/seedling planting, contouring for runoff control, or minor infrastructure/resource repairs.
NRCS Emergency Watershed Protection (EWP)	Privately owned land/property.	Supplemental congressional appropriations.	Projects must be completed within 220 days of EWP funding allocation for non-life-threatening disasters (10-day limit for such cases).	Conduct emergency measures to safeguard life and property and remove/reduce hazards caused by natural disasters, including streambank stabilization, channel sediment and debris removal, infrastructure repair, and slope stabilization.
FSA Emergency Forest Restoration (EFRP)	Non-industrial, privately owned forests.	Supplemental congressional appropriations.	Within two years of project approval.	Provides up to 75 percent of cost-share funding for debris/downed tree removal for establishing new stands, replanting costs, reconstruction of forest roads, fire lanes, fuel breaks and erosion control structures, fencing, and wildlife habitat enhancement.

Table 3.2: Summary of FEMA post-wildfire programs, jurisdictional limitations, implementation timeframes, and allowable treatments.

Program/ Policy	Jurisdictional Focus	Funding Mechanism	Operational Timeframes	Role in Post-fire Response and Recovery Process
Public Assistance (PA) program (Section 402)	Public land (state, county, or municipality)	Annual appropriations from Congress to the Disaster Relief Fund (DRF).	Must be submitted within one year of closing the incident period. A "lock-in" letter is provided with the total amount of funding assistance provided.	Emergency work: debris removal and emergency protective measures. Permanent work: infrastructure repair to roads, bridges, water facilities, public buildings, and utilities.
Individual Assistance (IA) program (Section 402)	Private land	Annual appropriations from Congress for Disaster Relief Fund (DRF), emergency appropriations.	Must be submitted within one year of closing the incident period. A "lock-in" letter is provided with the total amount of funding assistance provided.	Individual Assistance: housing assistance, social programs, crisis counseling, etc.
Hazard Mitigation Grant Program (HMGP) – Available in the Fire Management Assistance Grants (FMAG)	Public land (state, county, or municipality)	Funding for HMGP is based on a percentage of PA & IA funding.	Within six months of the end of the fiscal year in which FMAG funding was awarded.	Actions to prevent long-term damage to life and property from natural hazards, e.g., soil stabilization, flood diversion, and reforestation.
Hermit's Peak Assistance Act	Private land, businesses, governments, NGOs, and Tribal trust land	Congressional appropriations	Once a claim is submitted there is a 150-day timeline for required documents to be submitted, and a 180-day timeline for compensation determination.	Resolving damage claims for burdens placed upon claimants by the Hermit's Peak-Calf Canyon Fire.
The Robert T. Stafford Disaster	All non-federal lands.	Annual appropriations from Congress for	N/A	Governing policy for every FEMA program.

Relief Act (Stafford Act)	Disaster Relief Fund (DRF), emergency appropriations.

Approach

To answer our research objectives, we utilized an exploratory case study approach and conducted 22 semi-structured interviews with individuals holding positions across local, state, federal, and non-governmental organizations who had intimate knowledge of the Hermit's Peak-Calf Canyon (HPCC) post-wildfire efforts (Table 3.3). We examined the HPCC Fire because of its size, severity, jurisdictional complexity, unique cultural dynamics, and noteworthy political attention. While this was a large fire, local, state, and federal personnel working on response and recovery efforts are a small network of individuals. We excluded private landowner perspectives from our sampling because we chose to focus on the organizational leaders who could provide insight into governance approaches for post-wildfire program implementation. To some extent, challenges faced by private landowners were captured through the lens of our interviewees, but we recognize that to capture the perspectives of landowners and private citizens, additional research is needed.

Interviews lasted approximately 60 minutes and were conducted during the summer of 2023. Interviews captured the first year of response and recovery following the HPCC Fire. Post-fire recovery efforts for the HPCC will continue to be planned and implemented over the next decade. Initial interviewee outreach was purposive and informed by contacts at the state level in New Mexico; we then transitioned to snowball sampling where initial interviewees recommended other contacts that could provide unique perspectives. Interviewee affiliations are

listed in Table 3.3. We stopped collecting data after reaching saturation (i.e., we were not hearing new themes or new information on themes related to our research objectives).

This study is part of a larger research effort to investigate response and recovery policy and governance across the West. To date, our approach has been consistent across case studies, which have also included two 2020 fires in Colorado, the Cameron Peak and East Troublesome Fires. A comparative analysis of these events with HPCC is forthcoming. Interviews were conducted according to an approved human subject research protocol and were recorded, transcribed, and thematically analyzed. Quotations are provided sparingly herein and denoted with a unique number to maintain interviewee confidentiality. For the majority of this document, we summarize key findings from our data.

Table 3.3: Summary of Interviewee and Agency Information

Governance Level	Organization	Number of Interviewees
Local	Cities of Las Vegas and Santa Fe, and San Miguel County	4
State	DHSEM, EMNRD	6
Federal	FEMA, DOT, NRCS, USFS, Army Corps	8
Non-Governmental	WFLC, Universities, Consultants, Watershed Alliances	4

Findings

What were the major challenges that New Mexico faced during post-wildfire response and recovery?

Interviewees shared challenges with FEMA and the Public and Individual Assistant Programs, including limited access to temporary housing, low eligibility for Individual Assistance, problems with the reimbursement process and timelines, and lack of knowledge as to how to navigate the process. Details include the following:

- Due to policy guidelines, FEMA would not provide temporary housing units to individuals who did not previously have sewer, water, or electricity connections, despite many rural New Mexican communities using alternatives like outhouses, river water, and solar or hydroelectric power.
- Strict policy guidelines contributed to low Individual Assistance eligibility, and interviewees perceived additional disincentives to participate because of the funding available through the Assistance Act.

- FEMA Public Assistance programs are based on reimbursements to applicants (state and local governments); the agency does not guarantee which projects will receive funding and subsequent reimbursement, creating challenges for quick project implementation, given uncertainty about reimbursement.
- Post-wildfire knowledge varied among FEMA staff; interviewees thought staff in Region 6 (New Mexico, Texas, Oklahoma, Arkansas, and Louisiana) did not have institutional knowledge of post-wildfire contexts, especially compared to other regions (e.g., Region 9 and 10).

Most interviewees discussed challenges associated with the Stafford Act's policy guidelines, particularly the fact that disasters that result from wildfires, like subsequent floods, are not covered by initial disaster recommendations. The most common challenge mentioned was that cascading events (disasters that result from a post-wildfire environment) are not eligible for funding through the initial disaster declaration and must either go through a separate disaster declaration or be funded by the state. Many cascading events did not meet disaster thresholds, despite communities needing assistance.

Interviewees discussed challenges with the Hermit's Peak Assistance Act, including slow funding disbursement, an unfamiliar claim process and were not certain how it would be implemented effectively. Details include the following:

- Most interviewees said the disbursement of funding was slow because of the delayed establishment of the Claims Office and regulations.
- Interviewees said they already had familiarity with the Torts Claims process, the use of which could have reduced confusion across levels of governance and the public on how claims are processed.

- Most interviewees said they wanted the Hermit's Peak Assistance Act to provide funding that can be implemented across jurisdictional boundaries, but instead, it provided payouts for claim settlements.

Challenges with the Forest Service BAER program included a lack of external education on the program's scope, limiting assessment and treatment timelines, and restrictive authorities for cross-boundary assessments. Interviewees with the Forest Service said BAER implementation often requires educating the public and other coordinators that the program is for emergency response that, at best, can stabilize conditions until long-term projects can be implemented. BAER has short implementation timelines; assessments are conducted within two weeks and treatments must be implemented within one year of wildfire containment. Interviewees said BAER assessments can only be conducted on Forest Service land, even if the burn scar is on state or private land. Proposed treatments must help protect Forest Service assets, despite the need and opportunities to help protect downstream communities through work on National Forest lands. This is a challenge when communities are affected by post-wildfire flooding that originates on Forest Service land.

Challenges arose with the timing and applicability of Farm Service programs because they had not been utilized in a post-wildfire context. For instance:

- The Energy Minerals and Natural Resource Department (EMNRD) worked with the Farm Service to initiate the EFRP program for quick treatment implementation on private lands, but a lack of workforce capacity led to slow implementation as 700 applicants sought assistance.
- The Emergency Conservation Program (ECP) is a sister program to EFRP and is focused on restoring agricultural land. The Farm Service struggled to determine the distinction

between the two programs when landowners had previously forested land that was also used for agriculture.

Challenges with the Emergency Watershed Protection program included poor NRCS communication and coordination, use of aerial seeding and mulching, and vague program guidelines. Details include the following:

- Most interviewees at the state level shared that the NRCS demonstrated poor communication with landowners and other actors, including a lack of communication with landowners on a final treatment decision.
- Most interviewees found it difficult to coordinate with the NRCS, reporting that the agency routinely failed to share important information, such as program timelines and updates, during coordination meetings.
- Most interviewees at the state level criticized the NRCS' treatments (aerial seeding and mulching) because of the lack of effectiveness that has been shown in the literature.
- Some interviewees shared that the EWP program has been implemented on Forest Service land, but, according to these interviewees, the New Mexico NRCS was unwilling to investigate how to use existing authorities to allow this. Ultimately, the NRCS said this was due to a lack of clear policy around this use of the program and that they were waiting for formal policy guidelines.

State-level challenges include problematic state authorities and a lack of wildfire preparedness and institutional knowledge. State-level interviewees said the anti-donation clause in the New Mexico state constitution prohibits the use of state funding for projects on private property, further limiting the state's ability to conduct post-wildfire work. Interviewees said state agencies had vague authorities for post-wildfire response and recovery work. They added that it

took time to determine how they, as state agency employees, fit into broader efforts. Furthermore, most interviewees said New Mexico lacked institutional knowledge about post-wildfire response and recovery and did not have a structure set in place to fully operationalize federal assistance. This was further complicated by a lack of state and local workforce capacity that put pressure on employees, leading to information overload and burnout. Ultimately, there were few individuals who had post-wildfire practice at the local scale to cope with disasters of the magnitude of the HPCC Fire.

What factors allowed organizations and agencies to navigate response and recovery policies?

The Monsoon Taskforce and the Lines of Effort Framework were coordination and collaboration frameworks that helped establish a sense of familiarity among actors, create channels for communication, and reduce information overload (Box 3.2). The Monsoon Taskforce was created to provide a platform for daily updates where agencies could share progress on project planning, expected field conditions, and immediate emergency tasks. The Lines of Effort was an adaptation of the FEMA Interagency Recovery Coordination Framework; through this effort, actors organized according to the seven identified efforts (watershed mitigation, housing, community development, water quality, economic development, historic and cultural resources, and health and social services) to distribute resources efficiently and encourage collaboration among actors.

Box 3.2. Coordination and Collaboration in New Mexico

Monsoon Taskforce: During the first monsoon season, daily flooding occurred, affecting private landowners and local governments. EMNRD and FEMA organized the Monsoon Taskforce to provide a platform for daily updates where federal, state, and local actors could share progress on project planning, expected field conditions, and immediate emergency tasks. This helped New Mexico track progress and become more familiar with the varying federal entities. The Monsoon Taskforce was state-organized and formed to fill a coordination and communication void. The Monsoon Taskforce was only active during the monsoon months following the HPCC and is now replaced by the Lines of Effort Framework, which facilitates greater project collaboration, which was not an aspect of the Monsoon Taskforce.

Lines of Effort: The State of New Mexico created the Lines of Effort to align agencies with similar goals and formalize coordination. After the 2022 monsoon season, DHSEM used the Interagency Recovery Coordination (IRC) framework to develop the Lines of Effort. The IRC program was intended to connect state and federal partners with similar efforts, but interviewees said FEMA had difficulty navigating New Mexico's agencies. The Lines of Effort are made up of seven initiatives: watershed mitigation, housing, community development, water quality, economic development, historic and cultural resources, and health and social services. Each effort contains local, state, and federal entities that are working on those specific specializations. Each line of effort was further delineated into smaller task force groups that allow partners to work together on more granular issues. For example, within the watershed line of effort, there was a task force centered around acequia clean-ups. Overseeing all the Lines of Effort were DHSEM, FEMA, and the Governor of New Mexico. The Lines of Effort was intended to help reduce information overload across each effort and funnel resources to specific tasks.

Despite there being a lack of collaborative programs specific to post-wildfire, interviewees utilized existing authorities, such as Shared Stewardship, Good Neighbor Authority, and the Wyden Authority, to achieve cross-boundary results. Agencies like the Department of Transportation were able to secure Memoranda of Understanding and agreements that would allow them to work across jurisdictions. Interviewees with EMNRD said they utilized Shared Stewardship and the Wyden Authority to conduct cross-boundary projects with the Forest Service. The Forest Service said they used the Good Neighbor Authority to work with the state, indicating some inconsistency in people's understanding of the use of these different authorities.

Ultimately, EMNRD was able to use state dollars on Forest Service land, and in return, the Forest Service provided grant funding for EMNRD to implement treatments on private lands.

Waived EWP cost-share requirements and expedited BAER funding removed barriers for program usability on the HPCC Fire. The Bipartisan Infrastructure Law (BIL) was used to supplement the EWP 25% cost-share requirement (~$31.3 million). Interviewees said this exemption provided opportunities for the State because there was no financial commitment linked to being a sponsor. In addition, the Forest Service Washington Office approved the implementation of BAER treatments before the costs were determined, which allowed expedited project implementation.

Non-governmental organizations (NGOs) helped fill gaps, facilitate collaboration, and initiate recovery across federal, state, and local efforts. Examples include the following:

- The New Mexico Forest and Watershed Restoration Institute created the Hub Site for all agencies to input updates about their operations, so that community members did not have to search for information across agency sites.
- High Water Mark, an environmental consulting firm, acted as a navigator for New Mexico by sharing knowledge and expertise on federal assistance programs that interviewees perceived to provide value at the local and state levels.
- The Hermit's Peak Watershed Alliance is a local watershed group in Northern New Mexico that leveraged existing grants to help implement quick, small-scale watershed and slope stabilization projects. Interviewees said the Watershed Alliance acted as an alternative to other federal programs on private land.
- NGOs were not considered authorized post-wildfire actors by agencies like FEMA and were therefore limited on how they could engage in post-wildfire efforts.

What were the recommendations to inform future policy changes to facilitate more effective post-wildfire response?

Interviewees commonly recommended an increase in workforce capacity for post-wildfire efforts. Details included:

- Increase workforce capacity, specifically at the state and local level, to better manage contract procurements, land assessments, project implementation, and community engagement. While redundancy in roles and authorities across different positions may also reduce burnout, dedicated post-fire staff can help ensure pre-existing (non-post-wildfire) state and local initiatives continue to be implemented.
- Most interviewees recommended that FEMA be more purposeful with the personnel they resource order and recommended FEMA only bring individuals who provide clear value and can push post-fire efforts forward.
- Some interviewees mentioned that USFS Tiger Teams and the USACE helped increase workforce capacity but should not be relied on because these resources may not always be available for longer-term project implementation.
- Some interviewees said rural communities have relevant skills and equipment that could be leveraged to expand capacities by conducting work on their lands, rather than using contractors.

People at all levels of governance need greater education on post-wildfire response and recovery programs and ecological considerations. Interviewees shared that some federal agencies did not know how their programs could be used in a post-fire context. Interviewees explained that most personnel who were ordered to assist with response and recovery efforts did not bring new information to the table, and, when they did, it was not relevant given New Mexico's

available capacity and funding. Education should center around disaster readiness and how geographic variation can influence post-wildfire needs.

Develop and implement a navigator concept (i.e., a post-wildfire caseworker) to connect individuals and agencies with expert post-wildfire knowledge as they traverse response and recovery programs and policies. Various iterations of this concept emerged during data collection, but the core idea is to embed experts within a community to help individuals or governments identify the best programs based on personalized contexts. Interviewees pointed out that New Mexico already has a caseworker framework that could be used to legitimize this role. Navigators will need to be authorized actors within the post-wildfire space or else they will not be able to fully engage with some federal agencies. This was a challenge for High Water Mark, as they were never acknowledged by FEMA as an authorized actor in the post-wildfire space.

Create funding that can be implemented across boundaries and allow for a holistic post-wildfire approach. Interviewees recommended creating a funding source that can be utilized across multiple jurisdictional boundaries, which could either be a new funding source or an amendment to existing programs like the EWP, EFRP, or BAR. Interviewees also wanted authorities to allow BAER teams to analyze the entirety of the burn scar rather than just on federal land. Others recommended changes to the Stafford Act that would link post-fire flooding and debris flows to the wildfire disaster declaration or expand the disaster window.

Develop an incident command structure similar to wildfire management to work across multiple jurisdictions and connect funding sources. Those in favor of an incident command structure liked the idea of a unified control approach that would require greater coordination across programs and an increase in capacity and knowledge. However, others thought an incident command structure would not be suitable in post-fire environments because of the long-term

realities of post-fire needs and the fact that no real delegation of authority could be provided for private lands. Unified control could be facilitated through collaborative frameworks like the Lines of Effort or could fall under the navigator concept.

Conclusion

We found varying challenges with post-wildfire programs that result from scale mismatches and limiting policy guidelines. Post-wildfire effects are experienced across multiple jurisdictional boundaries, occur at different times, and may not follow similar patterns across disasters. Moreover, the programs available are siloed and do not have mechanisms that allow for or encourage collaboration across boundaries. Each post-wildfire program follows a short operational timeframe that provides minimal consideration for the extended nature of post-wildfire needs. Furthermore, policy guidelines are rigid and not consistently implemented across regions of the West. Programs have limited flexibility to tailor approaches to local contexts. This is exacerbated by limited institutional knowledge of post-wildfire programs, policy, and ecology.

Throughout our research, interviewees shared the following recommendations:

- Increase workforce capacity, specifically at the state and local level, to better manage contract procurements, land assessments, project implementation, and community engagement.
- Improve/create federal and state education on programs and ecological considerations around post-wildfire response and recovery.
- Develop and implement a navigator concept (i.e., a post-wildfire caseworker) to connect individuals and agencies with expert post-wildfire knowledge as they traverse response and recovery programs and policies.

- Create funding that can be implemented across boundaries and allow for a holistic post-wildfire approach.

Based on our broader research, we add the following policy recommendations to consider:

- Policymakers should address at the federal level inconsistency with EWP program implementation on National Forests so that cross-boundary opportunities are not missed.
- States should invest in greater post-wildfire planning and preparation to create more opportunities and to be aware of existing capacities. This could include communication with non-governmental or local government organizations to determine and train them in how they could assist in recovery, relieve state responsibilities, and increase community robustness and trust.
- The USDA should continue to consider how existing collaborative authorities, like the Collaborative Forest Landscape Restoration Program or the Joint Chiefs Landscape Restoration Partnership, can be leveraged in post-wildfire contexts.
- Federal support should be purposeful and not overextend state employees who regularly fulfill multiple responsibilities.
- The federal government should put funding towards “all lands” soil burn severity and analysis reports with requirements for long-term monitoring and report updating; ensure that they are delivered in a useful timeframe.
- Soil burn assessments should be conducted by inter-agency teams with members of local state offices to ensure usable recovery recommendations and improve accountability among stakeholders.
- Provide funding to local entities to support landowner education and proactive values at risk discussions before post-wildfire impacts.

Our research captures the first year of response and recovery following the Hermit's Peak-Calf Canyon Fire. Although our work can serve as a baseline to track and inform initial efforts, it will be important to study how long-term efforts are implemented. We hope this work provides value for other communities by highlighting the importance of pre-post-wildfire planning and investments in capacity. We did not capture private landowner perspectives on post-wildfire governance but interviewees said communities valued controversial practices like aerial seeding because it visually represented recovery. These dynamics should be further researched to determine the psychological impacts of response and recovery actions. Future research should consider how state capacities are leveraged during response and recovery and how learning from past events might position communities for greater success during the next event. And finally, research should determine if subsequent state disasters soften rigid policy and fill gaps in governance. Ultimately, any post-wildfire community of practice will need to ensure that they have a vision for post-wildfire policy "success" and are not addressing challenges with a piecemeal approach. State-level interviewees were wary of additional federal support because of the increased workload it may entail. Federal support and policy recommendations must be purposeful and create opportunities for successful recovery.

CHAPTER 4 – GOVERNING ACROSS JURISDICTIONS IN POST-WILDFIRE RESPONSE AND RECOVERY: AN ANALYSIS OF THE HERMIT'S PEAK-CALF CANYON WILDFIRE

Summary

Post-fire response and recovery is an increasingly important topic in the wake of more catastrophic, extensive, and frequent fires in the US West. Using concepts from the adaptive governance literature, we investigated the following questions: 1) What roles do land managers and agencies play during post-wildfire response and recovery efforts? And, 2) What are the policy and governance facilitators, challenges, and recommendations for improving post-wildfire response and recovery? We spoke with 22 individuals who had intimate knowledge of and held leadership roles in the response and recovery efforts to the 2022 Hermit's Peak Calf Canyon Fire in New Mexico. We found that challenges included inflexible policies, limited capacity and knowledge of post-fire contexts, limited incentives to work across boundaries, and an inability to adapt federal approaches to local contexts. Facilitating factors, as the literature would predict included local champions, the formation and use of boundary organizations, use of existing collaborative authorities, and federal funding support for post-fire response efforts. Recommendations were to expand workforce capacity, provide more education on post-wildfire programs and ecology, pursue legislative changes, and develop navigator positions. We conclude the paper by exploring these suggestions in detail and considering whether they align with governance institutions that are known to support greater adaptiveness.

Introduction

Post-fire response and recovery is an increasingly important topic, given more severe, extensive, and frequent fires in the U.S. West. The Joint Economic Committee found that the total economic burden of wildfires in the United States amounts to $394-$893 billion annually

(JEC 2023). A lack of adequate local and state resources is a common situation that has led to increased attention toward post-wildfire governance approaches in the U.S. West, raising debate on how governments and communities respond to incidents in an era of large and often catastrophic wildfires (Cheng et al. 2015; Haffey 2023; WFMMC 2023).

Although governance in pre-wildfire and incident response has been widely researched within the scientific literature (Rutherford and Schultz 2019; Davis et al. 2021), there has been minimal investigation into the governance approaches for post-wildfire response and recovery. This paper seeks to address this gap. We asked the following research questions:

1. What roles do land managers and agencies play during post-wildfire response and recovery efforts?
2. What are the policy and governance facilitators, challenges, and recommendations for improving post-wildfire response and recovery?

Literature Review

Fires affect ecosystems and people across jurisdictional boundaries, at different temporal scales, and at geographic scales too large for any one actor to manage. After a wildfire, short-term challenges like hydrophobic soils and vegetation loss create optimal conditions for sediment movement and flooding (Wine et al. 2018). This can result in water quality impairment and recurrent damage to critical infrastructure, like water facilities, roads, and bridges. Watershed conditions remain dynamic for upward of a decade. In addition, climate change-related conditions, like hot droughts and severe rainfall, when they occur in tandem with fires, result in major hydrological changes, landscape-scale ecosystem changes, and shifts in species compositions (Millar & Stephenson 2015). Wildfires act as a catalyst for forest ecosystem

change, and climate change is limiting regeneration and making it less likely forests will recover to pre-wildfire conditions (Stevens-Ruman and Morgan 2019).

In addition to ecological effects, wildfires cause economic challenges that can persist for more than a decade after the initial event (Hjerpe et al. 2023). California alone reported billions of dollars in structural loss from wildfires in 2017 and 2018 (Buechi et al. 2021). Headwaters Economics (2018) found that nearly half of the total costs of wildfire recovery are paid at the local level, by homeowners, businesses, and state and local government agencies. Post-fire flooding and debris flows damage critical infrastructure (Jones et al. 2022; Hjerpe et al. 2023). Wildfires also affect livelihoods and local economies when tourism, industry (e.g., timber harvesting), and ecosystem services are negatively impacted (Vukomanovic and Steelman 2019; Otrachshenko and Nunes 2022; Thomas et al. 2017).

Local and state entities must respond to ecological and economic challenges after a wildfire and often do not have the resources to address either short- or long-term recovery needs. Furthermore, local and state governments often do not conduct contingency plans for disasters at the scale of today's large fires (i.e., 100,000+ acres). Once state resources are depleted, federal response and recovery policies become available after a formal disaster declaration (see *Policy Overview* below). This process, when initiated, triggers a menu of programs designed to help communities recover (McCarthy 2010). It is, however, the responsibility of the state to have systems for funding distribution and provide local, contextual information (e.g., community characteristics or needs) to federal entities.

Policy Overview

Federal post-wildfire response and recovery policies are administered by four core agencies: the US Forest Service (USFS), the Natural Resource Conservation Service (NRCS),

and the Farm Service Agency (FSA), all with the Department of Agriculture, and the Federal Emergency Management Agency (FEMA), housed within the U.S. Department of Homeland Security. Each program typically is managed independently of others within the post-wildfire space.

The USFS administers the Burned Area Emergency Response (BAER) program to conduct and implement emergency soil stabilization actions and burn severity assessments. The BAER program aims to: "Identify imminent post-wildfire threats to human life and safety, [Forest] property, and critical natural or cultural resources on National Forest System lands and take immediate actions, as appropriate, to manage unacceptable risks." (FSM 25232.02). Fires over 500 acres or that have significant effects on Forest Service assets are eligible for BAER funding and program implementation. Funding is provided through annual appropriations to the Wildfire Management Fund, and annual amounts have averaged $10 million over five years (2019-2024); supplemental funds are often allocated (USDA 2019, 2020, 2021, 2023). The BAER program operates quickly, with initial funding requests from the Forest Supervisor to the Regional Forester within 7 days after containment and approved actions implemented within one year of containment or before the first damaging storm (FSM 2521.04(b) and 2523.03). Emergency treatments must protect human life and safety, property, and critical natural or cultural resources on National Forest System (NFS) lands and cannot be used on burned areas outside of NFS boundaries unless there is a direct benefit to the National Forest. Under the Wyden Watershed Restoration and Enhancement Agreement authority (105 P.L. 277, 112 Stat. 2681), BAER funding may be used to accomplish work on non-NFS lands if the work is essential to protect NFS lands, NFS roads, or the safety of NFS visitors. The BAER soil burn severity assessments are released publicly and offer information regarding watershed and slope

stability that may affect post-wildfire conditions. In short, BAER funding is for short-term assessment and stabilization actions on NFS lands for the purpose of managing immediate threats to values, people, or property on NFS lands.

Longer-term funding for Department of Interior (DOI) and Forest Service land is provided through the Burned Area Recovery (BAR) program, which allows post-wildfire infrastructure repair and restoration work to be conducted within three years of wildfire containment. Regulations vary slightly across each agency. BAR objectives are to "evaluate actual and potential long-term post-fire impacts to critical cultural and natural resources and identify those areas unlikely to recover naturally from severe wildfire damage" (620 DM3 3.2). BAR funding is allocated competitively through an internal application process and intended for non-emergency activities including minor infrastructure repair, tree planting, tree seeding, and invasive species removal (620 DM3 3.2). Treatments are funded in one-year increments and are reviewed annually for effectiveness (620 DM3 3.7). The BAR program has not received substantial funding historically (approximately $20 million across all DOI agencies and Forest Service annually), but a recent appropriation through the Infrastructure Investment Jobs Act (IIJA; 117 P.L. 58) provided a supplemental $360 million per year until 2027. In short, BAR funding is for longer-term recovery projects on federal lands.

The NRCS implements the Emergency Watershed Protection (EWP) program on private lands that require watershed stabilization work. The aim of EWP is, "to assist sponsors, landowners, and operators in implementing emergency recovery measures for runoff retardation and erosion prevention to relieve imminent hazards to life and property created by a natural disaster that causes a sudden impairment of a watershed" (7 CFR § 624.2). Sponsors must submit a formal request to the State Conservationist within 60 days of wildfire containment to be awarded funding. Sponsors can be a State or county, qualified Tribe or Tribal organization, or

unit of local government, and must be willing to provide 25% of the project cost. Cost-share can be paid in cash, through in-kind services (i.e., labor, equipment, design, surveys, contract administration, etc.), or a combination of cash and in-kind services (7 CFR § 624.6). Funding for EWP is provided through NRCS annual appropriations and totals approximately $50 million yearly, with additional IIJA supplemental funding for $300 million per year until 2027. Project funding must be spent on implementation within 220 calendar days after the date funds are committed to the NRCS State Conservationist (7 CFR § 624.9). The Forest Service is also authorized to implement EWP projects and funds on NFS lands to meet EWP goals, but cannot do so to replace existing programs (7 CFR § 624.1). Eligible practices include protection from flooding or soil erosion, reducing threats to life or property caused by watershed impairment, and restoring hydraulic capacity to the environment (7 CFR § 624.6(c)). EWP funds cannot be used on maintenance, public infrastructure, or in cases where a similar natural event occurred within 10 years. In short, EWP funding is meant to be used for watershed stabilization post-fire to protect life and property on non-federal lands.

Another program available to private landowners is the FSA's Emergency Forest Restoration Program (EFRP). The objective of EFRP is to "make financial assistance available to eligible participants on eligible land for certain practices to restore nonindustrial private forest land that has been damaged by a natural disaster" (7 CRF §701.203(b)). To be eligible to participate in EFRP, a person, legal entity, or Tribe must be an owner of nonindustrial private forest land affected by a natural disaster. Federal agencies, States, and counties are not eligible for EFRP funding. Duplication of funds is not permitted through EFRP, and receiving funding from other programs (e.g., EWP) triggers ineligibility (7 CRF §702.211). Actions for EFRP must restore forest health and forest-related resources and represent the minimum level of

performance needed to restore the land to State and Federal Forestry standards (7 CRF §701.212(b)). Individuals can receive 75% of the project cost, but that amount is limited to a maximum of $500,000. In short, EFRP is to restore private, non-industrial forest lands damaged during a fire.

FEMA administers a variety of programs that aid individuals and governments during response and recovery phases that are all governed through provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act; 42 USCS § 5121). The intent of the Stafford Act is to: "provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from such disasters" (117 P.L. 328 §101(b)). Federal assistance is triggered when the Governor of the affected state declares a disaster and has already taken appropriate response actions under state law (117 P.L. 328 §401(a)). The state must be able and committed to distributing funding to alleviate the effects of the disaster, and comply with all cost-share requirements. Some states facilitate funding distribution through the Army Corps of Engineers Silver Jacket team, the FEMA Interagency Recovery Coordination Framework, the FEMA National Response Framework, or through state-specific coordination processes. Once Presidential approval is given for disaster relief, FEMA will begin conducting damage assessments across public and private property to determine the total funding awarded. On private land, the maximum funding available for a single parcel is $37,900 (117 P.L. 328 §408); this is known as "Individual Assistance" (IA). State and local government assistance, known as "Public Assistance" (PA), is based on a percentage of total damages incurred. Not all disaster declarations cover both private and public damage; for instance, a federal disaster declaration might only cover damage to roads, but not necessarily private property. Cascading disasters that

are a result of an initial disaster (e.g., debris flows and flooding) are not eligible for disaster funding through the Stafford Act and must go through a separate declaration process to receive funding. The prominent FEMA programs governed through the Stafford Act are the IA, PA, and Fire Management Assistance Grants (FMAG) programs (see Table 4.1). IA and PA rebuild infrastructure to the preexisting specifications, while FMAG programs rebuild infrastructure to adapt to current and expected environmental conditions.

In summary, there are a variety of federal post-fire policies. Each is subject to different jurisdictional limitations, implementation timeframes, and allowable treatments (Table 4.1). Annual appropriations for these programs often must be augmented by supplemental appropriations after fires occur.

Table 4.1: Summary of FEMA post-wildfire programs, jurisdictional limitations, implementation timeframes, and allowable treatments.

Program/ Policy	Jurisdictional Focus	Funding Mechanism	Operational Timeframes	Role in Post-fire Response and Recovery Process
Public Assistance (PA) program (Section 402)	Public land (state, county, or municipality)	Annual appropriations from Congress to the Disaster Relief Fund (DRF).	Must be submitted within one year of closing the incident period. A "lock-in" letter is provided with the total amount of funding assistance provided.	Emergency work: debris removal and emergency protective measures. Permanent work: infrastructure repair to roads, bridges, water facilities, public buildings, and utilities.
Individual Assistance (IA) program (Section 402)	Private land	Annual appropriations from Congress for Disaster Relief Fund (DRF), emergency appropriations.	Must be submitted within one year of closing the incident period. A "lock-in" letter is provided with the total amount of funding assistance provided.	Individual Assistance: housing assistance, social programs, crisis counseling, etc.
Hazard Mitigation Grant Program (HMGP) - Program available in the Fire Management Assistance Grants (FMAG)	Public land (state, county, or municipality)	Funding for HMGP is based on a percentage of PA & IA funding.	Within six months of the end of the fiscal year in which FMAG funding was awarded.	Actions to prevent long-term damage to life and property from natural hazards, e.g., soil stabilization, flood diversion, and reforestation.
Hermit's Peak Assistance Act	Private land, businesses, governments, NGOs, and Tribal trust land	Congressional appropriations	Once a claim is submitted there is a 150-day timeline for required documents to be submitted, and a 180-day timeline for compensation determination.	Resolving damage claims for burdens placed upon claimants by the Hermit's Peak-Calf Canyon Fire.
The Robert T. Stafford Disaster Relief Act (Stafford Act)	All non-federal lands.	Annual appropriations from Congress for Disaster Relief Fund (DRF),	N/A	Governing policy for every FEMA program.

emergency appropriations.

Implementation and Policy Challenges

Given the ecological and economic challenges of responding to and recovering from wildfire, government entities and working groups have assessed challenges across federal post-wildfire response and recovery programs (BAER, EWP, and FEMA programs). The Government Accountability Office (GAO) assessed all 421 of the wildfires that received BAER soil stabilization treatments between 2000-2001 and determined there was no indication that they were effective (GAO 2003). More recent work discovered that BAER increased the risk of future wildfire by introducing invasive species and mulch (Coppoletta et al. 2016; Evans 2017) and that treatments like salvage harvesting cause an increased flooding risk (Wagenbrenner et al. 2015). Despite these findings, BAER treatments are still utilized in post-wildfire landscapes. The GAO found that the EWP program generally fails to provide a straightforward and streamlined process for project sponsors while trying to obtain timely funding (GAO 2021). Sponsors and stakeholders acknowledged the value of EWP but discussed the need for additional clarity in program guidance (GAO 2021). A working group organized in 2015 identified that bureaucratic hold-ups typically delay the arrival of funding (Cheng et al. 2015). Funds must be approved by the NRCS State Office and, if funds are available, may be allocated within 5-10 days. If funds are not available, the project is placed on a non-exigent waitlist, while Congress considers whether to make available supplemental appropriations (GAO 2021). This process can take months to complete and, even when approved, funds tend to sit in the Office of Management and Budget for three to five months (Cheng et al. 2015). FEMA programs have been criticized as well, and navigating the requirements of these programs is difficult even for large, disaster-ready

communities (Cheng et al. 2015). The GAO showed that a majority of post-wildfire disaster relief funds go towards short-term response efforts (e.g., saving lives, protecting property and environment, and providing basic human needs) and not long-term post-wildfire rehabilitation and recovery (GAO 2020). In addition, FEMA staff turnover presents challenges for municipalities and other entities that utilize these programs, because they are constantly reestablishing contacts and relationships (Cheng et al. 2015). The BAR and EFRP programs have not been investigated by the GAO or Congressional Research Service.

State-level challenges have not been studied widely, but research led by the Southwest Ecological Restoration Institutes on collaborative readiness indicates a lack of disaster readiness in the ability to collaborate across boundaries and facilitate funding distribution, which can result in delayed post-wildfire response and recovery (Huayhuaca et al. 2023). This was apparent after large wildfires in Colorado, where local officials scrambled to understand what agencies to collaborate with and did not know how to navigate the resources available to them after an incident (Cheng et al. 2015).

In response to program and policy challenges the Wildland Fire Management and Mitigation Commission (the Commission) provided numerous recommendations to Congress that would provide more opportunities for wildfire managers. In summary, the Commission recommended increased interagency collaboration and coordination, addressing bureaucratic and legislative challenges, providing for greater program flexibility, and increasing capacities at all levels and scales. To date, three bills have been proposed for congressional action (H.R.6435; H.R.1450; H.R.7070) that tackle these topics to some extent, but none have passed.

Conceptual Framework

Post-fire response and recovery present challenges that require adaptive governance, that is environmental governance that "allows emergence of collective action capable of facilitating adaptation to change and surprise as well as the capacity to itself evolve." (Cosens et al. 2018, p.3). Adaptive governance is a framework and area of scholarship exploring how to effectively coordinate resource management regimes in the face of complex and uncertain environmental challenges (Chaffin et al. 2014; Schultz et al. 2019b). The adaptive governance literature is expansive, but a primary focus is on addressing scale-fit mismatches by allowing objectives to be tailored to local contexts, promoting flexible problem-solving, and fostering collective learning (Schultz et al. 2019; Crona and Parker 2012).

Scale-fit describes the mismatches between the scale of ecological characteristics (e.g., processes like fire or flooding or characteristics like species composition and distribution) and the often-mismatched fit of governance institutions. The post-fire governance landscape presents a series of scale mismatches, where assistance programs do not match the temporal and geographic scales of the issues to be addressed (See Table 4.4; Cash et al. 2006; Schultz et al. 2019b). An example would be a program to address flooding, which occurs across multiple jurisdictions, but with funding that can only be used on a single type of jurisdiction. Temporal scale refers to processes that occur and repeat over different lengths of time (e.g., funding timelines versus forest disturbance and recovery processes), and geographic scale refers to the different levels as units of analysis or position within a scale (e.g., burn scar, landscape, and regions) (Gibson et al. 2000; Schultz et al. 2019b). Of relevance to the issue of scale-fit, are the scales at which governance institutions and organizations exist, whether these are jurisdictional boundaries, allowable actions under a particular policy, or an agency's practice or history that

defines what actions are undertaken (Schultz et al. 2019b). Scale mismatch is a persistent challenge across all environmental governance and is not exclusive to post-wildfire governance. Nonetheless, a challenge to consider is whether post-wildfire programs are adaptable across the scales needed to address post-fire needs (Table 4.1).

Policies that can be tailored to local contexts can help communities with diverse characteristics work within the same policies to achieve restoration outcomes. Theory suggests this can be achieved by setting standards through policy rather than creating rigid policy guidelines (DeCaro et al. 2017). For example, instead of basing project implementation on specific guidelines like community eligibility requirements, managers can base efforts on desired post-wildfire recovery outcomes (Craig et al. 2017). This helps guide flexible decision-making without specific requirements or solutions that may become outdated or too rigid when socio-ecological conditions change (DeCaro et al. 2017). In addition, flexible decision-making approaches can support and influence project prioritization, allow for flexibility in terms of which stakeholders or partners to engage with, and allow for a mix of implementation actions needed to achieve objectives. Collective learning is an important factor that supports adaptive governance and is the process of adjusting approaches over time and using lessons to address challenges in policy and governance (Crona and Parker 2012; Geralk et al. 2018; Schultz et al. 2019b). One method to support collective learning is pre-determined sunsets for comprehensive evaluation of policies, programs, and projects to provide opportunities for agencies to test alternative methods and update approaches accordingly (DeCaro et al. 2017; Craig and Ruhl 2014). Crow et al. (2018) found that more substantive learning occurs in communities with lower levels of local capacity and that sustain a higher level of damage because they do not have the luxury to not learn and adapt to disasters.

Boundary organizations, or groups that span across different levels of governance, have been linked as important facilitators of adaptive governance because of their ability to bridge scale-fit mismatches, identify local needs, and facilitate collective learning (Crona and Parker 2012; Davis et al. 2021). Guston (1999) defines boundary organizations as those that provide opportunities and incentives for the use of boundary objects (i.e., something that actors across boundaries interact with), engage actors, and are accountable to each side of the boundary. Within adaptive governance systems, the role of boundary organizations varies, but they generally establish relationships that help reinforce boundaries while maintaining common interests (Davis et al. 2021). For instance, a place-based collaborative can be a boundary organization and facilitate shared restoration outcomes across multiple actors and jurisdictions. In post-fire contexts, boundary organizations can help facilitate the adaptation of federal policies and procedures to local contexts, support coordination and data sharing, and engage collaborators outside of the affected areas (Moloney et al. 2023). In a policy context, they can also provide technical assistance to agencies and communities, as well as provide funding for project sponsorship (Carney et al. 2024).

Literature on adaptive governance has been applied to other aspects of disaster management (Hulbert 2018) but has not been explored within post-wildfire response and recovery contexts. Current post-wildfire response and recovery policies create emergent challenges to an adaptive governance approach, due to extensive, rigid policy guidelines and jurisdictional limitations (Table 4.1). We used adaptive governance as a sensitizing concept (see Chaffin et al. 2014) to consider challenges and facilitators in post-wildfire governance and the role boundary organizations are playing to help facilitate effective response outcomes. Aligning our findings to adaptive governance literature ideally adds to our investigation and analysis and

provides a perspective of natural resource management missing from the literature. Additionally, as national conversations about post-wildfire reform continue, adaptive governance may serve as a model for legislative changes (WFMMC 2023).

Methods

We aimed to investigate challenges to post-wildfire policies and programs, governance approaches, and potential recommendations to policy across the West. Our specific research questions were: 1) What roles do land managers and agencies play during post-wildfire response and recovery efforts? And 2) What are the policy and governance facilitators, challenges, and recommendations for improving post-wildfire response and recovery? To answer our research objectives, we utilized an exploratory case study approach that allows for contrasting separate settings and circumstances that make relevant insights more apparent (Stake 1995; Yin 2003).

For this paper, we examined the Hermit's Peak-Calf Canyon (HPCC) Fire because of its size, severity, jurisdictional complexity, unique cultural dynamics, and noteworthy political attention that are not common across the West. In 2022, The HPCC fire burned more than 340,000 acres in northern New Mexico (InciWeb 2022). The HPCC started as two separate fires, both of which started on the Santa Fe National Forest: the Hermit’s Peak fire started from the escaped Las Dispensas prescribed fire and the Calf Canyon fire started from a dormant pile burn that was conducted in January 2022. The two fires merged and resulted in the largest wildfire in New Mexico state history, burning approximately 200,000 acres of private lands (58%), 141,000 acres of federal lands (41%), and 745 acres of state land (.02%) (NMFWRI 2022). Over 150 homes and 900 structures (barns, sheds, etc.) were lost to the fire (NMFRI 2022). Communities had to respond to the damage and changing post-wildfire conditions after the trauma of a wildfire

but had limited post-fire knowledge and resources to address short- and long-term recovery challenges.

However, New Mexico has already experienced catastrophic fires because of federally led prescribed fire. The Cerro Grande Fire of 2000 also started from a prescribed burn in Bandelier National Monument and moved into Los Alamos, Santa Clara Pueblo, and San Ildefonso Pueblo, destroying over 280 homes and 40 laboratory buildings (Gabbert 2010). Recovery cost exceeded $1 billion and was prolonged for over a decade after the initial event (Gabbert 2010). Shortly thereafter in 2011, the Las Conchas Fire, which also started in Bandelier National Monument, affected more rural and Indigenous communities but received less federal attention.

To further challenge post-wildfire response and recovery, New Mexico communities have a history of distrust toward the federal government. The Treaty of Guadalupe Hidalgo, which ended the war between the United States and Mexico, was intended to recognize the existing property rights of the Hispanic landowners (Dunbar-Ortiz 2014). However, during the land grant adjudication processes community land from these grants was declared public domain, eventually becoming part of the San Juan, Rio Grande, Carson, and Santa Fe National Forests (USFS, 2020). The descendants of the original rightsholders still live in the surrounding area and claim rights to the land that once belonged to their ancestors (Jaramillo 2020). In addition, within New Mexico's boundaries are the Jicarilla Apache Nation and 19 Pueblos and their trust lands, and the unceded ancestral lands, much of which is now considered US public land, of these and other Tribes. Centuries of broken treaties and agreements have contributed to federal distrust in many New Mexican communities, and past federally caused fires contribute to the difficulty in rectifying the harm caused by the HPCC fire.

While this was a large fire, local, state, and federal personnel working on response and recovery efforts involved a small network of individuals. Our focus was on governance approaches for post-wildfire program implementation, rather than individual landowner challenges. Challenges faced by private landowners were captured through the perspectives of our interviewees, but we leave it to a subsequent project to interview individual landowners about their experiences.

In the summer of 2023, one year after the fire, we conducted 22 semi-structured interviews, each lasted approximately 60 minutes. We utilized purposive and snowball sampling to recruit study participants. Interviewees held positions across local, state, federal, and non-governmental organizations and had intimate knowledge of the HPCC's post-wildfire efforts (Table 4.2). Initial interviewee outreach utilized purposive sampling and was informed by our contacts working within the post-wildfire space in Northern New Mexico; we then transitioned into snowball sampling where interviewees recommended other contacts that could provide unique and relevant perspectives (Bernard 2017). Interviewee questions focused on: 1) approach to post-wildfire response and recovery and how initial efforts were organized, 2) which policies and programs were utilized for their specific recovery efforts, 3) challenges that arose during response and recovery planning and implementation, 4) insights regarding the timing, amount, and use of funding provided, 5) unique arrangements that created opportunities for post-wildfire coordination and implementation, and 6) governance and policy recommendations for future post-wildfire efforts. We used the adaptive governance literature to design our interview guide so that it would reveal scale-related challenges associated with policy, roles of boundary organizations, and roles of actors and institutions in shaping practice. Interviews were conducted according to an approved human subject research protocol at our institution.

Table 4.2: Summary of Interviewee and Agency Information

Governance Level	Organization	Number of Interviewees
Local	City of Las Vegas and Santa Fe, and San Miguel County	4
State	New Mexico Department of Homeland Security and Emergency Management (DHSEM), Energy, Minerals, and Natural Resource Department EMNRD	7
Federal	FEMA, Department of Transportation (DOT), NRCS, USFS, Army Corps	8
Non-Governmental	Wildland Fire Leadership Council, Universities, Consultants, Watershed Alliances	4

We reached data saturation when the same themes were being recorded, without new themes arising (Glaser 2001). While this was a smaller dataset, the number of individuals with high-level perspectives on post-wildfire governance on the HPCC was limited. In addition, qualitative researchers are determining that saturation can be achieved after 9-12 interviews (Fusch and Ness 2015; Guest et al. 2006). Interviews were recorded, transcribed, and then thematically coded using Dedoose qualitative analysis software. Thematic analysis is a common qualitative method that allows us to look for expected and unexpected themes (Saldana 2015). We developed codes based on emergent themes from the data, which were related to our questions. Codes were developed by the lead author and tested through an intercoder reliability process to ensure consistent application across each interview (Bazeley 2017). Excerpts by code were then aggregated and summarized in analytical memos. To preserve an emergent coding process, we did not assign theoretical constructs to our data (e.g., scale mismatch or boundary organization) unless interviewees themselves used these terms. Instead, we analyzed the data based on our questions and then connected our findings back to adaptive governance concepts– something we return to in the discussion section below. This data was also used to develop a

practitioner-oriented report and was reviewed by our interviewees to make sure their insights had been reported accurately (see Carney et al. 2024). Selected quotes are provided from our data below, with a unique number and a general role assigned to each quote to add context while also preserving confidentiality.

Results

What roles did land managers and agencies play during post-wildfire response and recovery efforts?

Across each level of governance, most interviewees shared that HPCC was their first experience with post-wildfire response and recovery and lacked knowledge of the process. Interviewees said the first step to post-wildfire response and recovery was determining where to start and often modeling efforts after other communities that have experienced similar post-wildfire effects or connecting with subject experts. Few of the federally deployed personnel were post-wildfire experts and lacked the knowledge to navigate program guidelines in light of local contexts. One interviewee said, *"It kind of gave me impostor syndrome for a while. And it still kind of does. But then I showed up [to a workshop], and I realized, nobody knows what they're talking about. I know more than all of these people [do]. And that's a little unsettling"* (#4, state employee). Many of the local and state-level interviewees were not familiar with post-wildfire programs and did not understand the bureaucracy around federal agencies, specifically citing FEMA as a primary example.

At the local level, officials were primarily concerned with post-wildfire effects on critical watersheds and transportation infrastructure. For example, the City of Las Vegas relied on the Gallinas Watershed for water security; once monsoonal rains started, their reservoirs filled with contaminants that the filtration system was not designed to handle. Local efforts centered around

trucking water in and designing a system that could make the water filtration system operational again. Monsoonal rains also caused debris flows that destroyed roads, bridges, and drainages. New Mexico appropriated $50 million in state funds for affected counties to work with the Department of Transportation to restore critical infrastructure. Interviewees said these were immediate emergency actions and did not account for the long-term effects and associated projects that needed to be implemented.

State-level agencies tried to leverage any federal programs relevant to post-wildfire response and recovery. The New Mexico Energy, Minerals, and Natural Resources Department (EMNRD) focused on forest and watershed work, such as hazard tree removal, slope stabilization, and forest restoration on private lands. These efforts were funded through Farm Service EFRP. The New Mexico Department of Homeland Security and Emergency Management (DHSEM) focused on individual assistance under Stafford Act programs and supporting municipalities and counties by leveraging programs offered by FEMA, Housing and Urban Development (HUD), and the Economic Development Administration (EDA). One state-level interviewee said, *"We've been pulling from all resources, including state and federal partners, nonprofits, just anybody and everybody that we can bring to the table and help coordinate"* (#20, state employee).

State agencies also lobbied for waivers to federal program policies when mismatches occurred between community characteristics and federal eligibility requirements. For instance, The New Mexico DHSEM advocated for waivers that would provide more temporary housing units (i.e., trailers) and additional IA funding. Challenges persisted with temporary housing eligibility requirements, but FEMA did expand IA funding from $37,900 to approximately $45,000 per household.

Federal agencies had varying focuses across response and recovery efforts. Interviewees said they tended to play a supporting role for the state. Interviewees with the Forest Service said they implemented BAER in three phases; the first phase was before full wildfire containment so that soil burn assessments could be shared quickly. Assessments are not typically conducted outside of Forest Service land. However, interviewees said because the fire was caused by the federal government, which faced increased political pressures as a result, the Forest Service was able to include private and state land within the BAER report with the use of county data. Most interviewees shared that BAER reports were vital to their planning and provided them with important information and insights into where flooding was likely to occur.

Interviewees with the NRCS said they implemented the EWP program across 70 sites, with 30,000 acres of aerial seeding and 25,000 acres of aerial mulching. Initial appropriations totaled $125 million, but local NRCS offices received additional funds to continue treatments, based on the speed of treatment implementation. Interviewees outside of the NRCS were critical of the agency's lack of collaboration, coordination, and effective public interactions. The Department of Transportation (DOT) worked with Acequia associations, which are governing bodies of culturally significant irrigation ditches, to remove debris and hazard trees. Additionally, they worked with the Forest Service to remove hazardous trees around road right of ways. New Mexico provided $50 million for recovery efforts and the DOT was able to utilize these funds to rebuild critical transportation infrastructure. To work across jurisdictions, interviewees with the DOT said they leveraged MOUs and found aligning interests to encourage project implementation. During emergency response, FEMA assisted Las Vegas in trucking in water and providing temporary housing (i.e., trailers) for eligible individuals. Similarly, state agencies used FEMA programs to help rebuild transportation, water, and other critical infrastructure. FEMA

also housed the Hermit's Peak Claims Office, which was created to distribute $4 billion provided by the Biden administration for claim settlements.

In summary, every local, state, and federal actor had a different focus to help aid during initial emergency response. Local actors were more involved with fixing critical infrastructure and individual community needs. State actors helped facilitate longer-term strategies for response and recovery through administered federal programs and attempted to advocate for local contexts. Federal entities had varying focuses across infrastructure repair, slope stabilization, and community assistance. No interviewees mentioned any BAR-funded projects, which at the time of data collection were in the planning phase and had not been implemented.

What were the policy and governance facilitators, challenges, and recommendations for improving post-wildfire response and recovery?

Most interviewees shared challenges associated with the federal post-wildfire approach in a rural and culturally sensitive landscape like New Mexico. Most interviewees described FEMA as having a top-down process that did not account for local contexts. One local-level interviewee said, "*[The FEMA process] was not designed to be responsive to people who have undergone trauma and loss… but [people] have loss, and are in a deep dark place with no savings, no records, or anything... It is a very non-trauma responsive way of handling trauma"* (#14, NGO employee) In addition, constant FEMA staff reassignments prevent state and local actors from establishing lasting working relationships with personnel who understand local contexts in Northern New Mexico.

Interviewees perceived limitations with post-wildfire policies as a pertinent challenge across all levels of governance. New Mexico has an anti-donation clause within the state

constitution that prohibits the use of state funding for projects on private property (N.M. Const. Art. IX, § 4). Interviewees said this forced private citizens to utilize FEMA, NRCS, or Farm Service programs for recovery, despite there being capacity for state-led projects. In addition, state agencies have authorities that do not outline what they can do for post-wildfire response and recovery efforts. These authorities limit New Mexico's ability to assist in response and recovery activities and reduce the need to rely on federal assistance programs.

At the federal level, interviewees said BAER was created under the assumption that fires would be contained to a smaller footprint and on federal land. One interviewee said, "*[The Forest Service] developed BAER for 10,000 to 20,000 acre fires, which used to be very large and predominantly contained to Forest Service lands. There were some [fires] within the WUI, but BAER was developed for the smaller fires with little complexity. That is not what we see today with cross-boundary lands and fires burning 60% on private property"* (#21, federal employee). Forest Service interviewees acknowledged that cross-jurisdictional dynamics cannot be addressed through BAER, and that short assessment and implementation timelines do not allow for strategic planning.

Almost every non-FEMA interviewee expressed frustration with Stafford Act guidelines. One local-level interviewee said that adobe-style houses were not eligible for FEMA assistance because such housing is not acknowledged in the Stafford Act. When discussing temporary housing units to replace lost housing, a state-level interviewee said, "*FEMA thinks [outhouses, solar energy, and river water] is not utility infrastructure, but in [Northern New Mexico] it is. This is how they lived before, and they are not asking you to upgrade it. This is the way they want to live. But FEMA can't put direct housing in because there's nothing for them to hook into."*

(#20, state employee). In this case, direct housing was a manufactured housing unit, but could also be a direct lease (e.g., ready-to-live-in units).

Interviewees said there was no formal approach to collaboration or communication that occurred among partners; rather, an ad hoc system was used to accomplish emergency measures and share pertinent information (discussed more in the next section). One state-level interviewee explained that New Mexico had no post-wildfire structures in place that would allow actors to coordinate and efficiently distribute funds. Furthermore, complicated agency processes made it difficult to have meaningful communication and collaboration. For example, non-NRCS interviewees said the NRCS has a straightforward program (EWP) that only requires personnel to "connect the dots" and does not require collaboration. Other interviewees found it difficult to coordinate with the NRCS and perceived that they routinely failed to share important information during coordination meetings. Other agencies like FEMA struggled to execute unified actions within the agency, and individuals were often uninformed about projects across the different programs they provide, according to non-FEMA interviewees. Likewise, the Forest Service did not provide many opportunities for meaningful collaboration, according to state and local-level interviewees. One interviewee attributed this to each agency and program having its unique focus within post-wildfire efforts, which encourages a siloed approach.

Interviewees were critical of the general lack of education on post-wildfire policy and ecology across all levels of governance. One interviewee shared that the Farm Service Agency was not educated on the EFRP program and was uncertain how it could be utilized in a post-wildfire context. In addition, there was confusion over how the Emergency Conservation Program (ECP), another FSA program that allows for the restoration of agricultural lands impacted by a natural disaster, would be used in conjunction with EFRP. Interviewees criticized

FEMA personnel, saying those personnel thought they knew how to address post-fire challenges based on their experience in other landscapes, thinking every event would require similar approaches. Some interviewees said that they received pushback from Washington, D.C. offices that wanted to see certain treatment alternatives, like seeding and tree planting, that were not appropriate or priorities for the HPCC fire at that time. Interviewees said individual landowners could not navigate rules and regulations alone and were forced to rely on lawyers, who typically took 20% of payouts.

Across all levels of governance interviewees mentioned a lack of capacity across local and state levels, which led to burnout and information overload. Interviewees said salaried personnel were working 15 to 20-hour days to accomplish response and recovery efforts, yet received no extra compensation. Most of the workload was put onto the state agency personnel, who were responsible for public outreach, collaboration, coordination, assessments, contracting, and project planning. For the EFRP program, the EMNRD had to work through 700 applications, which slowed project implementation. Interviewees said communities were also overloaded with information because federal agencies promised they could assist individuals with their recovery needs, only to reject individual applications once they were submitted. In addition, utilizing one program could make an individual ineligible for another program—and if accepted into both would lead to the duplication of benefits, which is illegal and monitored by FEMA.

Individuals played an important role in facilitating recovery. For instance, during emergency response, federal personnel with intimate knowledge of post-fire operations were resource-ordered (i.e., requested from national fire and disaster teams by FEMA or Army Corps of Engineers) to assist with planning and coordination. Interviewees shared that it was important to have people with extensive knowledge of post-fire, but these people sometimes recommended

actions beyond the scope of New Mexico's capacity, causing frustration. In addition, interviewees often mentioned that local champions, who spearheaded dialogues, provided resources, and consistently advocated on behalf of New Mexico's interests, were invaluable during response and recovery. For example, individuals at New Mexico DHSEM, EMNRD, and local governments were integral to progress and often had to be creative to facilitate progress (e.g., the creation of the Monsoon Taskforce and Lines of Effort Framework, discussed below). Interviewees valued leaders who could admit they did not have the answers or a clear recovery plan. Interviewees said local champions provided value but dynamics like redeployments, burnout, and election cycles compromised long-term dialogues and actions needed for recovery.

The Monsoon Taskforce and the Lines of Effort Framework were coordination and collaboration frameworks led by EMNRD and DHSEM respectively that helped familiarize actors with post-fire processes, create a line of communication, and reduce information overload. The Monsoon Taskforce was created to provide a platform for daily updates where agencies could share progress on project planning, expected field conditions, and immediate emergency tasks. The Lines of Effort was an adaptation of the FEMA Interagency Recovery Coordination Framework and organized actors into the seven identified efforts (watershed mitigation, housing, community development, water quality, economic development, historic and cultural resources, and health and social services) to distribute resources efficiently and encourage collaboration. Each effort contained local, state, and federal entities that were focused on those specific specializations. Each line of effort was further delineated into smaller task force groups that allowed partners to work together on more granular issues. When discussing the value of the Lines of Effort, one interviewee said, "*The intention was to find the federal programs that match the state programs and connect that federal counterpart with that state counterpart. For*

example, when you talk about HUD at a federal level, the Lines of Effort are supposed to be finding the equivalent to HUD at the state level, connecting them to cross-reference resources, and bringing the maximum amount of resources to the table" (#19, state employee).

Most interviewees shared that they often worked in the "gray," or areas of vague policy guidance, to achieve cross-boundary-like results, despite the lack of formalized authorities. For instance, the Department of Transportation was able to secure Memorandums of Understandings and Agreements that allowed them to work across jurisdictions. The Forest Service initiated Shared Stewardship, Good Neighbor Authority, and Wyden Amendment agreements with EMNRD to allow cross-boundary projects. The Forest Service also used county data to achieve cross-boundary BAER assessments. Moreover, the EMNRD worked with FSA to initiate EFRP, despite it never being used for post-wildfire recovery in New Mexico.

Because of political pressures and the federal government's commitment to expediting post-wildfire response and recovery for the HPCC fire, some program requirements were waived. The EWP program's 25% cost-share requirement was funded and, thus, essentially waived, through the Bipartisan Infrastructure Law (BIL). Interviewees said this provided opportunities for the State to be a sponsor and provide local contextual knowledge and capacity without the financial commitment. In addition, the Forest Service Washington Office approved the implementation of BAER treatments before the costs were determined.

Non-governmental organizations (NGOs) helped fill gaps and initiate recovery across federal, state, and local efforts. Interviewees said the New Mexico Forest and Watershed Restoration Institute (NMFWRI) was important for distilling information across boundaries through the creation of the Hub Site, which acted as a boundary object for information sharing across agencies. Agencies could input updates about their operations so that community

members did not have to search for information across agency sites. High Water Mark, an environmental consulting firm, acted as a navigator for New Mexico by sharing knowledge and expertise on federal assistance programs that provided value to interviewees at the local and state levels. Interviewees said the Hermit's Peak Watershed Alliance, a local watershed restoration group, acted as an alternative funding source to other federal programs like EWP on private land, and leveraged existing grants to help implement quick, small-scale watershed and slope stabilization projects. Challenges for all NGOs were the inability to hold federal partners accountable, not being viewed as legitimate actors, and limited project reach, according to interviewees.

Most interviewees recommended increasing the workforce capacity for post-wildfire efforts and had various ideas about how to do so. None of the interviewees held positions specific to post-wildfire and had other responsibilities that took attention away from response and recovery efforts. Interviewees said creating post-fire-specific positions, at the state or federal level, could relieve the workload and reduce burnout. Most interviewees recommended that FEMA be more purposeful with the personnel they order to a site and should bring individuals with clear value in terms of their knowledge of and commitment to recovery processes. One interviewee explained this by saying "*When you are putting things together, you need to bring the right experts, to the right job, for the right reason. Don't just send them out and ask them to help. That's not going to work*" (#15, federal employee). The state-led and federally supported approach allowed for locally driven goals but put more pressure on local and state officials. Interviewees mentioned that federal assistance for surge capacity, like the USFS Tiger Teams and the Army Corps personnel who were present, was helpful for emergency efforts but was not

available for longer-term project implementation. These were resource-ordered teams that expanded capacity to implement emergency actions or conduct land assessments.

Greater education on programs and ecology related to post-wildfire response and recovery was needed across all levels of governance, according to interviewees. State-level interviewees shared that the Farm Service was not knowledgeable on how EFRP could be used in a post-fire context before the HPCC fire. Similarly, interviewees with the Forest Service explained that implementing BAER always means explaining common misconceptions about what the program does and does not do. Interviewees explained that most of the personnel ordered by FEMA to assist with response and recovery efforts did not help bring new information to the table; when they did, it was irrelevant given New Mexico's available capacity and funding. In addition, FEMA staff who had experience with post-fire environments did not understand how the geography and weather unique to New Mexico would alter post-fire needs, further emphasizing the need for a state-led and federally supported approach.

Interviewees expressed the desire to create and staff a navigator position with an individual who had expert knowledge of post-wildfire policy to connect communities with the appropriate recovery programs. Through data collection, interviewees shared multiple visions for the navigator concept, but the main premise would be to create a position that would be embedded within the community and help individuals or governments navigate through the various programs and guidelines. This might be a local person who is pre-trained or is given access to specialized knowledge or people with experience in post-fire response and then serves full-time as a navigator. Interviewees said New Mexico already has a strong case-worker framework that is successful at working with households, and with proper training could be used to fill the navigator role.

Interviewees said legislative and regulatory changes are needed for adaptive funding that can be implemented across boundaries and allow for a holistic approach. One challenge for post-wildfire efforts is the various jurisdictions involved and the piecemeal approach to project planning and implementation. Interviewees recommended creating a funding source that has the flexibility to be utilized across multiple jurisdictional boundaries and over time to address short- and long-term recovery needs. Interviewees said this could be a new pot of money requiring a new set of regulations or it could be an amendment to existing programs like the EWP, EFRP, BAER, or BAR. For example, interviewees wanted the ability for BAER teams to analyze the entirety of the burn scar rather than just federally affected land. Others recommended changes to the Stafford Act that would link subsequent flooding and debris flows to the wildfire disaster declaration. Most interviewees wanted to implement EWP projects on Forest Service land, which is technically possible but which the State NRCS office did not authorize.

In terms of collaboration and cultural awareness, most interviewees recommended FEMA evaluate how their programs could be adjusted to better fit local contexts and aid rural communities. Interviewees expressed the desire to collaborate with other agencies but did not have the appropriate authorities to allow cross-boundary projects. Interviewees perceived the lack of authorities to collaborate as an incentive to encourage a siloed approach across actors.

Discussion

In this research, we investigated the policy and governance approaches of post-wildfire efforts, examining the utilization and implementation of response and recovery programs, specifically following the Hermit's Peak-Calf Canyon Wildfire. Interviewees shared several scale related challenges with a federal approach that was not tailored to the local contexts, state and federal authorities that limited the time, place, and purpose for which resources could be used,

lack of incentives to collaborate, lack of education on post-wildfire programs and ecology, and limited capacity in general (Cash et al. 2003; Schultz et al. 2019b). Interviewees also discussed facilitators to bridge scale mismatches despite these challenges, including local champions, boundary objects for collaboration and coordination, the use of existing authorities that allow for work across boundaries, federal funding support, and NGO involvement. Recommendations were to expand workforce capacity, provide more education on post-wildfire programs and ecology, legislative changes, and development of navigator positions.

How can we understand post-wildfire response and recovery efforts following the HPCC fire as an adaptive governance approach? Post-wildfire is a multi-scalar challenge that diffuses across jurisdictions, time, and governance levels, and as such is a complex governance challenge (Cash et al. 2006). Post-wildfire response and recovery in this case was a state-led and federally supported effort that presented both short- and long-term challenges, impacts across jurisdictions, and mixed ecological impacts across a large landscape that extended beyond the footprint of the fire due to watershed impacts. Local and state entities were expected to provide local contexts, have a system or framework for funding distribution in place, understand their network of capacities, and have knowledge of how to address post-wildfire conditions. At the same time, federal actors were expected to administer programs, provide technical assistance, help identify opportunities, and provide expert knowledge. The adaptive governance literature suggests a need for such a balance of federal funding and policy requirements that can be tailored to local contexts and implemented collaboratively with local partners (Rutherford and Schultz 2019).

Despite the need for multi-level coordination across time and space, we found considerable misalignment with principles of adaptive governance, which emphasize coordination across governance levels to address scale-fit problems and the need for tailoring

governance to specific and local contexts (see Table 4.3). Rigid policy guidelines (e.g., for BAER, EWP, and FEMA programs), lack of collaboration and coordination across federal agencies and programs, and a top-down federal approach that could not adapt to local housing and livelihood contexts, all stand in contrast to adaptive governance principles (Abrams 2019). At the federal level, we observed scale mismatches where policy and program requirements did not match the time frames at which post-wildfire challenges occurred and the geographic extent to which challenges were diffused. Interviewees at the local and state levels said this manifested through a top-down federal approach, a lack of collaboration across jurisdictions, and a lack of agency capacity to implement programs where and when they were needed. Federal implementation challenges made it particularly difficult for federal agencies to address post-wildfire needs in the context of rural New Mexican communities. At the state and local levels challenges were a result of a lack of disaster readiness, as shown when interviewees discussed not having prior post-wildfire experience, knowledge of the process, and a misalignment across state actors. New Mexico has experienced numerous fires that should have influenced greater disaster readiness, knowledge of the processes, and identified state agency roles. Limited capacities not only hinder adaptive governance but prevent New Mexico from learning from past disasters. Furthermore, state and local challenges made it difficult for federal agencies to utilize state frameworks for post-wildfire funding distribution. Interviewees pointed out that states like Oregon, Washington, and Colorado, which have built state capacities for post-wildfire are better positioned for success. Balancing state and local capacities for post-wildfire is challenging due to the episodic nature of disasters, however, in an era of larger and more frequent wildfire staffing post-wildfire positions must be a priority.

Facilitators and recommendations shared by interviewees aligned to some extent with the principles of adaptive governance, such as local tailoring, flexible problem-solving, and collective learning (DeCaro et al. 2017). The literature suggests that local leadership and trust building amongst stakeholders at the local level are what drive the emergence of adaptive governance (Cash et al. 2014). Local tailoring occurred through program waivers and treatment alternatives; both were advocated by state agencies who noticed a mismatch between the federal process and social and ecological characteristics (see Table 4.3). Interviewees thought the navigator position could increase local tailoring by further identifying program mismatches and addressing them through iterative feedback between navigators and federal agencies. Flexible problem-solving can support and influence project prioritization, allow for flexibility in terms of which stakeholders or partners to engage with, and allow for a mix of implementation actions needed to achieve objectives (DeCaro et al. 2017). A challenge to adaptability is the regulatory processes by which programs must be implemented in, which limit actors' ability to be more flexible. At the state level, interviewees were engaging with any federal agency that could provide opportunities to New Mexico. By expanding the number of federal programs that can be used, New Mexico was also able to inadvertently determine a mix of implementation actions that could be implemented. While there was minimal overlap of allowable treatment alternatives across post-wildfire programs, the EFRP, EWP, and Hermit's Peak Watershed Alliance projects all provided different treatment outcomes to landowners, however, it was up to locals to determine what treatments would be most advantageous. Navigators could help landowners make more informed decisions regarding treatment alternatives, but federal agencies should also consider how they can provide a mix of alternatives for varying land types. Collective learning was perceived to be occurring internally across each agency, but no interviewee discussed how

they planned to share lessons learned broadly (see Table 4.3). Many interviewees discussed organizing a roundtable to reflect on successes and shortcomings during emergency response. Federal agencies should schedule pre-determined sunsets to evaluate program implementation effectiveness and to ensure local challenges are being addressed. Nationally, lessons-learned forums exist through academic conferences and Commission workshops. Interviewees valued these national discussions but were not optimistic that they would result in positive change that would benefit New Mexico.

Interviewees shared how the success behind the Lines of Effort and the Monsoon Taskforce was driven by the ability to incorporate local contexts into coordination and collaboration frameworks. These frameworks served as boundary objects by providing a standardized mode of communication, holding actors accountable, and creating space to establish relationships (Davis et al. 2021). Interviewees said the Lines of Effort helped align agencies with similar post-wildfire focal areas and allowed flexibility in treatment alternatives; this was because relevant collaborators were paired to determine eligible treatment alternatives. Almost every interviewee said they discussed lessons learned internally, facilitating some learning, but there was a need to share these stories among the actors involved and in other communities to ensure smoother response and recovery efforts in the future. While we did not measure learning, we observed that New Mexico built post-wildfire capacity as shown by the initial lack of experience and education in post-fire, alongside the expansion of existing authorities (e.g., Good Neighbor Authority, Shared Stewardship) and development of frameworks for future efforts (e.g., Lines of Effort). In addition, most interviewees were tied into national conversations around response and recovery and provided their expertise to inform program waivers, reforms, and legislation. It is important to note that these successes are only being applied to the HPCC fire

and that other fires that have occurred since this incident have not received the same level of political attention, resources, or innovative governance approaches.

Local NGOs acted as boundary organizations in varying capacities and helped ensure individuals did not slip through gaps that formed between federal, state, and local efforts. The literature predicts this type of activity as a valuable aspect of adaptive governance (Table 4.3). For instance, the New Mexico Forest and Watershed Restoration Institute's creation of the Hermit's Peak Hub Site acted as a boundary object, as described by Davis et al. (2021), to help align messaging and information transfers across jurisdictions. In addition, they helped facilitate learning by providing information on treatment effectiveness and long-term realities for landowners. Other boundary groups provided expert knowledge to local and state actors as they navigated response and recovery, and helped advocate for New Mexico with federal agencies. Similar to Moloney et al. (2023), boundary organizations in Northern New Mexico helped facilitate learning and information transfer. We also found that they helped expand capacities by filling roles that local, state, and federal agencies could not fill, such as community outreach and information sharing, something that is predicted by Abrams (2019) as part of the increased reliance on networked governance in US forest management (see also Table 4.3).

Table 4.3: Adaptive governance framework with factors that facilitated and frustrated governance in practice and recommendations for greater adaptability.

Level of Governance	**Factors that Affect Adaptive Governance from Literature**	**Factors that Support Adaptive Governance from Our Findings**	**Factors that Challenge Adaptive Governance from Our Findings**	**Recommendations from Our Findings**
Federal Level	- Setting standards through policy rather than creating rigid guidelines (DeCaro et al. 2017) - Flexibility in decision-making approaches to support and influence project prioritization - Support collective learning through pre-determined sunsets for evaluation of policies (Craig and Ruhl 2014)	-Waivers to program requirements (e.g., EWP cost-share requirement) -Allocate additional funding (e.g., Hermit's Peak Assistance Act) -Provided surge capacity (Army Corps, USFS Tiger Teams) - Facilitate Commission workshops and lessons learned discussions.	-Lack of cultural sensitivity -Misalignment across agencies and efforts -Additional pressure on the state -Limited collaborative authorities -Rigid policy guidelines	-Create adaptive funding sources with flexibility in boundary implementation - Increase workforce and education capacity -Create authorities for inter-agency collaboration during assessments and project implementation.
State and Local Level	-Determine the mix of implementation alternatives needed for effective response and recovery outcomes. -Provide flexibility in which stakeholders to involve (e.g., EMNRDs choose to work with FSA to implement EFRP). -Advocate for federal program waivers to better capture local needs.	-Creation and use of boundary objects (e.g., Lines of Effort and Monsoon Taskforce) -Provide local contexts to federal actors. Effected the implementation of EWP waivers and Assistance Act. -Activating federal programs for post-wildfire use (e.g., EFRP). Expanded available treatment alternatives. - Use of existing authorities for cross-boundary work (e.g., Shared Stewardship, Good Neighbor Authority	-Limiting State authorities for post-wildfire work -Limited Capacity and institutional knowledge -Limited disaster readiness	-Create the navigator position -Increase workforce and education capacity -Expand state post-wildfire authorities
NGO/Boundary Organization Level	-Provide opportunities and incentives for the use of boundary objects -Engage actors across boundaries -Establish relationships that help reinforce boundaries while maintaining common interests (Davis et al. 2021)	-The creation and use of boundary objects (e.g., Hub Site) -Expanding capacities across boundaries -Facilitating information transfer across all actors	-Limited reach through small scale projects -Cannot enforce the use of boundary objects - Not viewed as legitimate federal actors	-Greater pre-post-wildfire planning with non-governmental organizations to determine how they could assist in recovery, relieve state responsibilities, and increase community robustness and trust.

Table 4.4: Types of scale challenges adapted from Schultz et al. (2019b) to summarize scale-related challenges, explain how they manifested in our study, and highlight options for policy reform.

Challenges	**Manifestations in Post-Wildfire Governance**	**Possible Policy Opportunities Identified in Our Research**
Ignorance of scale-related issues	The long-term effects and challenges of wildfire recovery are often not considered. Program guidelines fail to recognize assistance needs.	-Extend disaster window to make eligible cascading events for disaster declaration funding. -Expand eligible activities under the FMAG program because the program is not tied to disaster declaration.
Mismatch between scale of management and ecological problem	State and federal authorities limited the time, place, and purpose for which resources could be used.	-Evaluate treatment appropriateness for the time of implementation and overall effectiveness for recovery. -Create one funding source that can be utilized across jurisdictions to treat post-wildfire affects holistically
Mismatch between scale of social organization with either scale of management or ecological problem	Organizations lacked the ability to affect relevant ecological dynamics at large scales.	-Make local NGOs authorized post-wildfire actors to allow full participation with federal agencies.
Mismatch between scale of assessment and scale of information needed for decision making	Burn severity data is limited to a jurisdiction type and monitoring and updating assessment documents does not occur.	-Allow an all-lands soil burn assessment and make available funding for monitoring and updating of assessment documents to capture changing post-wildfire conditions.
Mismatch between ecological, political, and other decision-making timeframes	Activities do not receive multiyear investments due to program timelines and annual appropriation cycles	-Extend program timelines to allow strategic planning to address short- and long-term needs. -Dedicate annual funding for post-wildfire response and recovery.

We utilized adaptive governance to address policy mismatches at temporal, geographic, and governance scales; in this section, we expand on scale-related challenges to provide additional context to post-wildfire challenges and recommendations (see Table 4.4; Cash et al. 2006; Schultz et al. 2019b). Recommendations for legislative changes across post-fire programs aim to provide greater opportunities for response and recovery. For instance, amending the Stafford Act to fund cascading events would reduce ignorance of scale-related challenges, i.e., the policy guidelines that do not recognize post-fire specific dynamics or the long-term challenges unique to post-fire disasters. Likewise, expanding eligible post-fire activities under FMAG would assist communities that did not meet disaster thresholds, yet still require assistance. A mismatch between the scale of management and ecological problems manifests through authorities that limit where and how programs can be implemented and may be addressed through an evaluation of post-fire treatment effectiveness based on the time of implementation. Interviewees said Washington Office personnel wanted seedlings planted, but this alternative was inappropriate given environmental conditions. Others recommended a single post-wildfire funding source that can be implemented across jurisdiction types. This could be achieved by creating a new post-wildfire program or amending existing programs, like BAR or EWP, to allow greater time-scale flexibility and use across boundaries (Carney et al. 2024). Actors could not address post-wildfire challenges at the needed scale, highlighting a mismatch between organizations and either the scale of management or ecological problems (Schultz et al. 2019b). Local organizations are nimble and can implement treatments at a fast pace but are not recognized as authorized post-fire actors who can assist with larger-scale efforts. Federal agencies have the potential to address large-scale management and ecological problems but are not able to provide solutions at the time needed. The dynamics between local and federal

organizations contradict findings that managing complex environmental challenges requires coordination across sectors, jurisdictions, and with non-governmental actors (Emerson et al. 2012). Recommendations were to acknowledge local organizations as post-wildfire actors which would give them the ability to in broader efforts. Soil burn assessments were primarily limited to Forest Service lands despite the fire also burning on state and private land, which created mismatches between assessments and the scale of information necessary for decision-making. BAER teams should be composed of inter-agency teams and assess the entirety of the burned area. Furthermore, funding for monitoring is needed to ensure assessments reflect the dynamic forest and watershed conditions. Mismatches between ecological, political, and other decision-making timeframes are the most significant challenges to response and recovery. Recommendations were to extend program timelines to allow for strategic planning for short- and long-term success and to provide annual appropriations to response and recovery programs, removing competitive funding. Short-term accountability could be maintained through biannual reports where actors share program accomplishments and identify remaining needs, to promote long-term success. If adaptive governance is to be implemented, significant reform will be needed to incorporate adaptive legal design principles that allow for reflexive outcomes and support collective learning (DeCaro et al. 2017).

Adaptive governance offers a blueprint for future discussions around post-wildfire recommendations, reforms, and legislation. Post-wildfire challenges and the actors participating in response and recovery create a complex governance system, and the broader institutional arrangements across each federal program have shaped how actors interact and address emerging challenges. The Commission created multiple recommendations that were endorsed across agencies and can be implemented by amending programs or by expanding existing authorities

(WFMMC 2023). However, these recommendations oversimplify the complexity of governance and lack the nuance needed for policy implementation (DeCaro et al. 2017); the recommendations still need to be expanded to incorporate policy design for adaptive governance approaches and to address scale mismatches. Furthermore, developing new post-wildfire programs may provide greater opportunities to incorporate adaptive design into policy but might still be limited if existing policies are not fixed and already present boundary mismatches. Political responses to post-fire must not be reactive and instead be deliberate and fill gaps rather than duplicate existing program aims. Each existing program holds a specific role in response and recovery and different agencies hold roles and authorities that cannot be overtaken without intention. For example, FEMA holds programs and authorities that no other agency could replace. Options for policy reform exist, but a strategic vision that provides the greatest opportunities for communities and post-wildfire managers is still not clear in terms of whether it would require amendments to, supplementation of, or replacement of existing authorities.

Our research captures the first year of response and recovery following the Hermit's Peak-Calf Canyon Fire. Although our work can serve as a baseline to track and inform initial efforts, it will be important to study how long-term efforts are implemented and whether they further align with adaptive governance. We hope this work provides value for other communities by highlighting the importance of pre-post-wildfire planning and investments in capacity. In terms of theory, we add to the existing body of adaptive governance literature by providing post-wildfire perspectives in rural communities with limited local capacities. We did not capture private landowner perspectives on post-wildfire governance but heard from interviewees that communities valued controversial practices like aerial seeding because it visually represented recovery. These dynamics should be further researched to determine the psychological impacts of

response and recovery actions. Future research should consider how state capacities are leveraged during response and recovery and how learning from past events might position communities for greater success during the next event. Finally, research should determine if subsequent state disasters soften rigid policy and fill previous gaps in governance. Ultimately, any post-wildfire community of practice will need to ensure that they have a vision for post-wildfire policy "success" and are not addressing challenges with a piecemeal approach. Indeed, some challenges can be fixed without broader alignment to a governance approach (e.g., rain gauges and early flood warning systems), but it is still unclear how to best support states during response and recovery efforts and where or how to address federal policy limitations.

CHAPTER 5 – CONCLUSION

In this thesis, I explored different scale mismatches in pre-wildfire and post-wildfire management to derive an understanding of potential adaptation options in complex management systems.

In Chapter 2, I explored how PODs offer a unique way to approach pre-fire planning and integrate plans for land management, with consideration of using fuel treatments not just to mitigate local fire behavior but also strategically during wildfire incident management. A limitation of this study is that the sample size was relatively small. However, it was appropriate for these exploratory case studies to document the early adoption and adaptation of PODs in a new, and potentially innovative, context. Nonetheless, interviewees discussed how PODs are changing the way they approach fire, saying that past strategies for fuel treatment are not working as well in the face of larger fire sizes and with more communities at risk. Other interviewees explored these changing dynamics by showing how PODs offer a framework to integrate fire management across preparedness and response (Thompson et al. 2022b). Our cases also showed that PODs can be used as a boundary object to communicate and link treatments across jurisdictions and levels of governance. As such, they offer a potentially more integrated approach to land and fire management, although their utility and efficacy are still inconsistent and remain to be demonstrated more broadly (Colavito 2021). The recommendations for further PODs development, including increased capacity, clear leadership direction, greater buy-in, continued investment, and flexibility to adapt for context-specific uses, must be addressed at the regional and Washington levels. Nonetheless, their fit within the broader institutional

environment of social and political concern and investment in forest management to address large fires may facilitate their ongoing adoption.

In Chapters 3 and 4, I investigated the policy and governance approaches of post-wildfire efforts. A limitation of this study was the exclusion of private landowner perspectives and limited representation of long-term recovery actions. Private landowners held unique perspectives that will need to be captured to ensure a holistic conceptualization of response and recovery, as well as follow-up interviews to determine how learning has impacted efforts. I examined the utilization and implementation of response and recovery programs, specifically following the Hermits Peak-Calf Canyon Wildfire. Interviewees shared challenges with individual state and federal authorities that limit the time, place, and purpose for which resources can be used, lack of incentives to collaborate, lack of education on post-wildfire programs and ecology, limited capacity in general, and a federal approach that is not tailored to local contexts. Interviewees also discussed facilitators of progress despite these challenges, including local champions, the use of existing authorities that allow for work across boundaries, federal funding support, and NGO involvement. Recommendations were to expand workforce capacity, provide more education on post-wildfire programs and ecology, amend legislation, and develop navigator positions. Adaptive governance can offer a starting point for national discussions around post-wildfire and can help guide existing recommendations, reforms, and legislation (Cheng et al. 2015; WFMMC 2023). Additional case studies and triangulation across cases are needed to reflect the broader dynamics of post-wildfire landscapes to achieve generalized findings. Surveys could be an appropriate methodology for landscape-level studies on post-fire, but semi-structured interviews capture the depth and nuance needed to explain variation in community characteristics.

My work in PODs and post-wildfire governance has led to ongoing research efforts. The next evolution of PODs is captured through the Incident Strategic Alignment Process (ISAP) which incorporates PODs and other analytics into structured decision-making dialogues during active wildfires. This work is being conducted in collaboration with the Colorado Forest Restoration Institute, and we deployed a mixed methodology approach with participant observation and semi-structured interviews. Our research objectives are: 1) How are risk and strategy assessed, developed, contested, and communicated during ISAP? 2) How do deliverers and end-users understand the purpose of ISAP and determine its efficacy? 3) What components of ISAP are working well, and which need work, are less understood, or are less effective? 4) What factors at multiple organizational levels and points in time facilitate or frustrate the development, deployment, and application of risk-based analytics and the strategic planning model embedded within ISAP? And 5) how can the Incident Strategic Alignment Process and associated tools be improved to enhance use in incident management? We anticipate creating multiple 2-page documents for practitioners and a peer-reviewed article by the end of 2024. In addition, my post-wildfire research has contributed to the formation of a working group led by Dr. Courtney Schultz and Collin Haffey, which aims to develop policy recommendations for post-wildfire reform. To date, we have developed three recommendations that would emphasize collaboration across Natural Resource Conservation Service and Forest Service programs that have been developed by individuals working across diverse disciplines. Broader interest in my research has led to several invitations to present at academic conferences like the Association for Fire Ecology (AFE) conference and the After the Flames conference. I anticipate contributing to future research efforts on these topics.

This thesis opens an opportunity for future research to view wildfire management as one continuous process. Often wildfire is viewed through pre-wildfire, incident management, and post-wildfire lenses, and doing so might create mismatches across the wildfire process. My research shows PODs have utility for pre-wildfire and incident management efforts by helping managers validate decision-making and facilitate communication across boundaries. However, these same principles were not shown during the response and recovery efforts in New Mexico. Similarly, research shows that post-wildfire restoration efforts increase wildfire risk creating further challenges for wildland fire managers (Evans 2017). Future research should investigate how each phase of wildfire management can create opportunities for the next rather than operating as siloed efforts in a greater ecological process. Similar to scale mismatch, where policies do not match ecological characteristics, the Western wildfire management approach does not match the ecological process of wildfire. While this thesis consists of three distinct products, it can act as an initial bridge between pre- and post-wildfire governance approaches. Further research should determine how opportunities can persist across management transitions.

REFERENCES:

Abrams, J. (2019) The emergence of network governance in U.S. National Forest Administration: Causal factors and propositions for future research. *Forest Policy and Economics*, *106*, 101977. https://doi.org/10.1016/j.forpol.2019.101977

Bazeley, P. (2017) Qualitative Data Analysis.

Beeton, TA, Caggiano, MD, Colavito, MM, Huayhuaca, C. (2022) Use of Risk Management Assistance During the 2021 Fire Season: A Technical Report. Southwest Ecological Restoration Institutes. 1-23. https://cfri.colostate.edu/wp-content/uploads/sites/22/2022/12/Beeton_RMA_USE_2021_WildfireSeason_Report.pdf

Bernard, HR. (2017) Research methods in anthropology: Qualitative and quantitative approaches. 4th Edition. Rowman & Littlefield: New York.

Braun, V, Clarke, V. (2012) Thematic analysis. In: APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological. Washington, DC, US: American Psychological Association. 57–71. https://doi.org/10.1037/13620-004

Buechi, H, Weber, P, Heard, S, Cameron, D, Plantinga, AJ. (2021) Long-term trends in wildfire damages in California. *International Journal of Wildland Fire*, *30*(10), 757–762. https://doi.org/10.1071/WF21024

Caggiano, MD, O'Connor, CD, Sack, RB. (2020) Potential Operational Delineations and Northern New Mexico's 2019 Fire Season. CFRI-2020 https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/02/Caggiano_PODs-New-Mexico-Case-Study-2.14.20.pdf

Calkin, D, O'Connor, C, Thompson, M, Stratton, R. (2021) Strategic Wildfire Response Decision Support and the Risk Management Assistance Program. Forests, 12(10), 1407. https://doi.org/10.3390/f12101407

Carney, C, Schultz, CA, Griener, SM. (In Preparation) Complexities in post-wildfire governance: lessons from Colorado's 2020 wildfires. [Manuscript in Preparation for Submission to Fire Ecology]. Fire Ecology.

Cash, DW, Clark, W, Alcock, F, Dickson, NM, Eckley, N, Guston, DH, Jäger, J, Mitchell, RB. (2003) Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences, 100(14), 8086–8091. https://doi.org/10.1073/pnas.1231332100

Cash, D, Adger, WN, Berkes, F, Garden, P, Lebel, L, Olsson, P, Pritchard, L, Young, O. (2006) Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. Ecology and Society, 11(2). https://doi.org/10.5751/ES-01759-110208

Chaffin, BC, Gosnell, H, Cosens, BA. (2014) A decade of adaptive governance scholarship: synthesis and future directions. Ecology and Society 19(3): 56. http://dx.doi.org/10.5751/ES-06824-190356

Cheng, T, Ekarius, C, Gibbs, D. (2015) *Innovations in Forestry and Fire Mitigation: A Report on Colorado Solutions for Senator Michael Bennet*. https://www.sanjuancitizens.org/wp-content/uploads/2015/06/Fire-Forest-Outcomes-Report.pdf

COCO. (2024) *CNP USFS Grants & Funding – Coalitions & Collaboratives, Inc.* https://co-co.org/community-navigator-program/cnp-usfs-grants-funding/

Colavito, M. (2021) The Human Dimensions of Spatial, Pre-Wildfire Planning Decision Support Systems: A Review of Barriers, Facilitators, and Recommendations. Forests, 12(4). https://doi.org/10.3390/f12040483

Coppoletta, M, Merriam, KE, Collins, BM. (2016) Post-fire vegetation and fuel development influences fire severity patterns in reburns. Ecological Applications, 26(3), 686–699. https://doi.org/10.1890/15-0225

Cosens, B, Gunderson, L, Chaffin, B. (2018). Introduction to the Special Feature Practicing Panarchy: Assessing legal flexibility, ecological resilience, and adaptive governance in regional water systems experiencing rapid environmental change. *Ecology and Society*, *23*(1). https://doi.org/10.5751/ES-09524-230104

Craig, RK, Ruhl, JB. (2014). *Designing Administrative Law for Adaptive Management* (SSRN Scholarly Paper 2222009). https://doi.org/10.2139/ssrn.2222009

Craig, RK, Garmestani, AS, Allen, CR, Arnold, CA, Birgé, H, DeCaro, DA, Fremier, AK, Gosnell, H, Schlager, E. (2017) Balancing stability and flexibility in adaptive governance: an analysis of tools available in U.S. environmental law. Ecology and Society 22(2):3. http://dx.doi.org/10.5751/ES-08983-220203

Crona, BI, Parker, J.N. (2012) Learning in Support of Governance: Theories, Methods, and a Framework to Assess How Bridging Organizations Contribute to Adaptive Resource Governance. Ecol. Soc. 2012, 17, 32.

Crow, DA, Albright, EA, Ely, T, Koebele, E, Lawhon, L. (2018) Do Disasters Lead to Learning? Financial Policy Change in Local Government. *Review of Policy Research*, *35*(4), 564–589. https://doi.org/10.1111/ropr.12297

Davis, EJ, Huber-Stearns, H, Cheng, AS, Jacobson, M. (2021) Transcending Parallel Play: Boundary Spanning for Collective Action in Wildfire Management. *Fire*, *4*(3), Article 3. https://doi.org/10.3390/fire4030041

DeCaro, D, Chaffin, B, Schlager, E, Garmestani, A, Ruhl, JB. (2017) Legal and institutional foundations of adaptive environmental governance. Ecology and Society, 22(1). https://doi.org/10.5751/ES-09036-220132

Dilling L, Lemos MC. (2011) Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. Global Environmental Change, 21(2), 680–689. https://doi.org/10.1016/j.gloenvcha.2010.11.006

Dunbar-Ortiz, R. (2014) *An indigenous peoples' history of the United States*. Beacon Press.

Dunn, CJ, Thompson, MP, Calkin, DE. (2017) A framework for developing safe and effective large-fire response in a new fire management paradigm. Forest Ecology and Management, 404, 184–196. https://doi.org/10.1016/j.foreco.2017.08.039

EMC, FAM. (2022) Draft FAQs: Bipartisan Infrastructure Law Sec. 40806 (Fuel Breaks CE). USFS. https://cfri.box.com/s/klubrh847c0bwtfhbinythyq3eow7nmu

Emerson, K., Nabatchi, T., Balogh, S. (2012) An Integrative Framework for Collaborative Governance. *Journal of Public Administration Research and Theory*, *22*(1), 1–29. https://doi.org/10.1093/jopart/mur011

Evans, A. (2017) State of the knowledge about post-fire response. Fire Learning Network.

Fernandez, S, Rainey, HG. (2006) Managing successful organizational change in the public sector. Public Administration Review 66(2), 168–176. https://doi.org/10.1111/j.1540-6210.2006.00570.x

Fusch, P, Ness, L. (2015) Are We There Yet? Data Saturation in Qualitative Research. *Walden Faculty and Staff Publications*, *20*(9). https://scholarworks.waldenu.edu/facpubs/455

Gerlak, AK, Heikkila, T, Smolinski, SL, Huitema, D, Armitage, D. (2018) Learning our way out of environmental policy problems: A review of the scholarship. *Policy Sciences*, *51*(3), 335–371. https://doi.org/10.1007/s11077-017-9278-0

Gibson, CC, Ostrom, E, Ahn, TK. (2000) The concept of scale and the human dimensions of global change: a survey. Ecological Economics 32:217-239. http://dx.doi.org/10.1016/S0921-8009(99)00092-0

Greiner, MS, Schultz, CA, Kooistra, C. (2020) Pre-Season Fire Management Planning: The Use of Potential Operational Delineations to Prepare for Wildland Fire Events. International Journal of Wildland Fire 30(3), 170-178. https://doi.org/10.1071/WF20124.

Guest, G, Bunce, A, Johnson, L. (2006) How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Guston, DH. (1999) Stabilizing the boundary between US politics and science: The role of the Office of Technology Transfer as a boundary organization. *Social Studies of Science*, *29*(1), 87–111. https://doi.org/10.1177/030631299029001004

Haffey, C. (2023) Stuck in the Mud: Gaps in Post-Fire Recovery Programs. *Fire Adapted Communities Learning Network*. https://fireadaptednetwork.org/stuck-in-the-mud-gaps-in-post-fire-recovery-programs/

Headwaters Economics. (2018) *The Full Community Cost of Wildfire*. https://headwaterseconomics.org/wp-content/uploads/full-wildfire-costs-report.pdf.

Hjerpe, EE, Colavito, MM, Edgeley, CM, Burnett, JT, Combrink, T, Vosick, D, Meador, AS. (2023) Measuring the long-term costs of uncharacteristic wildfire: A case study of the 2010 Schultz Fire in Northern Arizona. *International Journal of Wildland Fire*, *32*(10), 1474–1486. https://doi.org/10.1071/WF23036

Holden, ZA, Swanson, A, Luce, CH, Jolly, MW, Maneta, M, Oyler, JW, Warren, DA, Parsons, R, Affleck, D. (2018) “Decreasing Fire Season Precipitation Increased Recent Western US

Forest Wildfire Activity." Proceedings of the National Academy of Sciences 115(36), E8349–E8357. https://doi.org/10.1073/pnas.1802316115.

H.R.1450 - 118th Congress (2023-2024): Treating Tribes and Counties as Good Neighbors Act. (2023, September 18). https://www.congress.gov/bill/118th-congress/house-bill/1450

H.R.6435 - 118th Congress (2023-2024): MALDEN Act. (2023, November 20). https://www.congress.gov/bill/118th-congress/house-bill/643

H.R.7070 - 118th Congress (2023-2024): Wildfire Response Improvement Act. (2024, January 31). https://www.congress.gov/bill/118th-congress/house-bill/7070/text

Huayhuaca, C, Cheng, AS, Beeton, TA, Sanderson, JS, Barton, AW, Kimple, AD, Colavito, MM, Zebrowski, J, Dunn, J, vonHedemann, N, Slack, AW. (2023) Preparing landscapes and communities to receive and recover from wildfire through collaborative readiness: A concept paper. Southwest Ecological Restoration Institutes

Hurlburt, M. (2018) Adaptive Governance of Disaster. Retrieved April 24, 2024, from https://link.springer.com/book/10.1007/978-3-319-57801-9

InciWeb. (2023) Hermits Peak Calf Canyon Incident Information. http://inciweb.nwcg.gov/incident-information/nmsnf-calf-canyon

Jaramillo, ET. (2020) Fluid kinship: Race, power, and the hydrosocial order of water flow along New Mexico's acequias. *Environment and Planning D: Society and Space*, *38*(4), 718–735. https://doi.org/10.1177/0263775819879719

Joint Economic Committee. (2023) Climate-exacerbated wildfires cost the U.S. between $394 to $893 billion each year in economic costs and damages. United States Joint Economic Committee. Retrieved March 25, 2024, from https://www.jec.senate.gov/public/index.cfm/democrats/2023/10/climate-exacerbated-

wildfires-cost-the-u-s-between-394-to-893-billion-each-year-in-economic-costs-and-damages

Jolly, MW, Cochrane, MA, Freeborn, PH, Holden, ZA, Brown, TJ, Williamson, GT, Bowman, DM. (2015) Climate-Induced Variations in Global Wildfire Danger from 1979 to 2013. Nature Communications 6 (1), 7537. https://doi.org/10.1038/ncomms8537.

Jones, KW, Gannon, B, Timberlake, T, Chamberlain, JL, Wolk, B. (2022) Societal benefits from wildfire mitigation activities through payments for watershed services: Insights from Colorado. *Forest Policy and Economics*, *135*, 102661. https://doi.org/10.1016/j.forpol.2021.10266

Lemos, MC. (2008) What Influences Innovation Adoption by Water Managers? Climate Information Use in Brazil and the United States. JAWRA Journal of the American Water Resources Association 44 (6), 1388–1396. https://doi.org/10.1111/j.1752-1688.2008.00231.x.

McCarthy, FX. (2010) *FEMA's Disaster Declaration Process: A Primer*. DIANE Publishing.

Millar, CI, Stephenson, NL. (2015) Temperate forest health in an era of emerging mega disturbance. *Science*, *349*(6250), 823–826. https://doi.org/10.1126/science.aaa9933

Moloney, K, Vickery, J, Hess, J, Errett, N. (2023) After the fire: A qualitative study of the role of long-term recovery organizations in addressing rural communities' post-wildfire needs. *Environmental Research: Health*, *1*(2), 021009. https://doi.org/10.1088/2752-5309/acd2f7

Moore, R. (2022) Match and Substantial Cash Contributions Policy Changes (1580). https://www.fs.usda.gov/sites/default/files/LC-GrantsAgreementsPolicyChangeLetter.pdf

New Mexico Forest and Watershed Restoration Institute. (2023, September 19). *Hermit's Peak and Calf Canyon Fire*. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/d48e2171175f4aa4b5613c2d11875653

Noble, P, Paveglio, TB. (2020) Exploring Adoption of the Wildland Fire Decision Support System: End User Perspectives. Journal of Forestry, 118(2), 154–171. https://doi.org/10.1093/jofore/fvz070

O'Connor, CD, Calkin, DE. (2019) Engaging the Fire Before It Starts: A Case Study from the 2017 Pinal Fire (Arizona). Wildfire 28(1), 14-18. https://www.fs.usda.gov/research/treesearch/57587

Otrachshenko, V, Nunes, LC. (2022) Fire takes no vacation: Impact of fires on tourism. *Environment and Development Economics*, *27*(1), 86–101. https://doi.org/10.1017/S1355770X21000012

Radeloff, VC, Helmers, DP, Kramer, AH, Mockrin, MH, Alexandre, PM, Bar-Massada, A, Butsic, V. (2018) Rapid Growth of the US Wildland-Urban Interface Raises Wildfire Risk. Proceedings of the National Academy of Sciences 115(13), 3314–3319. https://doi.org/10.1073/pnas.1718850115.

Rapp, C, Rabung, E, Wilson, R, Toman, E. (2020) Wildfire decision support tools: An exploratory study of use in the United States. International Journal of Wildland Fire, 29(7), 581. https://doi.org/10.1071/WF19131

Rogers, EM. (1995) Diffusion of Innovations. 4th Edition. The Free Press, New York.

Rutherford, T, Schultz, C. (2019) Adapting wildland fire governance to climate change in Alaska. *Ecology and Society*, *24*(1). https://doi.org/10.5751/ES-10810-240127

Ryan, GW, Bernard, HR (2003) Techniques to Identify Themes. Field Methods. 15(1), 85–109. https://doi.org/10.1177/1525822X02239569.

Saldana, JM. (2015) The coding manual for qualitative researchers (3rd ed.). SAGE Publications.

Schultz, CA, Miller, LFF, Greiner, MS, Kooistra, C. (2021) A Qualitative Study on the US Forest Service's Risk Management Assistance Efforts to Improve Wildfire Decision-Making. Forests 12 (3), 344. https://doi.org/10.3390/f12030344

Schultz, CA, Thompson, MP, McCaffrey, SM. (2019a) Forest Service Fire Management and the Elusiveness of Change. Fire Ecology 15 (13), 1-15. https://doi.org/10.1186/s42408-019-0028-x.

Schultz, C, Timberlake, T, Wurtzebach, Z, McIntyre, K, Moseley, C, Huber-Stearns, H. (2019b) Policy tools to address scale mismatches: Insights from U.S. forest governance. *Ecology and Society*, *24*(1). https://doi.org/10.5751/ES-10703-240121

Stake, R. (1995) The art of case study research. Thousand Oaks, CA: Sage publications.

Stevens-Rumann, CS, Morgan, P. (2019) Tree regeneration following wildfires in the western US: A review. *Fire Ecology*, *15*(1), 15.

Stratton, R. (2020) The Path to Strategic Wildland Fire Management Planning. Wildfire 29 (1), 10. https://www.iawfonline.org/article/2020-01-path-strategic-wildland-fire-managementplanning/#:~:text=The%20Cohesive%20Wildland%20Fire%20Management,(3)%20responding%20to%20wildfires.

Thomas, D, Butry, D, Gilbert, S, Webb, D, Fung, J. (2017) 'The costs and losses of wildfires'. National Institute of Standards and Technology Special Publication 1215(11).

Thompson, MP, Bowden, P, Brough, A, Scott, JH, Gilbertson-Day, J, Taylor, A, Anderson, J, Haas, JR. (2016) Application of Wildfire Risk Assessment Results to Wildfire Response

Planning in the Southern Sierra Nevada, California, USA. Forests, *7*(3), 3. https://doi.org/10.3390/f7030064

Thompson, MP, Gannon, BM, Caggiano, MD, O'Connor, CD, Brough, A, Gilbertson-Day, JW, Scott, JH. (2020) Prototyping a Geospatial Atlas for Wildfire Planning and Management. Forests 11 (9), 909. https://doi.org/10.3390/f11090909.

Thompson, MP, O'Connor, CD, Gannon, BM, Caggiano MD, Dunn ,CJ, Schultz, CA, Calkin, DE, Pietruszka B, Greiner, SM, Stratton, R, Morisette, JT. (2023) Potential operational delineations: New horizons for proactive, risk-informed strategic land and fire management. Fire Ecology, 18(1), 17. https://doi.org/10.1186/s42408-022-00139-2

Thompson, MP, Vogler, KC, Scott, JH, Miller, C. (2022) Comparing risk-based fuel treatment prioritization with alternative strategies for enhancing protection and resource management objectives. Fire Ecology, 18(1), 26. https://doi.org/10.1186/s42408-022-00149-0

U.S. Department of Agriculture. (2019) Fiscal Year 2020 Budget Justification. Available from: https://www.fs.usda.gov/sites/default/files/media_wysiwyg/usfs-fy-2020-budget-justification.pdf

U.S. Department of Agriculture. (2020) Fiscal Year 2021 Budget Justification. Available from: https://www.fs.usda.gov/sites/default/files/2020-02/usfs-fy-2021-budget-justification.pdf

U.S. Department of Agriculture. (2021) Fiscal Year 2022 Budget Justification. Available from: https://www.fs.usda.gov/sites/default/files/usfs-fy-2022-budget-justification.pdf

U.S. Department of Agriculture. (2022) Fiscal Year 2023 Budget Justification. Available from: https://www.fs.usda.gov/sites/default/files/2022-03/FS-FY23-Congressional-Budget-Justification.pdf

U.S. Department of Agriculture. (2023) Fiscal Year 2024 Budget Justification. Available from: https://www.fs.usda.gov/sites/default/files/FS-FY24-Congressional-Budget-Justification.pdf

U.S. Government Accountability Office. (2003) Better information needed on effectiveness of emergency stabilization and rehabilitation treatments. GAO Report No. 03-430. https://www.gao.gov/products/gao-03-430

U.S. Government Accountability Office. (2019) Wildland Fire – Federal agencies' efforts to reduce wildland fuels and lower risk to communities and ecosystems. GAO Report No. 20-52. https://www.gao.gov/assets/gao-20-52.pdf.

U.S. Government Accountability Office. (2020) National Preparedness– Additional actions needed to address gaps in the nation's emergency management capabilities. GAO Report No. 20-297. https://www.gao.gov/assets/gao-20-297.pdf.

U.S. Government Accountability Office. (2021) Assistance Program Helps Meet Post-Disaster Needs and Could be Improved with Additional Guidance. GAO Report No. 22-104326. https://www.gao.gov/assets/gao-22-104326.pdf.

USFS (2021) Potential Operational Delineations (PODs) | Rocky Mountain Research Station. https://www.fs.usda.gov/rmrs/potential-operational-delineations-pods.

USFS (2022a) USDA Forest Service National Prescribed Fire Program Review (2022). https://www.frames.gov/documents/usfs/USFS_20220908_National-Prescribed-Fire-Program-Review.pdf

USFS (2022b) FY2023 Priorities. https://www.usda.gov/sites/default/files/documents/30a-2023-FS.pdf

USFS. (2023). *Forest Landowner Support*. US Forest Service. https://www.fs.usda.gov/about-agency/state-private-forestry/coop-forestry/ira-forest-landowner-support

Vukomanovic, J, Steelman, T. (2019) A Systematic Review of Relationships Between Mountain Wildfire and Ecosystem Services. *Landscape Ecology*, *34*(5), 1179–1194. https://doi.org/10.1007/s10980-019-00832-9

Wagenbrenner, JW, MacDonald, LH, Coats, RN, Robichaud, PR, Brown, RE. (2015) Effects of post-fire salvage logging and a skid trail treatment on ground cover, soils, and sediment production in the interior western United States. Forest Ecology and Management, 335, 176–193. https://doi.org/10.1016/j.foreco.2014.09.016

Wejnert, B. (2002) Integrating Models of Diffusion of Innovations: A Conceptual Framework. Annual Review of Sociology 28 (1), 297–326. https://doi.org/10.1146/annurev.soc.28.110601.141051.

WFMMC. (2023) ON FIRE: The Report of the Wildland Fire Mitigation and Management Commission. Available at https://www.usda.gov/ sites/default/files/documents/wfmmc-final-report-09-2023.pdf

Wine, ML, Cadol, D, Makhnin, O. (2018) In ecoregions across western USA streamflow increases during post-wildfire recovery. Environmental Research Letters, 13 (1), p.014010. https://doi: 10.1088/1748-9326/aa9c5a

Yin, RK. (2003) Case study research: Design and methods. Beverly Hills, CA: Sage Publications.

APPENDIX A – POST-WILDFIRE INTERVIEW GUIDE

Background

- Can you please share with us your current (or past) position(s) and how you have been involved in the post-wildfire response and recovery process?

Understanding Post-Fire Policies and Programs

- In your experience(s), who have been the primary groups involved in the response and recovery process? What have been their roles and areas of focus?
    - Can you share from your experiences how coordination between various entities involved in the post-fire response and recovery process occurred and did it contribute to meeting response/recovery objectives?
    - Are there any other organizations that have been instrumental in coordinating with the federal programs during post-fire recovery?
- From your experience with post-fire recovery, can you discuss what program policies were beneficial in the recovery process, and those that hindered progress or meeting recovery objectives?
    - Are there differences in how program policies have affected post-fire response and recovery in **various jurisdictions** (i.e., public vs. private lands, different public land ownerships)?
    - Are there differences between how program policies affected **the types of recovery actions taken, like mulching, planting, or other stabilization efforts**? (i.e., are certain approaches limited by a policy barrier?)
    - At what **scales** have these efforts been focused? (i.e., **political** (individual property, county, state, special district); **physical** (individual catchment, watershed scale))
    - Do you have any examples of unique arrangements that allowed you to fulfill your recovery objectives? (i.e., approaches to working around/within the existing federal policy structure)
    - What have been the most significant barriers to implementing federally managed response/recovery projects? (i.e., BAER, EWP, BAR, FEMA)
- Are there any specific insights regarding the **timing, amount, and use of funding provided** for post-fire response or recovery policies? (Prompt here for: BAER, EWP, BAR, FEMA)

- How do you or your agency/organization determine success in terms of post-wildfire recovery?

- Can you share any other *success stories, surprises,* or *missed opportunities*?

    - Are these experiences being utilized in future project/organizational planning?

    - Have these lessons been captured or documented, and if so, how?

Recommendations

- Can you suggest 2-3 reform measures related to the existing programs/resources available for post-fire response and recovery or where new/outside-the-box measures could be of benefit?

- Are there any other insights or experiences with the post-fire recovery process that you would like to share that we did not specifically cover?

- Do you have recommendations of other individuals who we could speak with about this topic?

APPENDIX B – POST-WILDFIRE CODEBOOK

RO 1: Understand the major challenges that communities face in post-wildfire response and recovery.

1. What are the post-fire effects to resources and communities?
2. What are the primary challenges communities face when working with federal policies and programs to pursue response and recovery projects?

RO 2: Understand the successful and recommended governance approaches for improving post-wildfire response and recovery.

1. What are the governance approaches that allow organizations and agencies to navigate response and recovery policies?
2. What types of social learning do people perceive to be occurring as part of post-wildfire response and recovery?
3. What roles do boundary organizations play at various governance levels in post-wildfire response and recovery?
4. What are the recommendations for governance and specific policies to facilitate more effective post-wildfire response?

Notes

- There are multiple programs and governing agencies at play throughout the data set. Rather than creating subcodes for each code that delineates each program or agency, I chose to create memos each time a specific agency/program is at play.

Bold Text = Codes

1. **Barriers/Frustrators:** Challenges with specific programs or dynamics (not leadership or personalities related) that made response and recovery implementation difficult. This included scenarios that have caused frustration during the response and recovery process, even though they cannot be easily categorized as a barrier. This does not cause policy challenges [RO1.2]
2. **Recommendations:** Recommendations that would improve specific policies or programs. Or how to improve aspects of response and recovery (e.g. collaboration and coordination). [RO2.4]
3. **Response and Recovery Process:** How projects were implemented, how lead agencies went about planning and coordination, why specific decisions were made, scales that treatments are implemented at. Effects to communities and governments. [RO1.1]
4. **Policy/Program Guidelines:** Insights on how programs are structured (e.g. limitations, timing, governing agency, treatment and jurisdiction authorizations). [RO2.1]
5. **Success stories and unique arrangements:** Actions that were successful and aided with response and recovery actions. Arrangements that were new or relatively new to the HPCC recovery effort. [RO2.1]

6. **Non-governmental facilitators**: Actors that played a role in response and recovery. What role they played and how it assisted governmental entities (e.g. Universities, consultant groups, watershed alliances). [RO2.3]
7. **Lessons learned/debriefing:** How interviewees would have approached post-fire challenges with the knowledge they have now. References to workshops or meetings that will reflect on response and recovery efforts to date. Any reference to developing a post-fire playbook that would aid in future disasters. Also used to code surprises, success stories, and missed opportunities. [RO2.2]
8. **Policy disconnects**: Gaps between the goals and procedures of a policy/program and how they are actually implemented. Examples include: time scale mismatches (i.e funding and project implementation timing), spatial mismatch (i.e. jurisdiction limitations), functional mismatch (i.e. cultural differences or fiscal/administrative mismatches). [RO1.2]
9. **Collaboration/Adaptiveness**: Instances where collaboration was discussed and the context and forum in which it occurred. Examples of adapting current policy/programs to fit the needs of New Mexico or gaps that were filled in recognition of greater needs. [RO2.1]
    1. **Lines of Effort Framework:** Anytime the Lines of Effort are discussed.
10. **Leadership/Personalities**: Leadership in the response and recovery space and what outcomes they achieved. Personalities that made collaboration in response and recovery difficult. This might also include agency culture that has shaped the personalities of specific interviewees to interact the way they do. [RO2.1]
11. **Good Quotes:** Well-worded statements that capture research questions or themes.