UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

FIRE MANAGEMENT AND RISK PERCEPTION THROUGH AN

ORGANIZATIONAL LENS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

MONICA O'BRIEN MATTOX
Norman, Oklahoma
2024

FIRE MANAGEMENT AND RISK PERCEPTION THROUGH AN
ORGANIZATIONAL LENS


A DISSERTATION APPROVED FOR THE
DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL SUSTAINABILITY


BY THE COMMITTEE CONSISTING OF


Dr. Laurel Smith, Chair

Dr. Chris Fiebrich

Dr. Travis Gliedt

Dr. Mark Shafer

Dr. Joseph Ripberger

# ACKNOWLEDGEMENTS

The road to my PhD was a long one, marked by years of dedication, effort, valuable lessons learned, and a series of challenges and triumphs that have brought me to this significant milestone. Every step of my journey was constructed, piece by piece with the support and encouragement of many, for whom I owe the deepest gratitude.

To my committee chair, Dr. Laurel Smith: I am beyond fortunate to have worked under your advisement. Thank you for supporting me, challenging me, pushing me to grow beyond my own preconceived boundaries, and providing guidance and impeccable input. You introduced me to new ways of thinking, and you cheered for me at every turn, never letting me doubt myself. I was seen as a student, a professional, and a person. You made this experience the best version it could be, and I thank you from the bottom of my heart.

To the rest of my committee, Drs. Chris Fiebrich, Travis Gliedt, Mark Shafer, and Joe Ripberger: I could not have asked for a better group in my corner. Thank you for your support, your check-ins, your long dissertation reads, opening yourselves to questions and concerns, and providing feedback that always took my work to the next level. You helped me grow as a person and a scholar.

To my friends and colleagues at the Oklahoma Mesonet and the Department of Geography and Environmental Sustainability: What a fantastic network to be surrounded by! The curiosity, encouragement, and excitement you showed for me, my research, and my PhD journey helped drive me every day. None of this would have been possible without your backing and the flexibility you provided me during my PhD efforts.

To my dearest friends and family, my children, my parents, and my in-laws: Thank you for being my anchors, for pulling me up when I fell down, for every note of encouragement, and every burden you tried to carry with me. Specifically, to my parents, thank you for always being there for me and raising me to be strong, persistent, to relish new experiences, and be comfortable in the most uncomfortable and unfamiliar environments. Thank you, mom, for always making me repeat "I can do it!" in the mirror when I was a little girl, and still telling me I can as an adult. You showed me what being a strong, confident, and intelligent woman looks like. Thank you, dad, for including your girls in all of your Boy Scout, theater, outdoor, and life adventures. You never let anyone put limitations on what we could do. Thank you for encouraging my dreams while reminding me I still need to pay the bills. To Mary and Lynn, I could not ask for better in-laws. I am beyond grateful for your encouragement, unyielding generosity, and support. You are the best of humanity and I deeply respect and admire you both. I love you all so much, I *feel* your love, and I thank you for always believing in me.

Last, and *most certainly* not least, to my husband, Danny: You have always been my number one supporter. Thank you for your grace, your patience, your encouragement, and your uncanny ability to know exactly what I need, when I need it. Your unmatched skillset in the kitchen helped fuel me, especially during marathon writing sessions. Thank you for your sincere interest in my research, for being a focus group note-taker and travel partner when I was eight-months pregnant, and being a phenomenal proofreader. You have been there for all the ups and downs, and I could not have done this without you. This accomplishment is as much yours as it is mine. I love you.

Thank you, all, for being a part of my journey.

TABLE OF CONTENTS

# List of Tables

## List of Figures

# ABSTRACT

Acting as a relentless flame, increasing wildfire risk has left a scorched trail of devastation across the globe. Based on the most recent National Climate Assessment, this threat is only projected to climb as climate change increases the prevalence of warm temperatures and dry conditions (USGCRP, 2023). In response to fuel and land management changes, human activity, and climate change, the amount of acreage burned by high-severity wildfires in the West has increased eightfold since 1985. Not unique to the West, 16 megafires also blazed across the landscape of the Southern Great Plains between 2000 and 2018 (USGCRP, 2023). By February of 2024, that same region experienced the largest wildfire in contiguous U.S. history, having burned over one million acres across the Texas Panhandle and into far western Oklahoma, resulting in a major loss of livestock, infrastructure, and life (Henson, 2024).

Responding to such events and managing the potential for future catastrophic wildfire events are fire managers at various organizational levels. Fire management organizations operate within their own unique decision-making processes, informed by their perception of wildfire risk. To better address the looming threat of wildfires, researchers, funding agencies, fire managers, and stakeholders need to understand how fire managers make decisions, what pressures and challenges influence their decisions, and how they perceive climate change and wildfire risk. To answer these questions among the different organizational levels, I surveyed federal, state, and regional fire managers (FSR) across the United States and conducted five focus groups with local fire managers throughout Oklahoma. The robust amount of data that was gathered, coded, and analyzed, provides extensive insights that are compared across organizational levels.

Among the key findings are acknowledgement by fire managers at all organizational levels that wildfire risk and its severity are increasing, and that experience and trust play a significant role in shaping those risk perceptions. When relating risk to climate change, there were different levels of acceptance and concern, with more recognition at the FSR level than the local level. Impacts and challenges associated with fuel and land management, human activity, the wildland-urban interface, and population growth were thought to be the primary causes and challenges associated with wildfire risk. In addition, among the most influential decision-making pressures were staffing and funding for FSR managers, and public and landowner perception and influence at the local level. Given staffing and funding limitations, there is a lack of climate change consideration in long-term planning, general planning processes, and related policy at all fire management levels. To address ongoing challenges and pressures, staffing and funding need to be stabilized, and there needs to be a strong push in public communication and education on wildfire risk and fuel and land management.

These results provide a better understanding of what shapes and influences risk perception and decision-making across federal, state, regional, and local fire management levels. Such insights can inform and help prioritize areas of focus within organizations to improve organizational function and processes in response to the wildfire threat. In addition, the results underscore knowledge gaps that can be better connected between researchers, fire managers, and funding sources, as well as between fire managers and the public. While ample room exists for additional research on the various factors and nuances

of fire management risk perception, as well as policy development and implementation, this research establishes a strong foundation and starting point.

Keywords: fire management, wildfire, risk, organizations, organizational geographies, perception, policy, decision-making, human activity, land management, fuel, climate change

**CHAPTER 1: INTRODUCTION**

For centuries, fire has molded the global landscape. Occurring through lightning strike or set by Indigenous land management long before settler colonialism (Cardille et al., 2001; Henderson et al., 2005), fire has advanced humanity's capabilities with warmth, cooking, promoting grass growth for forage, and myriad other uses (Henderson et al., 2005). Notwithstanding its numerous benefits and rich history, however, the world is gradually becoming more familiar with the hazards of increasing and uncontrollable wildfires. Annual statistics from the National Interagency Fire Center (2022) demonstrate a dramatic increase in the 5-year moving average of wildfire acreage burned in the United States, highlighting the growing risk of wildfire (see Figure 1). This 5-year average shows three times the acreage burned during the most recent 5-year period as compared to when agency records began in 1983. In another report by the National Climate Assessment, a review of acreage burned from 2000-2016 found that at least 52 million acres burned nationwide during that time (USGCRP, 2018).

Observed increases in wildfire frequency, the number of large fires, and fire season length in many portions of the U.S. demonstrate that wildfires are a formidable and impending threat to many communities (Harvey, 2016). Exacerbating this threat further is development and related population increase at the wildland-urban interface (WUI), where communities intersect with forested areas at risk of fire (USGCRP, 2018). Humans are living in closer proximity to flammable vegetation, with WUIs making up the "fastest-growing land type in the conterminous United States" (Volker et al., 2018, p. 3314). Growing wildfire activity impacts the economy, ecology, agriculture, health and safety, and cultural traditions. Transformations include a surge in human fatality and property loss;

greater resource demand for disaster prevention and recovery; intensified carbon and particle emissions from fire activity, which cause adverse environmental effects; and declining access to traditionally significant plants, animals, and resources (Liu et al., 2013; Voggesser et al., 2013). Underscoring the timely relevance of this threat were devastating 2023 wildfires that impacted communities across the United States, from Maui in the west to drifting Canadian smoke plumes in the east. Structures and lives were lost and upended, and the August Maui fire became known as the deadliest in recent history (Arkin & Blackman, 2023; Dong et al., 2023; Holt, 2023; Treisman, 2023).
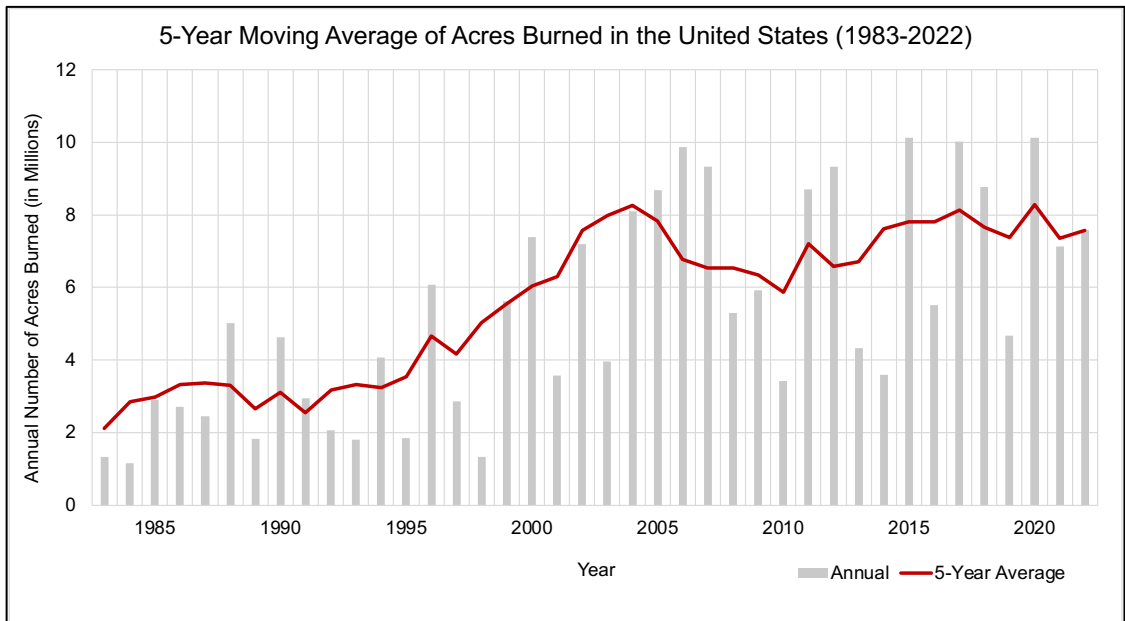


Figure 1. Annual number of acres burned in the United States (1983-2022) overlayed by the 5-year moving average (National Interagency Fire Center, 2022).

To combat threats associated with an increase in wildfires, resource and fire managers seek to understand potential risks and hazards. As they strive to adapt to, plan for, and manage responses to wildfires, they must navigate politically, organizationally, socially, and environmentally complex situations within their own organization and across

those at different governmental levels. Generally speaking, fire managers fall within the fields of emergency management, city fire departments, federal land management departments, prescribed burn associations, and more, with each agency following different strategies, priorities, and jurisdictions. A critical component of how they operate is shaped by their perceptions, expertise, and goals. For example, some prioritize the maintenance of federal reserves and habitats, while others aim to ensure the safety of homesteads and defensible zones. Doing their work effectively and efficiently demands understanding of fire management, risk perception, and decision-making at these various levels, as well as coordination among, and awareness of, these organizational constructs.

Substantial literature examines individual risk perception through the lens of generalized theory about organizational pressures; however, little research weaves together risk perception with data on the pressures internal and external to organizations that drive decision-making among fire managers (Leiserowitz, 2006; Martin et al., 2009; Thompson, 2014; Champ & Brenkert-Smith, 2016; Cova et al., 2017). To better understand how fire managers navigate the complexities of risk perception in light of pressures exerted at various levels (e.g., federal, state, and local), and as they relate to decision-making processes, I set out to answer the following overarching research questions:

1. How do individuals within organizations at different organizational levels perceive wildfire risk?
2. How do fire managers associate wildfire risk with climate change and/or human behavior?
3. What products and information do organizations use for their decision-making processes?
4. How do perceptions, decision-making tools/processes, and organizational constructs translate into policy or strategic planning?
5. What factors or pressures (political, legal, cultural, social, environmental) drive organizational decisions and perceptions?

In essence, I investigated how fire managers across different agency levels formulate and face climate-induced wildfire risk. I asked them how they access, assess, perceive, and prioritize the information driving their personal and organizational/agency-level fire management decisions.

Given how "positionality and situatedness influences the research process from early on" (Bosco & Herman, 2010, p. 10), I wish to locate myself and my work (Mansvelt & Berg, 2016). In my formative years, my parents worked in the medical and law enforcement industries. Their disposition to advance the well-being of others shaped my desire to do the same, particularly in relation to climate and weather. I wanted to know the science behind atmospheric phenomenon and how events and conditions impacted the well-being and safety of individuals and communities. I satiated my curiosity and concern by academically navigating toward the physical and social sciences and joining the School of Meteorology at the University of Oklahoma. Feeding my passion for science, weather, the environment, and societal impacts, I earned a Bachelor's degree in Meteorology.

Throughout those undergraduate years, I worked as a student assistant at the Oklahoma Climatological Survey and Mesonet. The latter cultivated my interests in climatology, hazards, and impacts, and with the support of a full-time position at the Mesonet, I went back to earn my Master's degree in Geography. Within the Geography department, I had an opportunity to work on my ideal project combining climate, weather, particulate matter, and health in West Africa. As I continued my professional journey at the Oklahoma Mesonet during my Master's, I became the Assistant State Climatologist. Within this position, I have built a portfolio of working extensively with stakeholders, decision-makers, fire managers, and the OK-FIRE program for over a decade. As a top-

notch and unique fire program, OK-FIRE has played a significant role in shaping my current interests.

The Oklahoma Mesonet, a partnership between the University of Oklahoma (OU) and Oklahoma State University (OSU), acted as the foundation for OK-FIRE (Carlson et al., 2011). Operating under the auspices of the Oklahoma Climatological Survey, and added to the state statute in 1982, the Oklahoma Mesonet developed into a gold standard for automated weather monitoring and quality-assured data with user-friendly products (Brock et al., 1995; McPherson et al., 2007). Born from the recognizable need for a decision-making support system for Oklahoma fire management that would provide the ability to plan for prescribed burns, manage land, reduce impact, and mitigate the threat of fire, the idea for OK-FIRE was sparked in 2004. Answering a call for proposals by the Joint Fire Science Program (JFSP), Oklahoma had an opportunity to build on an already existing weather network to develop a weather-based operational wildland fire management system.

Identifying the need to "incorporate a forecast component into the Mesonet-based fire management tools, to develop a stand-alone dedicated fire management website, and to provide necessary training to users of the system", OK-FIRE initially had three primary goals and objectives (Carlson et al., 2011, p. 3). The first goal was to develop a comprehensive suite of operational recent, current, and forecast products for fire weather, fire danger, and smoke dispersion. The second goal was to then develop a dedicated, easily accessible, and user-friendly website that would act as the delivery mechanism for those products. Once the products and website were in place, the final objective would be to provide regional training and customer support activities for users (Carlson et al., 2011).

The project was funded by JFSP in October of 2005 and the first initiative of the program was to create decision-support products to showcase on an OK-FIRE website. Shortly after web and product implementation, OK-FIRE started hosting training workshops for users. With an original targeted audience of federal land management agencies, one state agency, and one private organization—e.g., the US Army Corps of Engineers, National Park Service, Oklahoma Forestry Services, and the Nature Conservancy—users were eventually expanded to include the National Weather Service, the Natural Resources Conservation Service, fire departments, emergency managers, and private landowners (Carlson et al., 2011). Between 2006 and 2022, OK-FIRE trained nearly two-thousand decision-makers, fire managers, and private citizens through its handful of annual workshops. The program has also expanded its reach by supporting roughly ten-thousand unique online users per month through various online data products and decision-support tools.

While I have found my work with OK-FIRE and fire managers to be some of the most rewarding, I have also garnered valuable, complimentary experience as a Research Associate with the Southern Climate Impacts Planning Program (SCIPP) and as the Manager of Governmental Affairs at the South-Central Climate Adaptation Science Center (CASC). These positions gave me experience in addressing climate hazards and hosting focus groups with stakeholders and decision-makers across various agency levels. I have witnessed the process of strategizing and planning from the boots on the ground, up to the federal level. In addition, I worked closely with federal agencies and legislators across the country to determine community wants and needs as they related to climate change and impacts. Through this work, I built relationships within the weather and climate

community, researchers, decision-makers, and fire managers, all operating at different levels, with diverse priorities and operations.

Wanting to build on this experience and assist decision-makers at these various levels, especially regarding climate and fire management, I decided to further my education once again by working toward my Doctorate in Geography and Environmental Sustainability. This academic program nicely fuses the physical and social sciences and provides interdisciplinary opportunities. Drawing from my academic and professional background, I am in a unique position to build from existing relationships, my expertise in the physical and social sciences, and my experience working with decision-makers at multiple levels. This situates me nicely to pursue a dissertation focused on societal issues, weather, climate impacts and hazards, and fire management.

To address my research questions at different geographical and organizational levels and leverage my positionality, surveys (Phase I) and focus groups (Phase II) were employed. Phase I of the project included a survey specifically geared toward federal- and state-level fire managers that I disseminated to various agencies across the United States. This survey explored perceptions of climate change and wildfire risk, as well as organizational drivers of management practices and decision-making. Phase II highlighted these same inquiries at a local level within the state of Oklahoma, through the use of five focus groups, held in centralized locations for participants in each region. I facilitated focus groups in Lawton in the southwest, Woodward in the northwest, Norman in central Oklahoma, Sand Springs in the northeast, and McAlester in southeast Oklahoma. Participants included emergency managers, prescribed burn associations, fire departments, and OK-FIRE users, among others.

Robust information garnered and shared through this process has broad benefits to society, the environment, and fire managers, as well as more localized potential. Posing and answering questions about wildfires, perceptions, decision-making, and how pressures influence organizational actions can richly inform Oklahoma-specific policy and organizational decision-making. Furthermore, my research results can be leveraged to identify strengths, weaknesses, and opportunities related to agency practices, structures, processes, and allocation of resources. Learning how to better support fire managers and their needs will, in turn, better serve their communities.

The following chapter of my dissertation walks through the wildfire literature, with particular focus on the physical profile and drivers of wildfires, as well as the social components. Guided by the literature, I discuss the causes and trends in wildfires domestically and abroad. Projections related to wildfire activity are then reviewed as it is critical to know where the threat of wildfire is heading as it relates to seasonal trends, severity, and likelihood over time. This growing wildfire threat is then translated from a physical problem to a human problem, emphasizing the human role in ignition and fire managers as key players in addressing the wildfire problem. Since decision-making and social organizational structures are pivotal to this area of research, risk perception, fire management, and organizational studies are also discussed, underscoring the ways fire and management relate. Rounding out my second chapter is my theoretical framework that describes my use of risk perception and organizational theory, followed by an overview of and justification for my research methods.

Chapters 3 and 4 then dive deeper into my methods and findings, with Chapter 3 dedicated to the surveys at the national level and Chapter 4 covering the focus groups at

the state and local level. Within these two chapters, I present the results of each and discuss findings. The discussion is expanded further in Chapter 5, where I revisit my research questions and preparatory literature in the context of my results and make comparisons among the various organizational levels. Within the discussion are implications, recommendations, and limitations that can inform future research. I then conclude with a recap of my research, reflections, lessons learned, and potential areas of further analysis.

**CHAPTER 2: LIVING WITH FIRE—A REVIEW**

At first glance, fire may appear fairly one-dimensional. However, it is comprised of three driving factors that stretch well beyond the surface: climate and weather, ignition, and fuel (Nagy et al., 2018; Parks et al., 2016). Often these factors, in the simplest classification, get divided into physical (or biophysical) and human dimensions. Climate, weather, and fuel are often catalogued under the physical problem, while ignition plays on both sides of the fence. However, none of these components are void of human impact. Humans are a significant ingredient in climate change, they ignite fires intentionally and unintentionally, they influence wildfire spatial extent based on fuel and land management practices, and they act to prevent and extinguish wildfires. Recognizing this connection and bridging the physical and human components situates fire within a more holistic and interdisciplinary geographic tradition. In this chapter, I discuss how fire has been identified as a physical problem housed under physical geography and how it can be recategorized as a human problem. I then discuss my methodological framework with fire management organizations as my unit of study, and how I used surveys and focus groups to address my research questions.

## 2.1 Physical Geography of Fire

With the recognition that there are both positive and negative aspects of fire, much emphasis has been placed on the negative. In particular, concern has grown over the increase in fire size, severity, frequency, and fire season length (An et al., 2015; Kinoshita et al., 2016; Liu et al., 2013). Human encroachment and development in wildland areas have amplified the significance of changing fire regimes, placing humans at greater risk because the "natural range of fire sizes and resultant frequencies, timings, and intensities"

that characterize a fire regime are shifting (Moritz et al., 2014, p. 58). Not only can the increasing threat of fire impact the economy, human safety, and wellbeing of individuals, it also causes harmful biophysical effects, such as degraded habitats, poor water quality, and erosion (Kinoshita et al., 2016).

One of the primary forces orchestrating this growing danger is a changing climate. The natural climate variability and anthropogenic influences of climate change intensify the cascading effects of increasing temperatures, changing precipitation patterns, and fuel moisture. These climate conditions, coupled with fire weather (e.g., wind direction, wind speed, and humidity), greatly influence fire ignition and spread (Liu et al., 2013). Higher temperatures, combined with drier conditions, decrease fuel moisture and make vegetation more combustible. When discerning real-time threats pertaining to ignition and spread, days that are dry, windy, and have low relative humidity act as catalysts to large wildfires (Krueger et al., 2015). Assessing the threat on a slightly longer temporal scale, it has also been found that rising temperatures are increasing fire season length (An et al., 2015).

If we are to address this threat as communities, individuals, and decision-makers, these physical components of fire need not only a historical perspective, but continued investigation into how it will change in the future. Fortunately, weather and climate drivers, statistical analyses, and projections have been well documented in the literature with climate and fuel models reinforcing research on the magnitude and extent of changing fire regimes (Joseph et al., 2019; Litschert, et al., 2012; Prestemon et al., 2016). Incorporating an array of scenarios and estimating the effects of climate change on wildfires constitutes critical components in wildfire management and planning (Abatzoglou & Kolden, 2013;

Prestemon et al., 2016). Fire managers and governing agencies need to understand and utilize these metrics, projections, and probabilities, both spatially and temporally.

According to An et al. (2015), a wildfire can be defined as "any uncontrolled fire occurring within nature landscape, such as forestlands" (p. 3198). Fire is a fundamental and complex element in life that can be a source for good (e.g., warmth, food, land management), or a source of destruction. It is through the lens of destruction that we often view wildfires and the risk associated with them—the probability and potential losses they cause (Fischer et al., 2016). The growing risk of wildfires manifests as a longer fire season; a higher potential for very large fires (VLFs or megafires) and, therefore, larger burned areas; and an increase in frequency, number, and intensity of fires (Abazoglou & Kolden, 2013; An et al., 2015; Barbero et al., 2015; Liu et al., 2013; Nagy et al., 2018).

**2.1.1 Causes of Wildfire**

Ample research explores wildfire trends and highlights the physical drivers of wildfire (Litschert et al., 2012; Liu et al., 2013; Dennison et al., 2014; An et al., 2015; Lindley et al., 2019). The fire trifecta: climate and weather, fuel, and ignition set the stage for wildfires, and without them, the threat wouldn't exist (Nagy et al, 2018; Parks et al., 2016). In the following section, this trifecta is explained in detail, as are the significance and statistics of ignitions. The pattern and trends made evident in these details assist in painting a broader picture of wildfires as a shared, global problem and phenomena.

*2.1.1.1 Climate, Weather, and Fuel*

Climate and weather are significant factors that shape and prime the environment for potential wildfires. "Weather" in this context is often referred to as "fire weather", which consists of meteorological conditions, such as temperature, precipitation, wind,

humidity, fronts, etc., that can increase fire potential and modify fire behavior (Liu et al., 2013). The long-term average of these conditions creates our "climate". Due to natural and anthropogenic influences and an increase in greenhouse gas emissions, our climate and frequency of weather conditions are changing (Ayres et al., 2014; Liu et al., 2013). Global climate models have predicted significant warming over the next century, accompanied by regional drying (Pechony & Shindell, 2010). Projections in precipitation are not uniform, but they identify our Southern Great Plains region as being likely to see an increase in extreme precipitation events with intense dry periods in between (IPCC, 2014; USGCRP, 2018).

These changing climate conditions and extreme weather events impact nature's fuel for wildfires (Liu et al, 2013). Precipitation spurs vegetative growth and if that growth is followed by extreme warm and dry conditions as models predict, this allows the vegetation to "bake" and turn into kindle (USGCRP, 2018). This process is significant because vegetation acts as kindle for potential fires and drier kindle is more combustible (Krueger et al., 2015). With increasing temperatures working alongside precipitation abundance and then deficits, these trends are altering fuel profiles and increasing periods of fire potential and, thus, fire season length (An et al., 2015; Liu et al., 2013).

Fuel moisture is further reduced by day-of fire weather variables such as high temperatures and low relative humidity. High winds then provide an opportunity for ignition and spread (Liu et al., 2013). As we see these conditions become more common, they escalate the potential for wildfire occurrence, as well as increase chances for megafires (fires whose burned area exceeds 100,000 acres) (Lindley et al., 2019; Liu et al, 2013). In whole, climate change has increased the frequency of conditions that are conducive for

fires and increased the window of time in which fuels and weather are ideal for igniting and spreading fires (Barbero et al., 2015).

## 2.1.2 Trends and Projections in Wildfire Activity

There have been many efforts to analyze future wildfire threats, with approaches to projections and study areas varying throughout the literature. For example, Dennison et al. (2014) investigated nine ecoregions in the western United States for the period 1984-2011, intending to quantify wildfire trends with greater spatial extent. Focus was given to large fires greater than 1000 acres, likelihood of occurrence, total fire area, size, and date of ignition. Their Monitoring Trends in Burn Severity Project provides boundaries of area burned based on satellite remote sensing data. While many studies have underscored the significance of climate variables as wildfire drivers, Dennison et al. (2014) additionally incorporated seasonal temperature, precipitation, and Palmer Drought Severity Index values for their study area. They also analyzed quantile regression; trends, or slopes over time; and likelihood values.

Following their analysis of trends, Dennison et al. (2014) found that the number of fires increased at a rate of seven large fires per year for each ecoregion. Total fire area as well as number of fires increased significantly in the Southern Plains and the Arizona-New Mexico Mountains. However, there was much more variation when it came to the date of early season fires. Higher elevation and southern ecoregions trended earlier, and northern and interior ecoregions and Mediterranean California occurred later. It was also found that number of large fires and total fire area increased with drought severity and higher temperatures. Overall, much of the western United States saw significant positive trends in fire activity.

Also interested in wildfire trends, Liu et al. (2013) investigated potential changes throughout the continental United States under a changing climate for both 1971-2000 and 2041-2070. They measured wildfire potential with the Keetch-Byram Drought Index (KBDI), which uses daily temperature and precipitation data, as well as relative humidity and wind speed. Using regional climate change scenarios from the downscaling of models, they calculated and analyzed spatial patterns and seasonal variations of wildfire potential (measured as KBDI). Comparing KBDI to the modified Fosberg Fire Weather Index allowed them to examine the potential impact of relative humidity and wind speed. The findings from the models and analyses featured in Liu et al. were extensive. An examination of 1971-2000 shows that fire potential had been increasing in recent decades. Moving forward, fire potential is expected to increase throughout most of the U.S. with significant increases in summer and autumn, as well as an extended fire season in the South. The notion that increasing temperatures are the primary cause in fire potential reinforces these seasonal trends. Based on humidity and wind projections, however, fire potential is projected to be reduced in the northwestern U.S.

Prestemon et al. (2016) looked at projected area burned for 2011-2060 in the southeastern U.S. Historical data were used to build statistical models, which included climate, social factors (e.g., population density and income), and human-caused and lightning ignitions. Three potential emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC) were incorporated in the model. In addition, Prestemon et al. (2016) estimated how the societal factors and land use changes would impact the projections of area burned. Underscoring the significance of societal factors and income, the authors suggested that "locations with higher wealth generally have greater financial

resources available for fire suppression and prevention, leading to smaller overall wildfires. Such locations also typically have greater values at risk, which would compel greater investments in suppression and prevention" (Prestemon et al., 2016, p. 725).

Echoing Dennison et al. (2014) and Liu et al. (2013), Prestemon et al. (2016) anticipate an increase in the total wildfire area burned annually in the southeast United States. However, they also discern ample variability by state and ecoregion. For instance, at the state level, they project that Arkansas and Tennessee will see the most significant decrease in wildfire area burned, while Louisiana and Florida may see the largest increase. The difference in these projections were influenced by anticipated population growth, population density, income, and changes to the forest area. Separated by ignition source, it was also found that the projected area burned by lightning-caused wildfire is expected to increase by 34%. Conversely, burned area from human-caused ignition is expected to decrease by 6% due to population growth and, thus, increased land fragmentation and changes in fuel distribution.

Whether focused on the past, present, or future, all of these studies emphasize predominately increasing wildfire trends. Each also relates the primary drivers of increasing wildfire trends to climate change, particularly where higher temperatures and dry conditions factor significantly. Corroborating conclusions, as well as the differences in the aforementioned literature, provide unique insight regarding wildfire projections. The amassed research has substantiated the importance of physical drivers of wildfire risk and identified that the risk is anticipated to grow.

## 2.2 Translating a Physical Problem into a Human One

There is a strong physical science argument for an escalating wildfire problem. Trends, predictions, and atmospheric drivers have been thoroughly established by meteorologists, climatologists, physical geographers, modelers, and others in the physical research realm (Liu et al., 2013; Dennison et al., 2014; Neale & May, 2020). However, while the physical trifecta (climate, weather, and fuel) is an influential driver of fire, the human geography component is equally important. Broadly defined, human geography "seeks to understand how people experience events, places, and processes"; it also aims to recognize the factors that shape these experiences (McGuirk and O'Neill, 2016, p. 246).

The human geographic approach addresses questions of social structures, human values, behavior, actions, beliefs, knowledge creation, meanings, and experiences (McGuirk and O'Neill, 2016; Winchester & Rofe, 2016). Recognizing humans as active participants in fire ignition, land management, and wildfire response, translates wildfires from a physical problem into a human one. Such an example can be seen within Oklahoma where the history of fire exclusion, poor land management, and drought have helped with the successful encroachment and invasion of *Juniperus virginiana* (eastern redcedars) (Hoff et al., 2018). Given that this species is highly volatile, susceptible to wildfire, and has extreme flame lengths, fire suppression and control by responding agencies is difficult when wildfires occur. Shifting the physical problem into a human one occurs when you humanize the impacts of current and historical land management practices, such as redcedars posing a threat to fire managers and communities building alongside them in the WUI (Hoff et al., 2018). The subsequent section identifies the human role in ignition and discusses fire managers as key players in the wildfire problem. It emphasizes how fire

managers perceive wildfire risk and physical drivers of wildfires. It also considers how those perceptions and organizational pressures inform wildfire management, planning, and response.

## 2.2.1 The Human Spark

Although climate, weather, and fuel conditions prime the environment for wildfires, a spark still needs to exist for them to occur. These sparks are often divvied up into two categories: natural- or human-caused. The primary natural cause outlined in the literature is lightning, with a lesser extent of recognition given to volcanoes (Abt et al., 2015; Cardille et al., 2001, Narayanaraj & Wimberly, 2012). Human-caused ignitions, however, have replaced lightning as the primary ignition source for wildfires, with humans being responsible for four times as many fires as lightning (Kinoshita et al., 2016; Nagy et al., 2018).

Most fires caused by humans are unintentional (Abt et al., 2015). Many studies have linked fire ignitions to campfires, smoking, using fire as a tool (trash burning, land clearing, resource management, etc.), sparks from machinery, railroads, timber harvests, and recreational activities, such as fireworks (Abt et al., 2015; An et al., 2015; Wakelin, 2010). In addition, the wildland urban interface (WUI), population density, and infrastructure (i.e., electrical lines), have been linked to large wildfires (Nagy et al., 2018). The expansion of humans into the WUI and their encroachment into natural and undeveloped areas has increased opportunity for wildfires (Kinoshita et al., 2016). WUIs make up the "fastest-growing land type in the conterminous United States" and introduce a greater threat of fire ignition with humans living in closer proximity to flammable vegetation (Radeloff et al., 2018, p. 3314). Compounding the problem that ignitions

frequently occur at WUIs is the fact that houses are often burned at this interface and house fires are the most challenging to extinguish (Radeloff et al., 2018).

## 2.2.2 Mapping Ignitions

Research clearly illustrates how humans are the primary ignition source for wildfires throughout much of the contiguous United States (Abt et al., 2015; An et al., 2015; Calef et al., 2008; Nagy et al., 2018; Prestemon et al., 2016). This finding has not been consistent in Alaska, however, where a study by Calef et al. (2008) found lightning to be the primary cause from 1956-2000. Furthermore, in an analysis from 1988-2005, lightning gradually exceeded human ignitions at distances greater than 20 km from settlements and highways (Calef et al., 2008). When investigated at a more regional scale, it is also worth noting that one study by Cardille et al. (2001) found lightning-caused fires to result in larger fires in the western U.S. as opposed to human-caused fires in the Upper Midwest. The complexity of this latter finding is that although humans cause the majority of fires, those ignited by nature are able to rapidly grow in absence of human awareness, access, or intervention (Cardille et al., 2001). Also, while humans may ignite wildfires, they limit their spatial extent with fire suppression and land fragmentation from development (Aldersley et al., 2011; Narayanaraj & Wimberly, 2012).

Humans are the predominate cause of wildfires abroad as well. For example, New Zealand grasslands have seen an increase in wildfire ignitions from recreational activities on conservation lands. Very similar to the United States, these ignitions come in the form of overheated vehicles sitting on grass, cigarettes, machinery sparks, campfires, etc. (Wakelin, 2010). Destructive wildfires throughout forests and agricultural lands in Greece have also been attributed to humans, often due to negligence or accident (Alexandrian &

Esnault, 1998; Henderson et al., 2005). In a global study, Knorr et al. (2013) argue that humans are the dominant source of wildfires, although they also acknowledge that human impact decreases in sparsely populated regions. Consistent with findings from Aldersley et al. (2011) and Narayanaraj & Wimberly (2012), this global study also discovered that humans may be a source for wildfire decline due to fire suppression efforts and landscape fragmentation. In conjunction with human ignition, the impact of fire suppression and land management on wildfire tendencies points to the close relationship between human actions, fire management, and wildfire activity. This relationship ultimately underpins wildfire as a human problem, and one that may be best addressed by fire managers.

### 2.2.3. Fire Managers

Emergent wildfire threats amid a changing climate have required a human response to maintain the balance between society and nature and promote cohabitation. This threat has created a need for experts who can plan for, manage, and respond to wildfires, especially as population increases and communities move further into the wildland boundary with increased exposure (Charnley et. al, 2017; Neale & May, 2020). Much of the responsibility falls on fire managers in government institutions, land management agencies, land planning departments, municipal or volunteer fire departments, emergency management, and state-level natural resource departments (Fischer et al., 2016; Kinoshita et al., 2016; Neale & May, 2020). The term "fire manager" broadly refers to individuals or organizations that work with prescribed fire or wildland fire, or both. Managers could be involved in efforts ranging from the science and research behind fire planning, modeling, forecasting, and response support, to those on the ground actively suppressing or utilizing fire in land management. Among fire managers' primary concerns are the impact to what

the human population holds valuable (e.g., property, life, etc.), and the biophysical risk associated with fires—the latter being determined by the "probabilities of occurrence and the severity of impacts" (Smith et al., 2016, p. 131). These concerns translate to a physical conundrum and a human one, both of which are addressed by different types of fire managers.

Depending on the organization, fire managers have different approaches to fire governance and reducing wildfire hazards. Given the array of organizations that operate in fire management, the solutions are so diverse and noncomprehensive that wildland fire management has been coined a "wicked problem" (Chapin et al., 2008; Smith et al., 2016). Some managers and institutions prioritize the human impact and are involved in prevention and suppression, while others focus on measuring the potential of the physical problem. Neale and May (2020) refer to these as "frontstage" and "backstage" experts, respectively. Frontstage managers provide the field experience and boots on the ground, while the backstage experts are more office-based and handle the predictions, statistics, and modeling (Neale & May, 2020).

While both frontstage and backstage expert types are critical in fire management, it has become clear that social dynamics and institutions are a mounting and substantial factor in the wicked problem (Smith et al., 2016). In combination with the biophysical science of wildfires, special attention needs to be paid to these social dynamics at the center of fire management and decision-making, such as individual and organizational perceptions (Ager et al., 2015). The social geographies of experiences, culture, beliefs, values, and knowledge contour human perceptions. In turn, human perceptions show how

groups and individuals view and evaluate risk, which can then influence behavior and policy (Leiserowitz, 2006).

An abundance of research has focused on collective, or group, adaptation to risk (Brenkert-Smith, 2010; Everett & Fuller, 2011; Gordon et al., 2013). Findings have demonstrated that the perception of individual risk is often much lower than the sense of cumulative risk to a community or group, or socially amplified risk (Gordon et al., 2013; Slovic, 2016). Therefore, group risk encourages more mitigation efforts (Gordon et al., 2013). Leaning into this, my research asks how fire managers' perceptions of wildfire risk, both as individuals and as a group (or as an organization defined in this research) shapes their fire management practices. How do their experiences with and understanding of risk inform their organizational decisions and behavior? Evaluation of risk, or risk perception, determine human behavior and are vitally important to priorities and management practices (Ager et al., 2015).

## 2.2.4 Risk

Although organizations encompass their own culture and beliefs, they are comprised of individuals that have been shaped by experiences, values, and worldviews unique to them (Leiserowitz, 2006). This handful of traits, combined with many others, create an individual's perceptions, and play an important part in driving behaviors (Leiserowitz, 2006). Past events and experiences, social relationships, access to information, and culture are four common themes seen in risk perception literature (Burton & Kates, 1964; Champ & Brekhert-Smith, 2016; McCaffrey, 2004). These four themes, acting as the pillars of my risk perception theoretical framework, can be used to explain fire managers' actions and behaviors.

*2.2.4.1 Experience*

Devastating fires have been experienced by communities for centuries. During a particularly disastrous period, thousands of lives and hundreds of thousands of hectares of land were lost during the late 1800s and early 1900s. Fires, such as the 1871 Peshtigo Fire in Wisconsin, and numerous other timber-cutting fires in Michigan, left a solemn mark on society. As its World War II efforts wound down, the United States shifted into a newly found war on fire. These experiences reshaped public opinion and perception of risk, which resulted in efforts and resources exclusively directed toward fire suppression and related policy changes (Dombeck et al., 2004).

Fires have continued to roar throughout the last century. In the previous decade alone (2009-2019), the United States averaged roughly 65 thousand fires per year, over 6 million acres burned, and nearly 2 billion dollars in fire suppression costs by the U.S. Forest Service and Department of Interior (National Interagency Fire Center, 2021). While the occurrence of fires has been a consistent phenomenon, risk perceptions have not. Supported by numerous case studies on human experiences with fire and their perceptions of risk, these events have impacted response actions much differently than what was observed at the turn of the $20^{th}$ century (Champ & Brenkert-Smith, 2016; Martin et al., 2009)

In thinking about experience as a *direct* experience rather than shared or indirect, many research studies have found that experience does very little to impact risk perception (Champ & Brenkert-Smith, 2016; Martin et al., 2009; McGee et al., 2009). For example, risk perception has been found to decrease following a wildfire event in some instances. In addition, perception of risk tends to decline as length of time following the fire increases (Champ & Brenkert-Smith, 2016). As a result, experience does not necessarily lead to

mitigation actions or policy changes (Martin et al., 2009). Adding complexity to experience, however, is that past research has found that combining experiences with the consequences of those experiences can create a higher perception of risk. For example, those who lost homes or had to evacuate due to a wildfire were found to perceive a higher probability of wildfire occurrence and the negative impacts associated with them (Champ & Brenkert-Smith, 2016).

In addition, a common thread in risk perception literature is the notion that once a significant event happens, it likely will not happen again (Champ & Brekhert-Smith, 2016). Coined the "gambler's fallacy", this latter perception is described as individuals experiencing something so much, they become numb to it (McCaffrey, 2004, p. 512). Acknowledging that responses to experience are not universal, however, some studies have noted individuals feeling heightened risk post-fire exposure, while others believe "lightning doesn't strike twice" (Champ & Brenkert-Smith, 2016, p. 825). Given the research dedicated to risk perception and experience among community residents and the variation in response, it is vital to continue this conversation with fire managers. Understanding past experiences as they relate to level of perceived risk, whether their own or those of the community members they serve, can sway attitudes toward priorities, mitigation, management, and planning strategies.

### *2.2.4.2 Social Relationships*

Pulling in the concept of shared and peer (or indirect) experiences leads us to a second theme often perpetuated in the risk perception literature: social relationships. Case studies, interviews, and surveys with residents in the wildland urban interface suggest that indirect experience with fire events is a higher predictor of risk perception (McCaffrey,

2004). One such study by Champ & Brenkert-Smith (2016) disseminated surveys to residents in two different communities. Surveys were sent prior to a destructive wildfire, and again, shortly after the wildfire. Responses supported the finding that hearing about an experience through a neighbor or through your social network can have more meaning than if you were to witness an event yourself (Champ & Brenkert-Smith, 2016). With social connections between people acting as "facilitators of information", it only makes sense that information gleaned from shared experiences can greatly influence perceptions (Ager et al., 2015, p. 1399).

One of the main factors influencing the strength of these relationships and information flow is trust. People are much more likely to trust a friend or neighbor than agencies, experts, or anyone residing outside of their social bubble (Champ & Brenkert-Smith, 2016). Trust is something seen through a social context that can change perceptions and influence whether people decide to act on shared information and perceptions (Paveglio et al., 2019). Lemos & Morehouse (2005) reiterate this by saying trust can change whether someone believes information or knowledge to be legitimate. Trust in knowledge has strong abilities to shape perceptions, decisions, and actions (Lemos & Morehouse, 2005). This becomes incredibly relevant when discussing fire management organizations, their relationship with communities, and whether trust exists between the scientists disseminating wildfire information versus those who use it.

### 2.2.4.3 Access to Information

Creation of knowledge through the social contexts mentioned in the preceding section is just one of many ways people access information. This is vital in the world of risk perception and management in that information has potential to alter perceptions and

behaviors. The cautionary tale with information, however, is that information does not necessarily equate to fact or truth (Schein, 2010). Again, validation and acceptance of information often requires a social consensus from your social network (Lemos & Morehouse, 2005; Schein, 2010). Standalone information separated from the social context perpetuating it, no matter how detailed, is often insufficient to amplify concern or risk perception (Leiserowitz, 2006). Furthermore, there is little evidence to suggest that access to information leads to awareness or action (McCaffrey, 2004). All of this is not to say that information is not important; rather the point is that the vehicle through which people share and obtain information may be vital in influencing perceptions. Whether that 'vehicle' is a trusted friend, trusted agency, or trusted website is imperative.

### 2.2.4.4 Culture

Risk perception theories commonly claim that culture powerfully crafts people's perceptions. According to Schein's (2010) observational and clinical approach as a psychologist, it was deduced that culture helps direct where people place their values and concerns. This can then influence how they formulate beliefs and perceptions (Schein, 2010). Such a cultural lens can help explain behavior, resistance or acceptance to change, and the level of willingness to respond to environmental concerns (Schein, 2010). With particular focus on environmental concerns, Burton & Kates (1964) try to simplify the relationship between culture and environmental hazard perception by suggesting it may merely come down to human attitudes about nature.

Burton & Kates (1964) proposed three categories of cultural belief systems. First, that humans have no control over nature and are, thus, subject to it. Second, that humans should live with nature and maintain balance for the benefit of both the environment and

society. Or, third, that humans have power and control over nature (pp. 431-432). Depending on which belief system a culture resides can have major influence on how environmental risks, such as wildfire, are perceived and addressed. This anthropological study whose researchers lived within multiple communities and cultures, ascertained that variations in these belief systems affected management policies (Kluckhohn & Strodtbeck, 1961; Burton & Kates, 1964). For example, those who believe in the dominance of nature were less likely to be aware of and participate in environmental control strategies (Burton & Kates, 1964).

More recent researchers have found themselves arching toward similar conclusions. Experience of past events, education, and awareness do not necessarily increase perception of risk, nor lead to action (Burton & Kates, 1964; Gordon et al., 2013; Leiserowitz, 2006; McCaffrey, 2004; Moritz et al., 2014). All of these components do, however, shape and influence mental heuristics or "rules of thumb" that affect how people make decisions (Gigerenzer, 2021). Heuristics impact perception and evaluation of risk as "people are exposed to information about themselves, other persons and events, and have to make decisions or formulate judgments about these entities" (Kahlor et al., 2003, p. 356; Slovic et al., 2005). Based on the latter, access to information (including via media), experience, and culture can bias how risk is perceived and how mental shortcuts are created.

Given the variance and complexities of risk perception observed among individuals, risk perception as it relates to fire management is worthy of additional consideration. Experience, information, and social dynamics, in combination with a cultural lens, are vital pieces to the "wicked problem" and more research needs to be done through an organizational, fire management lens, in particular. Management efforts will

require an understanding of these social dynamics, and perhaps, a transformative shift in perceptions and beliefs (McWethy et al., 2019). Coexistence will involve understanding human perceptions, potentially flipping those perceptions, adapting, and finding a balance between accommodating fire and fighting it (Moritz et al., 2014). The arenas in which these evolutions will take place are fire management organizations at local, state, federal, and regional levels.

## 2.3 Organizational Framing and Methodology

The wicked problem of wildfire becomes more complex in an organizational setting. To address that complexity, an organizational geographies approach is a useful lens for studying social structures and cultural values in fire management. Organizations are dynamic units distinguished by various motivations, goals, and inter- and intra-personal relationships. When viewing organizations as a governing framework, they can be used to understand components that control attitudes, behaviors, and policies (Fischer et al., 2016). Del Casino et al. (2000) argue that organizations can be unique objects of geographical analysis that provide useful operational entry points for studying such relationships.

Potential methodological frameworks for studying organizations in geography include spatial science where the organization is mapped; critical realism that contextualizes the organization; and post-structuralism, which deconstructs the organization. Spatial science frames organizations as distinct entities in space and time with measurable attributes; entities that consist of transactions with the external environment and whose interactions can be studied; and whose organizational characteristics can explain the behavior of individuals within the unit (Del Casino et al., 2000). Examples of how critical realism frames organizations include recognizing them as

objects and events "produced by the interactions of mechanisms and structures"; whose activity and impacts are mediated at a local, regional, and global context; and whose individuals with practical knowledge can influence organizational practices, social relations, mechanisms, and structures (Del Casino et al., 2000, p. 529). Post-structuralism framing, on the other hand, would look at organizations as products of power relations that determine operating procedures, rules, and practices; social arenas that produce knowledge and meaning while also allowing for social interpretations to be challenged; and whose practices and discourses can create identities and influence actions, for example (Del Casino et al., 2000, p. 529).

My research draws on a combination of these organizational geographies presented by Del Casino et al. (2000) by mapping, contextualizing, and deconstructing fire management organizations within the U.S. Utilizing an organizational lens and framework, with specific focus on an organization's social dynamics and functions, can help explain how the problem of wildfire risk is being addressed and how management practices are shaped and implemented. Organizational theory can be defined as "the study of how organizations function and how they affect and are affected by the environment in which they operate" (Jones, 2013, p. 30). This definition, however, can be expanded by saying the "environment" it is affected by and in which it operates consists not only of social relationships and internal and external pressures (e.g., politics and power), but an environment shaped by perceptions. After all, perceptions are where values and beliefs are placed, and therefore have the power to dictate management strategies (Chapin et al., 2003; Garvin, 2001).

Fire management, risk communication, and community resilience are often driven and shaped by institutional dynamics across scales (Abrams et al., 2015; Boholm, 2019). The environment organizations interact with is made up of other organizations at various scales (or "levels" as termed in my research), communities, and sources of economic, social, and political pressures (Jones, 2013). The institutional levels and units at play range from federal and state agencies (e.g., the United States Forest Service and state-level departments of natural resources) all the way down to the neighborhood level (Fischer et al., 2016). Organizational structures and actions utilize social processes, rules, regulations, and resources to either enable or hinder management, adaptation, and mitigation actions of other individuals or organizations (Jakes et al., 2010). The amount of influence organizations have on management strategies and practices, as well as their unique makeup of social constructions, make them principal actors in the human-wildfire problem.

Although organizations are often the influencers, there are many factors that also influence how an organization functions and how decisions are made. This is demonstrated in the numerous organizational approaches discussed in literature (Aldrich & Pfeffer, 1976; Del Casino, et al., 2000; Jones et al., 2013; Faulconbridge & Hall, 2009). My research will be informed by and build upon these approaches and concepts. The two supporting concepts employed in my organizational theoretical framework will be delineated as internal and external pressures. For example, power, politics, perceptions, and culture can be investigated as either internal or external pressures. I form these supporting concepts with the acknowledgement that organizations are not closed systems and will likely experience overlap between the two.

### 2.3.1 Internal and External Pressures

One aim of my research is to assess internal and external organizational pressures, in addition to the physical environmental pressures, that influence organizational perceptions and decisions. How these pressures interact adds an additional layer of complexity. I pull from research investigating organizational drivers in the literature to share what this framework is built on. Recognizing that the amount of pressures and forces steering organizations is boundless, I focus on power, culture, and politics within this context.

Power is the ability to influence conflict, decisions, and overcome resistance (Jones, 2013). It comes in many forms with some of the leading sources being authority, which can be codified through legalities or cultural foundations; control over resources; and control over information (Jones, 2013). Internally, power may present itself as agency leadership and carry with it the ability to shape organizational behavior and values (Schein, 2010). It may also be represented through an internal organizational power struggle that grows from a response to an environmental problem inherent to a particular organization in which the reallocation of resources benefits some and not others. This imbalance of benefits between multiple parties can create conflict within the organization and be met with resistance or acceptance of organizational decisions (Jones, 2013). Power can also be conceptualized externally as a dynamic between two organizations across space, with competing resources and actions that influence the behavior of one another (Faulconbridge & Hall, 2009; Jones, 2013).

Not far removed from the power of leadership and its impact on values, pressures built from organizational culture can sway decision-making. Shared values and norms

31

make up an organizational culture, controlling member interactions with one another, as well as with those residing outside the organization (Jones, 2013). In a broad sense, many scholars believe "organizational action is fundamentally shaped by social and cultural processes" (Lounsbury & Ventresca, 2003, p. 458). Furthermore, culture is continually being reinforced and created within social systems, including organizations, and has the ability to explain how those systems function (Schein, 2010). With as much influence as culture has on people and behaviors, cultural values can represent themselves as a number of internal and external organizational pressures.

Politics are an additional influential pressure, which have acted as a force on and within organizations throughout history (Drucker, 1992; Jones, 2013). Internally, organizational members sometimes have to weigh their actions and whether there will be any political costs—political costs that may result in adverse career consequences or personal lawsuits (Thompson, 2014). Under an ever-changing political climate, government agencies at all levels have had to adapt their management strategies and organizational functions to fit the political circumstances (Berke & French, 1994). For example, timing of mitigation efforts have often been based on when supportive political officials are or will be in office (Berke & French, 1994). Whether politics work within a system or force themselves on a system from the outside, its impacts are often far reaching.

A review of the scholarly literature within my many research areas (i.e., wildfire, climate, risk, perceptions, organizations, and decision-making), provides my research with solid roots. Despite the complexity and many moving parts of my research questions, they have found a home under the theoretical framework of risk perception and organizational

theory. It is within these frameworks I seek to explain and understand organizational decisions and actions around the increasing threat of wildfires. Risk perceptions are constructed through social relationships, information, and cultural ideas, meanings, and practices. When these perceptions are expressed not just through individuals, but as a social system, they can influence an organization's values, actions, and decisions. Approaching these concepts through an organizational lens will allow a deeper understanding of those perceptions and how they are met with internal and external pressures. An increased understanding of organizational pressures and perceptions will improve decision-making in the face of the very human, wicked wildfire problem. These latter goals bring me to my research questions outlined in the introduction, and the methods I use to answer them.

## 2.4 Undertaking the Conversation with Focus Groups and Surveys

To enrich conversation and insight within various organizational levels of fire management, I used surveys and focus groups, with the latter represented as a case study. Questionnaires were distributed at a national level to federal and state fire management organizations. Focus groups were then held in northeast, northwest, central, southeast, and southwest Oklahoma to garner more localized viewpoints. This mixed-method approach made it more logistically feasible to collect, analyze, and compare qualitative and quantitative data across a large spatial extent of fire managers. Supporting this approach was the fact that these methods have matured and developed throughout the years and are well-established in the literature (Winchester and Rofe, 2016).

According to McLafferty (2010), questionnaires are ideal for uncovering institutional attitudes. At an individual level, they also uncover attributes, behaviors, and beliefs (McLafferty, 2010). McGuirk and O'Neill (2016) suggest doing this in a systematic

way by posing standardized, formally structured questions to a sample population. This method allows for self-reported observations and delivers a collection of qualitative and quantitative data (McGuirk & O'Neill, 2016; Rattray & Jones, 2007). Questionnaires also offer flexibility with open-ended questions (Rattray & Jones, 2007). By incorporating open-ended questions in my survey, participants are allowed to make comments without limitation, reflect, and expand on their interpretation of the questions. Mixing the open-ended questions with closed questions in the form of lists, rankings, and scales, further expands the robustness of the survey.

In addition to question structure, combining qualitative and quantitative questions can be very beneficial. For one, they can reveal patterns that divulge broad structural relationships (Elwood, 2010). They uncover useful information about institutions, such as attitudes and opinions about social, political, and environmental issues, which makes them invaluable in understanding fire management organizations (McLafferty, 2010). Since people are often more forthcoming with opinions when offered anonymity, surveys give participants a secure space to reflect on their institutional roles and struggles (McGuirk & O'Neill, 2016). Given these strengths and benefits, questionnaires were one of the most practical methods for reaching fire managers across the country and asking about their experiences and perceptions.

Locally organized focus groups were selected as a follow-up method to the questionnaires. By having conversations with participants, additional information can be uncovered that was potentially only hinted at or overlooked in a questionnaire. Using focus group interviews allows the exploration of more complex behaviors and motivations among fire managers. This method also provides insight as to where there may be debate

or consensus around meanings and experiences (Dunn, 2016). All interview types, including those set in a focus group, are useful for understanding meanings, relationships, and interactions (Elwood, 2010). Focus group interviews afford an opportunity to gain information from "gatekeepers of knowledge" and amplify previously unheard voices (Winchester & Roffe, 2016).

To moderate conversations about fire managers' experiences and concerns, I selected the use of semi-structured focus group interview questions. This structure focuses on the content around the questions, which are predetermined to an extent, but allow informality and flexibility (Longhurst, 2010; Dunn, 2016). Successfully using this semi-structured approach requires listening carefully, creating a comfortable environment, and allowing room for open discussion within responses (Longhurst, 2010). Since the semi-structured focus group setting is more conversational, it is also possible to interject when necessary to redirect questions or expand on them (Dunn, 2016). Additional benefits include the ability to observe non-verbal cues and hear responses in participants' own words. If confusion around a topic or question arises, or there is a misunderstanding between the moderator and participants, these issues can be immediately resolved (Baker & Edwards, 2012; Dunn, 2016).

The five focus groups comprise a state-level case study that is useful for understanding a larger body of fire managers. According to Gerring (2004, p. 342), case studies are "an intensive study of a single unit for the purpose of understanding a larger class of (similar) units." Investigating subsets of a population or smaller instances of a larger phenomenon allow for a better understanding of the in-depth nuances of the phenomenon (Baxter, 2016). While the focus groups are representative for local managers

specific to Oklahoma, each group represents a different region of the state. Given that Oklahoma has some of the most diverse ecoregions in the country (Travel Oklahoma, 2023), each focus group identifies with unique geographic and wildfire management challenges and techniques. In addition, each Oklahoma region is equipped with different resources and different fire management histories. The diverse circumstances and backgrounds among the Oklahoma focus groups can draw parallels to other cases and organizations throughout the country (Baxter, 2016).

The benefits of the case studies, focus group interviews, and survey methods discussed above demonstrate their utility and practicality for my multi-scalar research audience and research questions. Surveys and focus groups allow deep exploration of perceptions, attitudes, behaviors, and relationships across local, state, and federal fire management organizations. These methods also have the power to theorize and explain fire management and decision-making at large, while acknowledging the contextual influences across the various levels (Baxter, 2016). The use of interviews and questionnaires, and their ability to draw qualitative and quantitative data can help explain human experiences and perceptions, especially among different social structures (Elwood, 2010). This latter information will reveal drivers of perception and the factors that influence decision-making across fire management organizations. These methods, analysis, and findings will be detailed more thoroughly in the next section.

**CHAPTER 3: SURVEYING THE FIRE MANAGEMENT LANDSCAPE**

## 3.1 Introduction

With a long road ahead, paved with complex perceptions and challenges within fire management, the best path forward in addressing my research questions was to first disseminate surveys to fire managers at the federal, state, and regional level. By using this approach, I tackled my research questions on perceived wildfire risk, its association with climate change and humans, decision-making products and information, organizational pressures, and policy and planning. Intent on comparing these questions and findings across various organizational levels, this would be one of two methods used in receiving feedback from diverse fire management organizations. A mixed method approach with qualitative and quantitative data from surveys and then followed-up by locally facilitated focus groups provided a comprehensive story on fire management and risk perception. In the section that follows, I discuss my survey design, data analysis, and the demographics of the respondents. I then detail the results that were uncovered from my survey that addressed the various topics outlined in my research questions.

## 3.2 Survey Design and Analysis

I designed the survey to be as comprehensive as possible, carefully considering its structure, content, readability, and clarity. It consisted of 47 questions and incorporated multiple-choice, open-ended, Likert-type, and ranking formats. By diversifying the question format, I was able to garner qualitative and quantitative information pertaining to fire managers' unique understanding and perspectives of wildfire risk. Furthermore, the mixed method approach offered the opportunity to incorporate participants' different ways of knowing (Elwood, 2010). To reach as many fire managers as possible, I leveraged my

existing networks and relationships within the fire management community, snowball sampling, and targeted online searches for federal and state fire management organizations. This strategy allowed me to directly email my online survey to 938 potential participants, with additional participants reached through email forwarding and listservs. Acknowledging the length of my survey and my underestimation of the time it would take to complete it, I was pleased—and immensely grateful—to have received 264 survey responses. Based on the direct number of known emails sent, that gave me a robust response rate of 28.1%.

The design and distribution process provided valuable insights and broad representation from federal, state, and regional fire managers across the United States. Quantitative analysis from the ranking, Likert-type, and multiple-choice questions gave a succinct and quantifiable assessment of the fire managers' views and preferences. This coupled nicely with the open-ended responses, which uncovered detailed thoughts and emerging themes. To better organize and grasp these emerging themes among the qualitative answers, I coded the content of the open-ended questions. This method of analysis allowed for me to organize and better navigate the large amount of data, as well as more easily explore it and uncover themes (Cope, 2021).

Using Word and Excel, I performed content analysis to identify and quantify terms or phrases. I simultaneously created an index of code numbers that were uniquely associated with particular phrases in Excel, while also marking that code in the survey's Word document by means of comments and track changes. Given that my survey was already organized by topic (risk, decision-making, pressures, etc.), I created descriptive, *in vivo* codes that came directly from phrases within each individual's response (Cope, 2021).

Each open-ended survey question, then, had its own set of codes. Once the appropriate questions were coded, I determined the prevalence and pattern of each theme with many themes repeated throughout the entirety of the survey. An example of the code developed for one of the survey questions can be seen in Figure 2.

| Question 44: What are some of the biggest challenges to the success of your organization? | | | |
|------|-------------------------------------------|-----------|-------------------|
| Code | Theme | Frequency | % of Participants |
| Z1 | Staffing | 81 | 46.02 |
| Z4 | Money | 69 | 39.20 |
| Z7 | Training/education/experience/skill | 13 | 7.39 |
| Z14 | Leadership/administration/management | 13 | 7.39 |
| Z21 | Public influence/perception | 11 | 6.25 |
| Z36 | Equipment/resources | 11 | 6.25 |

Figure 2. Example of thematic coding from survey question 44.

The example in the figure above organizes the themes according to the percentage of mentions by participants. Due to differing response counts for each question, the percent frequencies needed to be re-calculated based on the varying number of participant responses. After sorting the themes by frequency, I was then able to determine the predominant comments or concerns, as well as analyze the relative frequencies in comparison with one another.

### 3.2.1 Demographics

Demographic data reveals the geographical diversity of the participants, with fire managers representing 34 states, four regions, the national level, and two international locations. Oklahoma was highly represented, which resulted from the existing networks used in my survey distribution. Participants were predominantly male, comprising 85.6% of the total, with females accounting for the remaining 14.4%. The age distribution followed a bell curve with a significant majority being over the age of 45. Participants'

years of experience ranged from less than five to 55, again following a bell curve with the majority having served 16-25 years in fire management. Capturing the various levels *within* the organizations, 57% of participants identified as mid-level fire managers, followed by 34.6% who identified as top-level. Noteworthy, however, was that among the 38 female participants, only 12 occupied these top-level positions. Based on these demographic responses, the survey highlighted far greater participation of older, experienced, mid-level to high-level male fire managers. If this is representative of the field at large, there exists a strong gender disparity in senior leadership roles, as well as a lack of young recruits and early professionals. This underscores the need for greater diversity in the field, which can potentially impact risk perception and decision-making.

## 3.3 Risk Perception

The survey results indicate a significant level of concern among federal, state, and regional fire managers regarding wildfire risk and its associated impacts and threats. When prompted to assess the level of risk linked to wildfires, 47.2% of the participants indicated a high level of risk, while 34.7% described it as moderate. Being that "high" and "moderate" were the top two levels of risk provided in the survey, a considerable portion of participants perceive wildfires to pose a substantial level of risk. Given the opportunity to rank specific fire-related threats in order of concern, participants assigned significant concern to wildfire severity, and rated wildfire season length, fuel, frequency, and size much lower on the scale (see Figure 3). When asked to expand on additional risks or concerns, the top five mentions include the wildland urban interface (WUI) or human-environment interaction, fuels and land management, staffing, resources, and money.
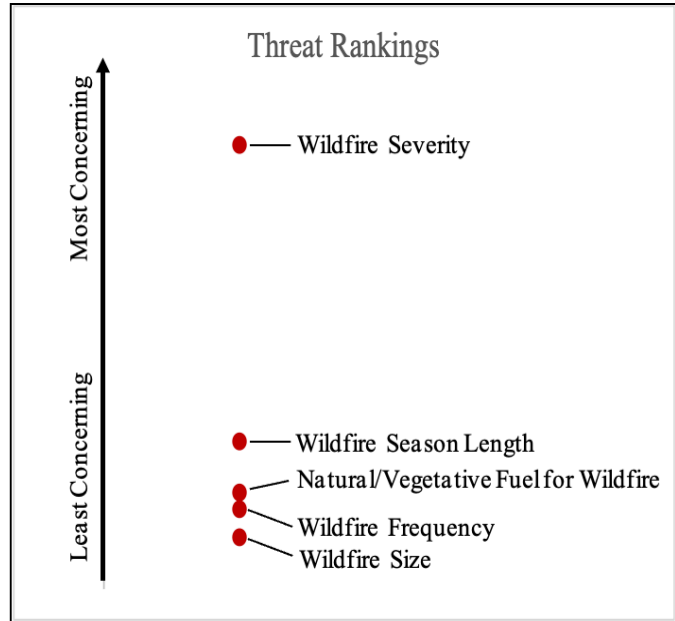
Figure 3. Wildfire threats ranked by perceived level of concern.

These prevalent concerns and perceptions among fire managers can be attributed to over 80% of participants reporting experience with a catastrophic fire event and 56.8% having experienced these events within the last two years. Furthermore, approximately 70% of the surveyed fire managers acknowledged that these past fire events have influenced or altered their perspectives on wildfires. Within the detailed field of answers on how past fire events changed their views, 40.2% discussed their observation of increased severity and risk. Additional comments pertain to how their experiences inform their management decisions and operations, as well as a large number of participants recognizing the need to improve fuel, land management, and prescribed burning. Participants' comments emphasize how firsthand experiences profoundly shape attitudes and perceptions within the fire management community.

### 3.3.1 Wildfire Risk and Climate Change

In examining the association between wildfire risk and climate change, the survey revealed valuable findings regarding fire managers' perceptions. Those who are moderately or extremely concerned about climate change in general accounted for 47.9% of participants, underscoring a fair amount of apprehension around the topic. However, when asked how concerned they were that climate change will potentially escalate the wildfire threat, 56.3% of participants conveyed moderate to extreme concern. This suggests a heightened level of concern specifically related to the intersection of climate change and wildfire risk. When pushed further on their level of confidence on whether climate change could be primarily attributed to humans, 31.5% expressed "not at all" to "somewhat", while 49.8% selected "moderately" to "very confident". Among the fire managers, 49% also acknowledged that their views on climate change have shifted over the years, and with the majority showing concern of climate change impacts on the wildfire threat, it is likely this shift has moved toward the acceptance of the phenomenon.

Climate change, its relation to wildfire risk, and whether climate change is primarily a result of human activity was further analyzed at a geographical level. When managers were asked how concerned they were about climate change, 72% of those extremely concerned were located in the western United States. Conversely, for those who selected "not at all concerned", 94% were located in the central or eastern U.S. Most fire managers who took the survey expressed moderate or extreme concern over climate change's impact on wildfire threats. However, 93% of those not at all concerned and 87% of those only slightly concerned were again from central and eastern regions. As it pertains to humans being a primary factor in climate change, western fire managers accounted for

62% of those very confident in the human role, while 87% in the central and eastern regions indicated they were not at all confident in human involvement. Despite these geographical differences in views on wildfire risk causes and climate change, it is crucial to reiterate that 82% of fire managers rated the overall level of wildfire risk as 'high' or 'moderate'.

### 3.4 Decision-Making Processes

### 3.4.1 Communication and Collaboration

Fire managers rely on a diverse collection of products and information to guide their decision-making processes, often emphasizing effective communication internally and externally. Regarding communication with the public, 75.9% of participants reported that their organization communicates most or all of the time. The primary vehicles of communication included social media, public information officers, print media, email, and television media. Similarly, collaboration and communication with other fire management organizations was perceived positively with 77.2% indicating frequent communication. Email and phone emerged as the predominant methods of communication among the various organizations. Highlighting a strong network of inter-agency cooperation, collaboration stretched across organizations at various levels with notable engagement at the municipal, county, tribal, and neighborhood level. Particular attention was paid to communication at the county level by state and federal agencies.

### 3.4.2 Tools and Information

Weather forecasts and various forms of information, products, and tools are vital to the decision-making process in fire management. When asked to rate the level of importance of different forecast periods, participants overwhelmingly prioritized day-of forecast periods, with 89% declaring them very important. Three-day forecasts were the

second highest valued period, with 78% also rating them as very important. As the forecast period increased, however, the importance to fire managers decreased. Monthly and weekly forecasts were moderately important to the majority of participants, while most thought multi-month forecasts, often climate or seasonal, were only slightly important. Regarding agency responsiveness to planning and addressing the climate change-driven wildfire threat, 46.1% of federal, state, and regional fire managers feel their organizations are somewhat or not at all responsive. Only 26.6% said their organizations are moderately or very responsive. This coincides with the intriguing finding that, although most fire managers expressed concern over climate change increasing wildfire threats, the majority still do not consider climate change and longer temporal forecasts in their decision-making or planning. In coordination with the short-term forecasts they do use, fire management organizations often use external websites and tools. The most widely used resources include the National Weather Service; state Mesonets; state, regional, or university level decision-support platforms; and federal websites and management tools. Most participants reported equal use of external and internal tools created by their own organizations to aid in decision-making, which further demonstrates the importance of various decision-support tools.

### 3.4.3 Pressures

Fire managers navigate a complex landscape of internal and external pressures that influence their decision-making processes. According to responses from those surveyed, finances, including budgetary constraints, play a significant role in organizational decisions, with 70% claiming it dictates their decisions most of the time or all of the time. Immediate threat to life and property, such as day-of emergencies or events, were cited as

very influential as 68.3% acknowledged its impact on decision-making. Politics were a significant factor as well, with 53.4% indicating that politics drive their decisions at least half of the time, most of the time, or all of the time. Climate change was less likely to have any pull on their decision-making as the majority said it only sometimes, or never, influences decisions. Similarly, ecological impacts, community culture, and social or community approval were also unlikely to influence decisions.

### 3.5 Operations

### 3.5.1 Policy and Related Actions

Fire managers deploy diverse strategies to mitigate wildfire threats and adapt to evolving challenges. Among the possible actions to reduce wildfire threats, nearly 70% of participants said they have taken steps to manage fuel and land. The second prioritized action involved public outreach and education initiatives with a focus on wildfire awareness and fuel management. The following three most prevalent actions identified by fire managers include mass communication and messaging, agency partnerships and collaboration, and efforts to increase mitigation and build adaptive communities. Many participants noted that their agencies take a multi-layered approach, employing a combination of these strategies. Some specific actions included creating and supporting FireWise Communities (a program to assist communities with reducing wildfire risk), visiting schools, using social media campaigns for fire prevention messaging, fuel thinning projects, and procedural documents for prescribed burning.

When asked about changes to their organization's decision-making processes, approval processes, incident response, and project prioritizations over the years, 22.4% of the respondents admitted to a complete lack of observed change. Those that did cite

changes gave two primary responses: enhanced agency collaboration, coordination, and communication; and factors influencing their actions and decisions. Regarding the latter, society, resources, politics, funding, updated scientific insights, and shifting agendas were mentioned as influentially significant. Conversely, when asked how influential their organizations were with altering local, state, or federal fire management policies, they indicated varying degrees of success. Thirty-seven percent said they impacted policy "sometimes", 25.2% said "most of the time", 17.3% selected "half of the time", and the remaining responses were split between "always" and "never."

### 3.5.2 Challenges and Successes

In addressing the biggest challenges facing their organizations, several recurring issues were revealed (see Figure 2). Foremost were the cyclic nature of the budget, with concerns revolving around the availability of funds, as well as the timing and manner of how those funds were allocated. Despite the critical need for fuel management, funding is often distributed to alternative projects, such as suppression efforts. In addition, staffing was identified as another pertinent challenge with recruitment, funding for staffing, and the quality of staff (e.g., sufficiently trained and experienced), mentioned in particular. Although there was significant concern over the aging demographic within their organizations, participants expressed hesitancy around the work ethic and motivation of younger recruits.

Reflecting on the changes in funding levels over the past decade, a significant portion of respondents (46.6%) reported either stagnant or decreasing funding, while 39.1% noted an increase. Roughly eleven percent highlighted funding instabilities and fluctuations, and approximately 12% felt the need to point out that the funding levels were

insufficient. Several participants underscored the repercussions of these financial dynamics, with many commenting that they are continuously asked to "do more with less." Furthermore, for many who said their funds were stagnant or have increased, these funds remain insufficient to make up for increasing costs.

Despite these challenges, each organization has their strengths. Diverse agency sizes—both large and small—offer different advantages, with larger organizations commenting on their capabilities and resources, and smaller ones emphasizing organization, relationships, and the ability to get things done. Furthermore, 28.2% cited the dedication and drive of staff as a keystone to their strength and success, and 26.4% mentioned their staff's skills, knowledge, and training. Effective partnerships and external coordination efforts were recognized as key assets by 14.4% of participants, and 13.2% claimed strong relationships internally among staff, and externally with the public and stakeholders, were paramount to their success. Given the numerous challenges fire management organizations face, these strengths underscore their ability to navigate those challenges by utilizing their passion, dedication, experience, and teamwork in the face of increasing wildfire risk.

## 3.6 Survey Discussion

The findings from this survey shed light on several critical aspects of fire management at the federal, state, and regional level; encompassing perceptions, pressures, challenges, strengths, and operational strategies within the field. By analyzing these results, we can glean valuable insights, identify connections, and address apparent contradictions, all of which contribute to a deeper understanding of fire management. Demographically, the predominance of mid- to high-level, male fire managers aged 45 and older underscores

the pressing need for better diversity and representation in the field. This observation coincides with the struggle to train and recruit new fire managers.

While wildfire severity emerged as the highest-ranked threat when the survey provided participants with pre-identified options, the ability for fire managers to elaborate on additional threats and concerns reveal fuel and land management as a top response. This suggests that fuel and land management, along with the impact of a growing population, may pose a greater threat than initially perceived by fire managers. It was perhaps the opportunity to think more deeply about their concerns in the open-ended questions that allowed this insight. This observation highlights the importance of considering broader perspectives when assessing risk factors by both researchers and organizations, which could potentially shift priorities, strategy, and funding allocation.

Further findings showed the concern over climate change escalated when combined with the threat of increasing wildfire risk. This indicated that while changing weather patterns were apparent, it was the addition of the human impact that exacerbates the perceived wildfire threat. However, despite acknowledging the connection between climate change and wildfires, the majority of participants did not integrate climate change forecasts into decision-making or planning processes. Participants primarily attributed this lack of prioritization and consideration for long-term planning to inadequate staffing and funding, both of which fluctuate in relation to federal administration priorities. Such priorities and interest are often based on decision-makers' short-term memories and hot button issues, which tend to peak following catastrophic events. Without stable, long-term funding, planning remains nearsighted. Funding will continue to pose as a significant hurdle to effective implementation unless adequately addressed.

In addition to staffing and funding challenges, many managers discussed the responsibility of landowners in land management practices and expressed frustration over the public's perceived lack of understanding and action in preventing wildfires. Mental health and safety concerns among fire management personnel were also noted, underscoring the importance of addressing internal well-being within organizations. The frustration in the surveys was palpable regarding the risk placed on fire managers when the public and landowners often exacerbate the risk. A fair amount of resentment and anger was expressed in the fire managers' comments about risk to their comrades' life and safety, as well as wasted time and efforts.

Furthermore, while fire managers advocate for increased collaboration and education between themselves and the public, there appears to be a disconnect between existing efforts and what they see on the ground. Given the magnitude of responses where participants identified their outreach and educational initiatives, as well as collaborations with the public and schools, there still exists a negative perception and stereotype around fire. There is little understanding around prescribed burning, land management, and development, and how those efforts play into fire risk. With the "all fire is bad" perception by the public, prescribed burns are often deemed dangerous and portrayed poorly by the media. *What* and *how* wildfire risk and management topics are communicated between fire managers and the public requires more attention. Other contradictions arose when participants commented on the challenges and irritations around public perception in the open-ended responses. This demonstrates the significance of public perception despite fire managers indicating on a multiple-choice question that social and community approval had minimal influence on organizational decisions.

To address these challenges and disconnections, focus needs to be given to education, communication, staffing, funding, the need for fuel and land management, and the increasing threat of human impacts. The groundwork exists with current policies and actions, but there needs to be a concerted effort to enhance the effectiveness of public communication and education strategies. We need to find ways to promote defensible spaces (a perimeter of reduced fuel around private properties), provide resources for landowners to do that, educate on accidental human ignition factors, and alter the overall negative perception of fire and prescribed burning. In addition, fire managers and researchers must reach beyond the public and improve communication with funding sources regarding wildfire risk, fuel management, and mitigation. Having better informed funding sources who understand the significance and need for fire management can improve the stability and long-term planning potential within fire management organizations. Improved federal and state funding, combined with enhanced outreach and education by fire organizations (e.g., town halls, workshops, camps, school outreach events) can also increase interest in the profession of fire management and aid in recruitment and retention. Overall, addressing these issues will be crucial in strengthening the fire management field, mitigating wildfire risks, and fostering resilience within communities.

**CHAPTER 4: VOICES FROM THE FIELD: FOCUS GROUP INSIGHTS**

**4.1 Introduction**

Riding on the coattails of the surveys and tapping into lessons learned, I wanted to get to the heart of local fire management by conducting focus groups within Oklahoma. While the surveys offered valuable perspectives from federal, state, and regional fire managers across the nation, I was eager to hear from the Oklahoma voices in the field. Being situated in central Oklahoma presented a unique opportunity to sit across the table from those with their boots on the ground, connect, and have meaningful dialogue. Over the course of this project, I facilitated five focus groups across the state, aiming to better understand fire managers' perceptions on wildfire risk, decision-making, and pressures. In the upcoming chapter, I provide an overview of the focus group design and data analysis, as well as the conversations that transpired. During those conversations, participants shared insightful realizations, lessons learned, experiences, and reflections in response to the research questions I asked.

**4.2 Design and Analysis**

To initiate the focus group experience, I utilized the same established network and professional affiliations within the fire management sphere as my surveys and circulated a focus group recruitment email. The email elicited interest from 36 fire managers. In response, I worked with each prospective participant to discern which regions within the state they could most easily travel to—northeast, northwest, central, southeast, and southwest. Five potential dates were offered, affording flexibility to the fire managers. I grouped participants based on where they lived and when they were available, aiming for five to nine people per group. After receiving RSVPs from 35 individuals, I carefully

mapped out and selected towns in each region to minimize travel time for attendees. Once the dates and locations were finalized, I found suitable venues that were convenient, easy to get to, and offered a warm, relaxed, and informal atmosphere. I reserved private rooms at the public libraries in Norman, McAlester, and Sand Springs, Oklahoma. Since the libraries were unavailable in the other two locations, I arranged for a rentable office space in Lawton and a training room at the County Events Center in Woodward.

Table 1 below details the focus group dates, locations, participant demographics, and affiliations, while Figure 4 maps out the relative focus group locations throughout the state. In total, twenty fire managers participated in these focus groups. The composition of focus groups can be designed in a variety of ways, such as grouping by commonalities, homogeneity of roles, whether participants are acquainted, etc. (Cameron, 2016). Among the selected participants was the common characteristic of working within fire management—a choice made during recruitment and a factor of commonality that would promote discussion on sensitive and controversial topics (Cameron, 2016). The compositional structures of my focus groups, however, were primarily reliant on participant location and availability. Despite the homogeneity of being fire managers, there was heterogeneity of roles and affiliations among the participants that allowed for various perspectives, experiences, and knowledges to be shared (Cameron, 2016). A significant shortcoming in the composition was the limited participation of females. This same lack of gender diversity was apparent in the survey participation and speaks to a broader issue in fire management diversity that spans all organizational levels. Notwithstanding the lack of female representation, the general composition of the focus groups aided in lively

discussion. This resulted in a copious amount of recorded material that then needed to be

transcribed and analyzed.

| Location | Date | Participants Attended [Number Recruited] | Gender | Fire Management Affiliation |
|---|---|---|---|---|
| Lawton, OK | 9/9/2022 | 1 [5] | M | Rural Volunteer Fire Department |
| Norman, OK | 9/14/2022 | 4 [9] | M | City/Career Fire Department |
| | | | M | Prescribed Burn Association |
| | | | M | Rural Volunteer Fire Department |
| | | | M | National Weather Service |
| Woodward, OK | 9/16/2022 | 5 [8] | F | Emergency Management |
| | | | M | Prescribed Burn Association |
| | | | M | Volunteer Fire Department; Career Volunteer Department; Emergency Services; Nonprofit Disaster Relief Program |
| | | | M | Oklahoma Department of Wildlife Conservation |
| | | | M | Nonprofit Conservation Organization |
| McAlester, OK | 9/28/2022 | 5 [6] | M | Emergency Management |
| | | | M | Natural Resource Conservation Services; Prescribed Burn Associations |
| | | | M | Public-Private Conservation Organization; Prescribed Burner |
| | | | M | Oklahoma Department of Wildlife Conservation |
| | | | M | Oklahoma Department of Wildlife Conservation |
| Sand Springs, OK | 9/30/2022 | 5 [7] | M | Prescribed Burn Association |
| | | | M | Wildlife Management Area |
| | | | M | Wildlife Management Area |
| | | | M | Emergency Management |
| | | | M | The Nature Conservancy |

Table 1. Details of focus group compositions.

Figure 4. Map of focus group locations in numeric order based on date held.

I manually transcribed the first focus group and sent the remaining four focus group recordings to a transcription service to expedite the process. Once I re-listened to the recordings multiple times, I began coding the content using the same process as I did for the surveys. Given that I followed an interview guide, the transcribed conversations were already organized into key themes: The fire managers' role; perceptions of risk and climate change; operations and decision-making; and barriers, challenges, and successes. Within the primary themes, I addressed myriad topics such as perception of wildfire risks, climate change, and the human role in climate change, as well as organizational actions and policies, tools, internal and external pressures, and needs. The frequency of descriptive codes, or obvious themes or comments stated directly by participants, were occasionally tallied to quantitatively identify specific tools, weather parameters, and forecast periods routinely used by fire managers (Cope, 2021). To supplement the coding, I also made note of important quotes that reflected the key concerns or thoughts regarding the various topics,

which helped draw comparisons among focus groups and themes (Cameron, 2016). To further identify these specific themes and categories among responses, I practiced margin coding in which certain letters represented specific topics (e.g. C## for challenges and P## for pressures) (Bertrand et al., 1992). Despite having coded the entirety of my focus group transcriptions, I opted against converting all codes into quantitative results and instead often concentrated on the overarching messages to gain a broad understanding of the most widely discussed topics and their significance to participants. This focus group analysis and discussion provided a depth and richness to the life, stories, and concerns of Oklahoma fire managers. In the accounts that follow, I reflect on the overall focus group experience and touch on the overarching themes that were revealed.

## 4.3 The Focus Group Experience and Discussion

Recognizing the importance of meeting the comfort and needs of the fire managers in a relaxed focus group environment, I provided snacks and beverages. While they enjoyed the Dr. Pepper and coffee, I was equally grateful for the nearby food as I was eight months pregnant. As a thank you for their participation, I also provided gift cards. Although many could not accept the gift cards based on their organization's policy, they were nonetheless appreciative.

Leading up to the focus groups, there were several cancellations or individuals unable to attend last-minute. The first focus group, scheduled in Lawton, was expected to have five participants. Unfortunately, only one showed up, turning the group discussion into a one-on-one conversation. Despite the low turnout, the attendee who came was enthusiastic and engaged, and eagerly shared their insights on fire management and risk. Using a structured interview guide, I steered the conversation through key topics, including

the participants' roles in fire management, perceptions of risk and climate change, operations and decision-making, and pressures, barriers, challenges, and successes. While maintaining a conversational atmosphere, I allowed the discussion to flow organically, so long as the primary topics were covered. The first focus group provided fruitful information and a jumping off point that informed the subsequent focus groups.

In each of the following focus groups, there was at least one participant who knew another or had collaborated in the past. The vast representation of fire management roles among participants made for interesting conversation and learning. Among the attendees were a mix of career firefighters, volunteer fire fighters, prescribed burners, natural resource conservation groups, wildlife management groups, emergency managers, and more. While some participants were technically employed by a state agency, their operations were predominantly local or regional within Oklahoma. Despite the various roles and organizations, there was a sense of comradery and familiarity among the participants; a comfort among them that allowed for an easy connection. The scheduled two-hour sessions often extended to three hours due to the richness of the conversation and despite providing ample opportunities to end it. The knowledge, passion, firsthand experiences, and stories of life within the wildfire and prescribed fire realm were riveting. It was evident that we all seemed to share a common goal of care for others and the world around us.

### 4.3.1 Risk Perception

The initial meet and greets kicked off with small-talk, jokes, and conversations about current events and the weather. Once I introduced myself, we delved into the focus group interview guide, where everyone introduced themselves and shared their experience

and roles in fire management. Transitioning into the topic of wildfire risk and climate change, I had learned to initiate the conversation by first defining "risk" as the term can be interpreted in various ways. What followed were their stories of wildfire experiences, close calls, loss of friends and property, cutting fences to give cattle a fighting chance at surviving an encroaching fire, and holding on for dear life as fires overtook their trucks. Acknowledging that heat, smoke, stress, and the health of their partners often lead to short lives and heart attacks was harrowing. These stories were example enough of the threats they continually face. Moreover, the challenge of managing fires with volunteer personnel, limited resources, scarce funding, and minimal staff added to the risk. Despite the cards often stacked against them, their spirits always appeared strong. Given these experiences, I wanted to know if they all believed wildfire risk was increasing. The answer was an unequivocal yes. However, concern didn't stem from growing wildfire frequency, but rather size and intensity as there was often recognition of fires becoming more difficult to tackle.

When I started to frame the threat around climate change, it came as no surprise that there was skepticism, especially considering our rural and politically conservative state. The term "climate change" was met with resistance with one fire manager referring to it as a "dirty word." Most participants declared they weren't "buying into it," we didn't have enough data, or we haven't been around long enough to know. Often referring to their observations as just cyclic, one participant said, "The whole term climate change seems redundant to me because the climate always changes." While roughly 10% of participants were open to accepting the term climate change, more participants were strong in their belief that it was not an issue, or no one really knew.

I then asked if there was anything that had impacted or swayed their perception on climate change and its relation to wildfire, such as influential opinions or information shared by co-workers, experts, or friends. It seemed that neither their peer network nor experts could change their opinion. The credibility of the source and whether they believed it could be trusted was more relevant. Individuals with boots on the ground and firsthand experience and knowledge in the field were more likely to sway their opinion. One manager said, "Most of it is what I would classify as sensationalized information anyway, and it only is relevant to today's news cycle." Trust of the information source without sensationalizing the information or following a political agenda made a difference. The conversation around trust and information sources reinforced the findings from Champ & Brenkert-Smith (2016) who discussed the significance of trust in information flow. With most participants thinking the data doesn't exist or that we haven't been around long enough, there appears to be a significant information gap between the established science and the people on the ground. However, when I rephrased the phenomenon as a change in weather extremes, drought, and related impacts that could be observed on the ground, there was a clear recognition from participants. Given the acknowledgement of climate change observations and yet a strong reluctance to affirm its existence, this begs the question: Where is the misstep in communicating this information?

What then was driving their concerns around wildfire risk? What was to blame for the wildfire threats? According to all participants, they emphatically said, "humans." Moreover, it wasn't the physical characteristics of the fire themselves that alerted them to the growing threat, but that the wildfire problem was indeed a human problem—a human problem created by humans and fostered by them. According to one participant:

As population increases, the risk goes up. It's just that simple. I'm not ready to buy into the global warming is causing all the trouble deal yet, but I'm not saying it's not having an effect. I don't know that I'm really ready to say that. It's just people and how we're living and how we're doing it and how we're not fire-wise.

This quote is one example of a shared understanding among participants that population growth, people moving into the wildland urban interface, the lack of fuel and land management, and piece-meal development or land fragmentation have coalesced to create a highly fire-conducive environment. According to participants, the latter factors take precedence over any relation climate change has to wildfire risk. Human action, or inaction as it relates to managing fuel, is the biggest threat as it impacts fuel availability, increases likelihood of ignition, and increases the challenges around fire mitigation, response, and suppression. Why is the fuel and land management problem so bad? To the local fire managers, the crux of the problem was a complete lack of knowledge regarding land management and prescribed burning practices. Furthermore, there is an absence of awareness concerning what it means to have a natural "tinder box" and volatile cedar trees lining your property.

When I pressed further on where this disconnect of knowledge and land practices comes from, it was a disheartened acknowledgement of evolving land use practices, the loss of generational knowledge, the migration of youth to urban areas, and the influx of urbanites into rural areas. The belief and practice in land stewardship has declined as people emigrate from rural areas and, as a juxtaposition, urban residents are immigrating to rural areas with a lack in land management and wildfire knowledge. Changes in the economy and popularity of rural areas has brought non-local individuals into these communities. Often referred to as "weekend warriors", "hobby farmers", or folks with "ranchettes" by participants, individuals traditionally buy up property for recreational use or vacation

properties. Unfortunately for the sake of land management, these weekend warriors want to keep the vegetation "natural", are not there full-time, or don't understand the threat non-managed land poses. For the few that do have interest in building defensible space around their property, the fear of danger and liability, as well as limited access to experts and resources for prescribed burning, makes for additional challenges.

Similar to the survey responses, there was a clear sense of frustration among fire managers over the human-exacerbated fire problem. Among the land management, population growth, and development issues were the accidental human-caused ignitions, which make up the majority of all wildfire ignitions. In addition, although a few participants acknowledged the positive role media can play, such as building awareness and bringing in external fire support, many lamented the media's constant miscommunication and misrepresentation of prescribed burning. In particular, media often feeds negative public perceptions of fire and land management practices, inadequately portraying the cause and danger associated with prescribed burns. As one participant put it, "The problem is perception and education. Anytime you see a fire on the news, it's a catastrophic event. That's what people think prescribed fire is going to be. In fact, the media reinforces that by, they say it's a controlled burn that escaped. I'm screaming at the TV, there's no freaking way anybody would do a prescribed fire on this day. You know it's not controlled burn." Another participant humorously swore that the media's approach was to just show up and say, "Who's the wildest person here? Let's interview that shit." Others echoed that sentiment, agreeing the media regularly failed to accurately portray fire.

Not only does this poor media coverage craft negative perceptions and misinformation, but fire managers also have to contend with tv media and social media-

driven "wildfire chasers." Akin to storm chasers, these civilian novices believe themselves to be fire experts based on their social media surfing and, in an attempt to "chase" and video wildfire events, ultimately put themselves and others in harm's way. This creates access and response challenges with emergency and fire personnel operating in the area. The combination of these grievances and human-driven obstacles has created an incredibly challenging and complex problem for fire managers. Not only do they have to combat the physical fire, but human behaviors and perceptions as well that cause wildfire ignitions and complicate response and management.

## 4.3.2 Decision-Making and Operations

Decision-making and operations are a significant component to reducing and managing wildfire risk, as well as implementing prescribed burns as a land management practice. This section, in particular, covers the intricacies of policy, planning, tools, collaborations, challenges, and pressures as described by local fire managers. Within these conversations, I uncover a mosaic of roles and approaches to decision-making. While there are nuanced differences related to specific strategy or operations, analogous themes arose regarding limited policy, planning, preferred tools, weather variables, and forecast information. The following segment navigates through these focus group discussions as they pertain to various aspects of decision-making.

### 4.3.2.1 Policy and Procedure

Following our discussion on risk, we moved into the topic of decision-making and operations. The described roles were incredibly diverse with different participants prioritizing prescribed burning, response and suppression, wildlife conservation, and ecology. Many fire managers, particularly those not connected to paid career fire

departments, wore multiple professional hats. Within the smaller organizations, structure, strategy, and policy seemed to be more lax. Organizations affiliated with federal or state agencies, or rooted in urban areas, had more requirements, formal training, and defined procedures or policies. For most, however, there was a recognition of little to no mandated training. For prescribed burn plans or procedures, the rigorousness often ranged from following an organization's formal documentation, to writing down weather forecasts or not having a burn plan altogether.

When asked more specifically about existing policies or procedures and whether those have changed through the years, responses were thin. Structured policies were scarce other than prescribed burn guidelines and plans. Informal, common practices were discussed much more, such as notifying agencies or the public when a burn was going to be permitted, upgrading gear or equipment, and instituting WAR Days. WAR Days are designated days in which there will be guaranteed, shared mutual aid from neighboring departments based on the forecast of extreme fire conditions or wildfire outbreaks. Most comments, however, were policy-related complaints. These included: the inefficiency of burn bans, the absence of policies addressing private liability and insurance for prescribed burning, the need for policy that would incentivize private land management, and issues with programs like the Conservation Reserve Program (CRP) by the Farm Service Agency. Many of these programs are thought to be useless or actually escalate the wildfire problem by promoting ineffective land management strategies. In addition, many acknowledged the general need for good policies. One participant reflected on the challenge of policy evolution by saying,

> I'd like to tell you that policies are an ever-changing thing and they should be adapting as conditions change and we try. [But] how many organizations actually

pull their policies off the shelf and review them every 3 or 5 years? Usually, they only do it when they end up in court because the policy was no longer valid and violated something or somebody got hurt.

That's traditionally what I see. That's not unique to the fire service. Fire, police, business, those things don't change until somebody makes some change. Two hundred years traditionally unimpeded by progress is not really just a fire department problem. We joke about [the lack of progress], but it's not. We change when people make us change. The number of us that want to be proactive, we're not always welcome.

This comment identifies the "two hundred" years of tradition in which progress has remained stagnant. Although there are some fire managers that want to be proactive and progressive with policy that promotes land management and long-term planning, many others in their departments are content with the status quo, often pushing back on any attempted change.

While there were mentions of more structured policy coming from the state level, such as Hazard Mitigation Plans or Wildlife Management Plans, participants emphasized how policy development or implementation was an area that could be improved upon. For those that worked in fire suppression and prescribed burning, following the "10 and 18" was more common practice. The "10 and 18" refers to the 10 Standard Firefighting Orders and 18 Watch Out Situations—a guideline for wildland firefighters that lists best practices and potential scenarios to be mindful of to reduce injuries and fatalities (National Park Service, 2024). Interestingly, one of the first orders in the "10 and 18" is to "keep informed of fire weather conditions and forecasts." Although the majority of participants did say they are weather-aware and monitor forecasts and current conditions, some commented on other fire managers in the industry that were often not abreast of the weather, which can impact planning, response, and operations.

*4.3.2.2 Planning and Tools*

Moving into discussions on planning and preparation, it became apparent that there was often a lack of weather consideration or long-term planning. Those in the minority were involved in wildlife management as they had to work around scheduling and species habitats. When it came to prescribed burning, planning was based solely on personnel availability and which landowner, or property, could get on the schedule when. Most participants admitted to being more reactive than proactive. One fire manager self-confessed that their preparation involved packing bottled water and relying on the daily news. Interestingly, that same fire manager described their organization as proactive. However, being proactive would entail such efforts as mid- and long-term planning, outlook awareness, and resource staging and allocation.

Cognizant of how some managers brazenly acknowledge their lack in preparation, another participant recalled a burn association meeting he attended and said, "they're not even monitoring on-site [weather] conditions… At our meeting, somebody was like, 'Well, you can just go to the Mesonet after the burn and print out the data.'" When asked how far ahead they looked in terms of weather forecasts, most local managers said they don't look past a week out, which echoed the survey responses. More emphasis was placed on the one-to-three-day range while decisions were typically made two days out. Given the nature of prescribed burning and fire events, most fire managers said they were constantly using current and hourly forecasts for monitoring and response during active situations.

As a follow-up to how participants accessed this information in the field, it was found that mobile phones and hand-held instruments, like kestrels, were their primary devices. The predominant websites, tools, and modes of information were the National

Weather Service and the Oklahoma Mesonet or OK-FIRE. Given that OK-FIRE is a fire management tool that integrates Mesonet data and was specifically created for Oklahoma fire managers, this made sense. A lot of comments arose on how and what format the information was shared. For example, internal and external emails, phone calls, briefings, and webinars within the organization itself or with the National Weather Service are commonly used, especially at the start of the week. Other popular sources of information included Oklahoma Forestry and satellite imagery. When discussing the specific weather variables they relied on to make their decisions, relative humidity was cited as the number one parameter, followed by wind speed, wind direction, and temperature. Less commonly used parameters included ventilation rate, mixing height, and smoke dispersion. Those who focused on these additional parameters were typically associated with federal organizations with more established processes and procedures that required more in-depth details on environmental conditions.

### 4.3.2.3 Collaborations and Decision-Making

When active operations were in play, there was strong collaboration both internally and with other agencies. Across focus groups, there was notable mention of improved relationships with federal or state groups, such as State Forestry and the Bureau of Indian Affairs. However, when external agency tensions did occur, they were due to the occasional disconnect between some fire departments and prescribed burn associations, as not all fire departments fully support prescribed burning. This pushback on prescribed burning by some departments relates back to negative public perceptions in which prescribed burning and its associated hazards are poorly understood. Many of these departments reside in more urban areas and have staff that are less familiar with land

management. Even with these differing perceptions and the admittance of internal egos and Type A personalities, teamwork and collaboration were regularly emphasized throughout the discussions.

Minor rivalries across organizational levels, such as those between volunteer departments or rural areas and state or federal agencies, also became apparent throughout the conversations. Some volunteer fire managers recounted instances of state or federal agencies initially attempting to assert dominance, "trying to be a big swinging dick" before realizing the local managers knew what they were doing. Conversely, a fire manager from one of the larger organizations recalled incidents where smaller burn groups or private landowners failed to correctly execute burns. He described it as "this really macho, cliquey, who's got the biggest hat kind of situation...A wiener showing contest, whatever you want to call it." As it happens, fire managers across the different organizations had similar perceptions of one another. At the end of the day, however, the participants say it's a brotherhood, despite any differences they have. These internal and external comraderies and collaborations are what most fire managers cite as their greatest strengths and sources of success, no matter the personal interests. As one participant said:

> There's guys if they're broke down on the side of the road, I have a way to give them the bird as I drive by. If we're out on a fire and they're dragging a hose by themself, I'll go help the brother. It changes like a work environment from a personal environment. I've seen them trash me on Facebook, but I would still give everything I have to help them.

Despite rivalries, competing opinions, and social pressures, differences disappear in the field. Fire managers respond to threats with a shared goal, and work as a team to address those threats safely and successfully.

In terms of who makes the decisions and sets the priorities, it typically falls on the chief of the fire department or the highest-ranking individual in paid departments.

Elsewhere, it's usually a collaborative effort or, more often than not, whoever is available at the time. The majority agreed with one participant's perspective that, "It's really whoever is on scene, on-site that's capable and willing... It isn't always the longest-tenured or the most credentialed person. It just depends on how it all works out, especially on the volunteer." For those involved with prescribed burning as part of their agency's operations, such as wildlife reserves, it usually comes down to one or two individuals who handle the burning who then make decisions independently or with one another. Regarding prioritizations, it's typically a first-come, first-served basis. With limited time, personnel, and resources, they must address the most pressing issues as they arise. As for their approach and strategy, many organizations are steeped in tradition. If something works, they continue that process or tradition without giving much consideration to change or updates.

It was acknowledged, however, that there were notable differences in fire management approaches depending on geographic location. Focus groups conducted in western and eastern Oklahoma commented on these differences. Ecologically, the two sides of the state are incredibly diverse with dry grasslands in the west and heavier precipitation, forests, and mountains in the east (Tyrl et al., 2017). Yet, the differences extend beyond ecoregions alone. Variations in available resources, smaller farm acreage per farmer, and a longstanding culture of prescribed burning embedded in the history of land management practices in the east, carved out these differences. In addition, the forest protection district operates in the east, so state forestry is often leading many wildfire and burn efforts in that region. When reflecting on some of these differences, one fire manager referenced the common practice of prescribed burning in the Osage Plains. I asked what

accounted for certain areas to be more accepting of these practices over others and one fire

manager from the west retold a conversation he had with a colleague:

> Because that's the way we've always done it. All of my life, [I ask] why do you do
> it that way? [They say] 'Because it's what we've always done it.' [Then I ask,] Well,
> you can't do it a different way? [Then they say,] 'Well, this is the only way I know
> because this is the way we've always done it.'

Similar to the previous quote on stagnant policy, this recollection demonstrates the

hesitancy for change in the field of fire management. Many organizations or departments

would rather continue with the same, familiar practices than accept a new way of doing

things. For them, having mastered an old method may appear more efficient, when in

reality, they should invest time and effort into adopting change and a potentially even more

efficient approach.

### 4.3.2.4 Pressures

Continuing the discussion on decision-making and the tools they use, another fire

manager shared, "I just stick with what I'm comfortable with and what I've always done

and so that's what I do." This suggests that adherence to tradition is one form of internal

pressure guiding the decision-making. When given the opportunity to elaborate on the

different internal and external pressures influencing them and their organizations, the list

became extensive. The pressures encompassed jurisdictional differences, such as differing

burn bans and permits across county lines and incorporated areas; media; leadership; labor

union pressures; prioritizing suppression based on what would save the most money;

project allocation of funding; resources; wildlife or habitat security; and more. The

pressures that came up time and time again, however, were public pressure and influence,

landowner pressure, competing internal objectives, and staffing. The continual optics,

negative perception of fire and prescribed burning, lack of public understanding, and

attempts by landowners or donors to dictate which properties to manage were persistent pressures for all fire managers. Private or political donors who give money to fire departments and burn associations were mentioned numerous times as a common and frustrating pressure that fire managers felt shouldn't be part of the land management or decision-making process.

Apart from donor pressure and unlike their federal and state counterparts, neither money nor politics are primary drivers of decision-making. While these factors do play a role, they are not the predominant influences. In fact, across multiple focus groups, participants emphasized that money "wasn't everything". It could potentially bring in new employees, but it wasn't what would keep them there. As one participant noted,

> Money's proven to be a short-term motivator. If you're talking funding, if the funds got you better equipment, then...I think [recruits] would come for equipment. They'd stay for equipment. I'll put it that way. They would stay for equipment. Because now we've got a nice ladder truck. We've got a nice station. I don't make as much as a doctor, but I'm okay here because we got nice stuff.

Another said, "[New staff will] come for more money for a little bit, but then as they came for the money, they won't stay." One story was told of a fire department that went from a poor department to a rich department overnight. The funds made the staff turn against each other in disagreement of how it should be spent, which resulted in an overthrow of leadership and a quick deterioration of the department. Ultimately, the money created a problem rather than fixing any. The same participant that recalled this story emphasized,

> Money doesn't affect [department and fire managers] the way you think it does. The pouring money at them, yeah it makes things easier, but not it doesn't change today's wildfire response. You can give a fire department... if you got say fire in your district, and it's burning 10,000 acres, and you show up and write a fire department a check for $1,000,000, the response to that fire won't change. The response to the next fire won't change.

Again, money does not necessarily address the issues at hand. While it can provide resources, a change in the budget will not necessarily change the strategy or approach to fire response.

What the fire managers frequently identified as pressures often doubled as their challenges or barriers. Time and again, the issues boiled down to human factors. Staffing is low, recruitment is low, fire managers are aging out, and there doesn't appear to be a passion or interest in fire management. With each retirement, valuable experience is lost and those that take their place are untrained and unexperienced. The expansion of the wildland urban interface and the increase in population also means more opportunity for ignition. Fire is getting worse because of a collective lack of situational awareness, insufficient land management, and dismissal of using fire as a management tool. As the fuel load and risk increase, fire managers aren't equipped with the personnel, time, resources, or ability to address those risks. When reflecting on this, many participants recalled instances where the fires were just too intense and uncontrollable, with little hope of extinguishing them.

What the fire managers need more than anything are solutions to address the human component of the wildfire problem. While they would certainly welcome a single database for all of their online fire tools, additional weather observations, and mobile accessibility to these tools, their most pressing needs relate to outreach, public education, and engaging the younger generation in land and fire management. According to focus group participants, their primary challenges stem from society's widespread lack of understanding regarding mitigation, land management, and wildfire risk. They want efforts to go into bridging this knowledge gap, strengthening public and media relationships, and instilling

a sense of responsibility and interest in youth for a fire-ready world. Furthermore, how are researchers and fire managers sharing that information, communicating it, and working *with* communities? For upcoming generations, we need to cultivate care and concern for natural resources and encourage more time outdoors. Suggestions from participants include integrating natural resource and fire courses into FFA programs, introducing badges for scouting organizations, and collaborating with schools. However, it is also essential to ensure continuing education that reaches both landowners and young individuals who may lose interest as they transition to college and beyond.

## 4.4 Human Solutions to an Escalating Human Problem

Given the thorough discussion about wildfire risk, climate change, decision-making, policy, pressures, challenges, and needs, a central theme became evident across the focus groups: The fire problem is fundamentally a human problem, and the human problem requires human solutions. These solutions boil down to improved communication, outreach, and policy as it pertains to land management and wildfire awareness. Key targets for improved communication and outreach goals need to occur between researchers and the scientific information and fire managers, as well as between fire managers and the public and landowners. When asked about climate change and its connection to humans and wildfire, a large majority of participants said they don't think climate change exists, nor do they relate climate change to wildfire risk. They either said there isn't enough evidence and so they didn't know, or they didn't label their observations as "climate change."

Considering the well-established science and literature linking human-caused climate change to wildfire trends and severity, there is a clear breakdown in communication

between the science and the people on the ground. Despite having robust data to support this connection, where exactly is the communication falling short? Moreover, how can researchers, fire managers, and the media better inform the public and improve awareness regarding wildfire risk, fuel, and land management to ensure it doesn't negatively impact decision-making for fire managers and exacerbate the problem? Additionally, how can fire management organizations work with policymakers to tackle the fuel and land management problem, increase funding for these efforts, and encourage best practices among landowners? As wildfire risk continues to escalate and communities face devastating losses, it is imperative that we address this issue with the urgency it calls for. Failure to address these challenges may place humanity on an irreversible path of devastation, with limited opportunities for mitigation, adaptation, and containment.

**CHAPTER 5: DISCUSSION**

The surveys I sent out to federal, state, and regional fire managers (FSR), along with the focus groups I conducted in Oklahoma, each provided their own set of valuable insights. When these insights are intertwined, however, they offer a broader, more comprehensive picture of fire management across all organizational levels within the field of fire management. Guided by the research questions, the following chapter summarizes this comprehensive picture and relates it back to the literature. To reiterate, the questions that form the backbone of this research include:

1. How do individuals within organizations at different organizational levels perceive wildfire risk?
2. How do fire managers associate wildfire risk with climate change and/or human behavior?
3. What products and information do organizations use for their decision-making processes?
4. How do perceptions, decision-making tools/processes, and organizational constructs translate into policy or strategic planning?
5. What factors or pressures (political, legal, cultural, social, environmental) drive organizational decisions and perceptions?

In addition to answering these questions, this chapter delves into the similarities and differences across organizational levels. It concludes by discussing potential implications and limitations of this research, providing recommendations, and suggesting future research areas that can expand or improve upon the methods and findings within this dissertation.

**5.1 Research Question 1: Perception of Wildfire Risk**

Fire managers across all organizational levels (federal, state, regional, and local managers within Oklahoma) feel that wildfire risk is increasing and express a significant level of concern over this risk. With regard to the specific fire characteristics or trends they are most concerned with, all levels unanimously identified wildfire severity as the most

critical risk. When given the opportunity to point out additional concerns, all managers underscored the threat of the growing wildland urban interface as well as land and fuel management. Although both FSR and local managers mention concerns over staffing and recruitment, their interests diverge beyond that focus. In particular, FSR managers primarily worry about resource availability and funding, whereas local managers emphasize the lack or loss of public education and knowledge as it pertains to wildfire risk and land management, especially among younger generations. The limited concern over funds among local managers may be due, in part, to the limited funds they have always had to traditionally operate within. Being able to successfully "make do" with smaller budgets has steered their concern toward human-related and human-induced risk factors as they relate to wildfire severity.

To expand on their mention of public land management shortcomings in the focus group discussions, local fire managers offered various explanations. The growing human population has led to more opportunities for ignition, with one participant offering up his own analogy: "You get more [people], there's more chances. You get 100 people with knives, 10% are going to cut themselves. You get 200, you got 20 people now." "More people, more trailers with chains" said another participant in response. Oklahoma fire managers argue that in addition to opportunistic ignition increases, urban and non-local individuals who buy up property in rural areas and fragment the land while also not managing it effectively, compound the threat. Furthermore, they find managing smaller parcels of land through prescribed burning particularly challenging due to surrounding obstacles and structures that force them to start and stop the burn more frequently rather than let it run continuously.

Concerns were also attributed to shifts in land-use practices, migrating knowledge, and generational differences. Older generations with traditional land management knowledge pass away and younger generations leave rural areas for urban life. According to many focus group participants, land management practices are not being passed down to the youth and, as a result, their interest in family farming, and thus natural resource and land knowledge, wane. While these trepidations around social dynamics and problems were prevalent among local managers in Oklahoma, they were not as universally shared by the FSR managers. FSR managers expressed more concern over money, resources, and staffing, alluding to more operational rather than social challenges. Considering that local managers experience more daily, direct contact with the public and are therefore more operationally impacted by public action, this distinction seems logical.

Experience significantly influences perceptions of wildfire risk; they profoundly shape an individual's viewpoint. Organizations are a conglomerate of these experiences that can be understood as a unified set of cultures and beliefs (Leiserowitz, 2006). Despite the impactful nature of experience, previous literature on natural hazards has been hesitant to state definitively that experiences effect risk perception, decision-making, and mitigation efforts (McCaffrey, 2004; Champ and Brekhert-Smith, 2016). Alluding to the inconsistency of experiences, some scholars believe it creates a "limited and therefore biased source of information" (McCaffrey, 2004, p. 512). Studies like Champ and Brekhert-Smith (2016) have suggested that experiences play only a minor role in how people perceive wildfire probability and consequences. Similarly, when researching homeowner risk perception and experience, Martin et. al (2009) found that wildfire experience had little influence on risk perception or mitigation strategies. While previous

research often focuses on homeowner or public perception, my study offers a different perspective by examining risk perception among fire managers. This group is unique in that they are continually collecting and being shaped and informed by these experiences. Unlike the other studies referenced, my research suggests it is more likely and expected that experience constitutes a significant component in fire management risk perception.

Supporting this suggestion are the survey results in which 70% of the FSR managers said that past experiences have shaped their current view on wildfires. Nearly 81% categorized those experiences as catastrophic fire events in particular. When asked how their past experiences changed their views on wildfires, FSR managers recounted events that impacted them both personally and professionally. These experiences either reinforced or demonstrated the extent of wildfire severity and heightened risk. One participant witnessed enough catastrophic events to span several lifetimes:

> Iron 44 crash [the "deadliest wildland fire aviation disaster in United States history" that killed seven firefighters and two pilots while attempting to combat the Iron Complex Fire in California in 2008 (Gabbert, 2016, par. 3)]. I was a firefighter on the Iron Complex Wildfire, and my superintendent was the Operations Section Chief… My crew was assigned to this fire where we lost 19 fellow hotshots, I was pallbearer for 5 before I couldn't take it anymore; Carr Fire—dozer operator was ran over by fire and died on my division; Tubbs Fire—wind driven fire with minimal resources lost public lives and property; Craig Mountain Complex—air [evacuated] one of my firefighters, from remote wilderness, with minimal outside communications; Caldor Fire—my own home was evacuated while fighting this fire, lost many homes in my own community.

Unfortunately, these experiences are not unique or isolated incidents. Several other participants relayed similar stories, emphasizing the changes in wildfire behavior or occurrence. One manager expressed, "Too many to list. From Cameron Peak to East Troublesome in Colorado in 2020, we saw such significant fire behavior that was far beyond what we used to consider 'normal'. A combination of drought, beetle kill, and extreme weather caused these fires to make runs that were beyond our ability to contain or

control." Another participant added, "There is now a catastrophic event every year in the NW. Entire towns are lost. Professionally, [I] try to help cover for employees who have lost their own homes."

Local fire managers conveyed similar thoughts, highlighting their experience with fires that have become more severe and harder to manage. As one person recalled, "When you go on some of those significant wildfires and you see some of the things that can happen in a pretty short period of time, and you look back on then. It definitely gives you a new look on things." Fire managers at the local level reminisced over these harrowing experiences that took place throughout their entire career and, while 40% of FSR managers specifically detailed a catastrophic event that occurred within the last year, 22% still recounted events from over six years ago. These meaningful experiences were shared by fire managers across all organizational levels, independent of organizational size or who they report to. Although past studies have been indecisive about the link between experience and risk perception, my surveys and focus groups clearly show that experiences have a deep and lasting impact. Every individual I spoke with acknowledged that their perception of wildfire has been influenced by their experiences. While these experiences may not always directly shape policy or planning decisions, this is often due to practical challenges like funding, personnel shortages, and other bureaucratic red tape. Experience is intimately connected to the perceived escalation in wildfire severity.

### 5.1.1 Research Question 2: Climate Change and the Human Role

While my research findings didn't align with previous literature regarding experience and perception, they corroborated existing studies on information sources, relationships, and trust. Paveglio et al. (2019) and Lemos & Morehouse (2005) emphasize

the crucial role of trust in shaping perception, knowledge creation, and information acceptance. Similarly, Champ & Brenkert-Smith (2016) highlight the significance of trust, noting that individuals are more likely to trust someone within their social circle, such as a friend or neighbor, rather than an agency or expert. Trust is what establishes legitimacy, with social consensus from one's social network often providing that validation and legitimacy (Lemos & Morehouse, 2005).

This became evident in my focus groups and surveys when we explored the connection between climate change and wildfire risk, as well as the human role in climate change. Among FSR managers, 47.9% said they were moderately to extremely concerned about climate change, while 27.6% said they were slightly or not at all concerned. Similarly, when asked about the relationship between climate change and wildfire risk specifically, 56.3% said they were moderately or extremely concerned that climate change will increase wildfire threats, while 26.2% said they were slightly or not at all concerned. Additionally, nearly half of respondents were moderately or very confident that climate change is primarily caused by human activity, with 31.5% falling in the "somewhat sure" to "not at all sure" categories. Based on these findings, it is evident that there is a considerable level of climate change concern among federal, state, and regional fire managers, as well as acknowledgement of its relationship to humans and wildfire risk.

However, when discussing the same topics with local fire managers in Oklahoma, the results looked very different. There was notably less acceptance of climate change in general, as well as its connection to wildfire activity. As highlighted in Chapter 4, many fire managers in the focus groups were unwilling to attribute the observed changes in wildfire threats and severity to climate change. Despite recognizing shifts in weather

patterns or extremes, most local fire managers were unwilling to label it as "climate change." They believe that wildfire risk primarily stems from human activity and failures in land management. To explain this line of thought, local fire managers cited the lack of climate change data, the cyclical nature of climate, climate change as part of a political agenda, the sensationalization of it among news outlets, or that humans just haven't been around long enough to truly understand the science and extent of climate change.

They also downplayed any significant human role in climate change, focusing instead on factors like population growth, development, wildfire ignition, and land management. This perspective contrasted sharply with that of FSR fire managers who showed a higher level of acceptance and concern over anthropogenic (human-induced) climate change. Given these differences in perspective, it is important to note the political context. Many federal, state, and regional respondents represented western or more liberal areas of the U.S., while the local fire management organizations are situated in the more conservative state of Oklahoma. This aligns with findings from the Pew Research Center, which indicate that Republicans are three times less likely than Democrats to prioritize climate change as a top concern. Furthermore, increased concern over climate change as a threat has predominantly been observed among Democrats (Kennedy & Johnson, 2020).

Despite climate change data and information being widely established science, this political context and credibility of the sources of information play a pivotal role in shaping perceptions of climate change. Ultimately, the acceptance of this scientific information boils down to a matter of trust. Another possible explanation for differences in perception among organizations is that much of the research and data are produced by the larger FSR organizations. These organizations not only generate the information at times, but also

disseminate the information and create the decision-support tools and data visualizations. Local fire managers often receive this data and information from external agency sources, which can influence their trust in the information. As mentioned earlier, one participant said they were more willing to receive climate change information if it came from a co-worker or someone with first-hand experience and boots on the ground. The sense of "otherness" associated with this information can impact trust levels. McCaffrey (2004) highlighted this, showing evidence that mere availability of information does not necessarily lead to increased awareness or action. The manner in which people receive information, their trust in the source, and whether the information is presented in a relevant social context are crucial to climate change perceptions among local fire managers (Leiserowitz, 2006).

Shifting the lens of analysis to a geographical scale, the combination of survey and focus group results suggest a regional divergence in climate change perception. Both methods indicated that fire managers located in the central and eastern United States are more hesitant to acknowledge climate change or the influence of humans on the phenomenon. Of the fire managers who were most concerned about climate change and its relationship to wildfires are those at the federal, state, and regional levels within the western U.S. Similarly, western fire managers are also more confident in the human role as it pertains to climate change. While these regional contrasts are likely due to deep-seated complexities around politics, socioeconomics, culture, etc., the long history around fire suppression, land management, land development, and a more widely accepted attribution of climate change to the wildfire problem in the west is a potential explanation for such geographical differences (Hudson, 2011).

## 5.2 Decision-Making

### 5.2.1 Research Question 3: Products and Information

Takeaways from the FSR and local fire managers regarding forecast products, tools, and information reveal striking similarities. When asked separately about the products they use in their decision-making processes, all organizational levels pointed to the National Weather Service (NWS) and Mesonets as their top two choices. What emerged as vital to operational decision-making wasn't just the forecasts and outlook products provided by the NWS, but also the human support that complements the data. There was a lot of appreciation and emphasis on this aspect, especially among local fire managers who participate in weekly briefings with the NWS and had direct access to their support via phone and email.

Although all organizations also mentioned the use of "mesonets," the mesonets referenced by the FSR managers were different than the Oklahoma Mesonet used by Oklahoma fire managers. The Oklahoma Mesonet is an environmental monitoring network specific to the state of Oklahoma that also supports the OK-FIRE decision-support platform. Although not identical, various state mesonets offer their own networks of surface weather observations. It is important to note that despite the difference in mesonet ownership and operation, their use by fire managers at all levels demonstrates the importance of ground-based observational weather networks. Considering the role relative humidity, wind, and temperature play in fire behavior, it is evident why weather observations are critical sources of information. The underlying physics of fire behavior remain the same regardless of location, underscoring the utility of these weather parameters at a national level.

Similar to the broad applicability of weather variables and tools, FSR and local fire managers agreed on the usefulness of forecast periods. Various forecast periods were presented to FSR managers, which included day-of, 3-day, weekly, monthly, and multi-month forecasts. Based on their ratings of importance, monthly and multi-month forecasts were considered moderately important while shorter forecast periods of a week or less were deemed very important. In fact, the shorter the forecast period, the more critical it was in their decision-making processes. This was echoed by local fire managers in Oklahoma as well, with most focusing on forecasts no more than a week ahead, with decisions often being made one to two days in advance. Based on the role weather plays in fire behavior, it makes sense that shorter forecast periods are more influential in decision-making. Given that forecast accuracy improves the closer the date gets, these shorter periods would be the most reliable. If a shift in the weather forecast were to occur, which is more likely with longer forecast periods, adjustments to resource staging and personnel planning would have to be made to meet the updated environmental conditions and potential fire risks.

### 5.2.2 Research Question 4: Policy and Planning

Forecast periods and fluctuating weather patterns are vital in planning. They impact resource staging, staffing strategies, timing of prescribed burns, anticipation of critical fire events, and more. While some attention is given to long-term planning and evaluation of monthly and multi-month outlooks by FSR managers, prescribed burn associations, and wildlife management organizations, the majority of fire managers across all levels said they don't plan long-term. In particular, most acknowledge they primarily only utilize forecasts a week out. This lack of foresight extends to the consideration of climate change in long-term planning and decision-making as well. Given that the majority of FSR managers

acknowledge the importance and impact of climate change on future wildfire threats, this was surprising. In contrast, local fire managers showed little focus on long-term planning with a complete disregard for climate change at all, with most perceiving the climate change threat as either insignificant or non-existent.

With some local fire managers admitting their organizations are reactive versus proactive (i.e., they operate by reacting or responding to a problem versus anticipating or mitigating future potential problems), the shortcomings in planning for both FSR and local managers were rarely due to a lack in desire to plan. Despite the looming threat of climate change on future wildfires, everyone agreed that planning and preparation are crucial in fire management. However, what often hinders this planning are operational challenges that act as barriers. Fire managers at all levels prioritize immediate threats and allocate their resources to those needs. As one fire manager candidly stated, "No, there's a million things I worry about before I worry about climate change to do my [burn plan] that day." In the survey responses, FSR managers frequently attributed the lack of long-term planning to staffing and funding shortages.

The unpredictability and instability of funding for federal, regional, and state organizations exacerbates these challenges. Federal funding, unlike fire department memberships or sales taxes that fund local organizations according to focus group participants, is subject to federal priorities and short-term interests. One FSR manager elaborated on these challenges caused by unstable funding and highlighted how organizations struggle to address staffing issues within the constrained timeframes funding is available:

> The forthcoming budget is expected to significantly increase funding; however, these rare surges in funding are often somewhat ineffective because we cannot build

the capacity quickly to capitalize on those investments (e.g. there is no pool of highly qualified firefighters or managers who are just waiting for us to create the FTE and acquire the funds to hire them - those positions must be developed, requiring significant workforce transformation over a period of several years). Moreover, increasing funding probably will not reverse the trend of increasingly negative wildfire outcomes (though it may slow the rate, yet it's difficult to prove that correlation). Accordingly, these flushes of funding - historically - have been withdrawn due to a lack of results, which further destabilizes the workforce and undermines long-term management strategies.

Similarly, another manager underscored the inability to adequately use funds when given the opportunity, by describing their budget as a:

Cyclic rollercoaster every year depending on the politics in the White House and whatever shiny object has caught the eye of the Chief. Every year we have lots of big fires we see a reaction in expectations and budget. In the last 2 years, we've seen an epic increase in funding without an understanding of how long our archaic organization will take to utilize that funding.

These reflections demonstrate the inefficient use of moneys, poor planning, and the inability to quickly utilize those funds to remedy staffing shortages during temporary periods of increased funding. Unfortunately, that has hindered the stabilization and implementation of long-term fire management strategies.

With various challenges impeding long-term planning across all fire management organizations, discussion around policy also revealed areas for improvement. Again, this wasn't due to a lack of interest, but rather insufficient resources and a low level of prioritization. Of particular note was that when given the opportunity to elaborate on fire prevention policies, that specific topic garnered much fewer responses compared to other survey questions. Similarly, focus group participants showed less enthusiasm and provided fewer comments regarding policies they have impacted or implemented. This could stem from a genuine lack of interest in policy matters, the recognition that policies in fire management are stagnant, or a feeling of limited influence or impact on policy decisions or creation despite the growing risk of wildfires. Among the policies discussed, most were

agency-led efforts or action plans, as opposed to formal guidelines, procedures, or legal initiatives. According to the FSR managers, the top four policies or actions implemented in their organizations included 1) public outreach, education, or training; 2) messaging or mass communication campaigns (e.g., Smokey the Bear); 3) increased fuel and land management focus; and 4) community planning and adaptation and mitigation programs. Also mentioned, albeit by fewer than 15% of respondents, were the development of general agency plans or guidelines, and the emphasis on interagency collaborations.

Despite the limited response on policies by FSR managers, even fewer policies were described by local managers. Although smaller fire management organizations lauded their efficiency and lack of bureaucracy, the scarcity of resources, funding, and staff are challenging for policy implementation and planning. The most common policy mentioned by local fire managers was the creation of burn plans which include environmental conditions, action plans, and strategies for the burn. However, there was acknowledgement and consensus that the level of detail in these plans varied widely across agencies. While some require extensive information, others simply ask for a single weather forecast. The second most discussed policy shared in the focus groups involved landowner memberships or subscriptions to fire departments or burn associations, which cover prescribed burning or land management assistance and response from those organizations. Based on the policies highlighted, there appears to be a stronger focus on response, land management, operations, and resource use among local fire managers, whereas communication and community collaboration take precedence for FSR managers. This suggests that FSR managers have more capacity for planning and strategizing, while local managers prioritize immediate response and management. Worth reiterating is that while a lot of interest was

shown in developing better land management policies, outreach, education, and community-based projects, all fire management levels struggle with the necessary finances, staff, and time required to support such initiatives.

### 5.2.3 Research Question 5: Pressures and Challenges

The barriers to long-term planning mirror the organizational hurdles mentioned by fire managers across the board. Naturally dividing into two categories, local fire managers grapple with operational challenges and land management challenges. Their primary operational challenges include staffing, limited resources, and funding constraints. Although not a priority as described in Chapter 4, there is recognition that funding would assist resource and staffing issues. With regard to land management, challenges include public and landowner exposure to and understanding of land management practices and prescribed burning, availability of staffing and resources, and complications around the WUI and land fragmentation. While FSR managers also face land management issues, local fire managers contend with the public and land management challenges more routinely as part of their day-to-day functions. Reflecting on the operational side of challenges, FSR issues align more closely with those experienced by local managers. Staffing and money are the most significant operational barriers for FSR managers. Managers at all levels are concerned about diversity, recruitment, interest among youth, salary, training, and retention challenges as they pertain to staffing. For all fire managers, staffing issues impede response and planning efforts, which may also be why FSR managers feel their organizations are not responsive enough in addressing climate change-induced wildfire threats, as mentioned in Chapter 3.

Not only do these challenges pose daily hurdles, but both FSR and local fire managers also deal with additional internal and external pressures that directly influence their decision-making. When presented with a predefined list of pressures, FSR managers rated their significance based on the degree they drive organizational decisions and perceptions. The top three most noteworthy pressures identified were finances, immediate threat to life and property, and politics. Factors such as social and or community approval, as well as climate change, were only sometimes or never considered. When given the opportunity to write down additional pressures in an open-ended format, politics, staffing, competing agency agendas or objectives, external or public influence, and leadership were listed among the top five pressures affecting decision-making. Staffing emerged, again, not only as a challenge, but as a significant pressure on how decisions are made.

Comparatively, local fire managers experience distinct pressures apart from staffing. While FSR managers ranked public influence and approval lower on their list of pressures, this aspect is a primary pressure for local managers. In fact, the discussion on challenges and pressures largely revolved around public influence and concern over public optics, pressure, and landowner input on land management. While local organizations do feel pressure from local government or politics, as well as competing strategies or objectives, the conversation always circled back to public and landowner pressure. This seems logical given that local fire managers operate daily within the public and landowner domain. Based on the pressures faced by fire managers at these various levels, there is a critical need to improve education and communication with funding sources and the public. This would foster greater interest in fire management, convey the threat of wildfires, and secure the necessary resources and support to plan and manage the land effectively.

## 5.3 Implications and Recommendations

The implications from my research methods and findings are significant for understanding fire management and they provide actionable recommendations to address key challenges. Reflecting on the mixed methods of surveys and focus groups, both approaches reveal valuable insight from the various organizational levels, ultimately offering a comprehensive view of the field when combined. Despite the inability to have sit-down conversations with federal, state, and regional fire managers throughout the country, the surveys effectively captured their perceptions. By starting with surveys, I was able to identify key areas needing clarification or further discussion. This informed the subsequent focus group sessions, offering opportunity for that clarification. The mix of qualitative and quantitative data provided by both methods allowed participants to share their knowledge and perceptions in various ways. Multiple-choice, ranking, and Likert-scale formats allowed for more succinct and pointed responses, while open-ended questions allowed fire managers to elaborate and steer the conversation in their desired direction.

The focus groups complemented survey responses and added the additional benefit of being able to clarify questions or comments, allow opportunity for back-and-forth dialogue, explore deeper concerns and passions, and build relationships with the fire managers. Furthermore, the qualitative methodology among focus groups provided a deeper understanding of key concepts, themes, perceptions, and beliefs that were not necessarily included in predefined discussion topics. For example, issues and concerns such as poor land management and public perception emerged as primary concerns and drivers of wildfire risk, despite not being originally identified as core themes before the

focus groups began. Given the lessons learned and the successful implementation of both methods, this approach can serve as a blueprint for future research involving practitioners, stakeholders, community members, and more.

With regard to my research findings and their relevance to the broader field of fire management, there are significant implications that extend to various aspects of risk perception, decision-making, policy, planning, pressures, and challenges within the organizational framework of fire management. As wildfire severity and a changing climate pose a critical threat, this area of study is crucial. While much of the previous research focuses on these aspects from the perspectives of public individuals and homeowners, this study offers a unique perspective by comparing different organizational levels within fire management. Furthermore, this research frames the wildfire problem as something that can be better addressed by organizations collectively. By aggregating individual thoughts and identifying common concerns or themes at different organizational levels, an opportunity is created to address specific issues and build initiatives at an organizational level. In addition, by comparing and contrasting perceptions and decision-making processes across federal, state, regional, and local organizations, efforts can be placed on leveraging similarities, differences, strengths, and needs to collaboratively tackle the wildfire threat. Moreover, my research also emphasizes the importance of recognizing wildfires as a human problem rather than just a physical one within the realm of fire management. The key takeaways can be summarized as follows:

1. The increase in wildfire risk and its severity are acknowledged by fire managers at all organizational levels.
2. The majority of fire managers across all levels, with special emphasis on local fire managers, believe wildfire risk is largely due to fuel and land management, human activity, and population growth.
3. Experience and trust in information sources profoundly shape risk perception.

4. FSR managers are more concerned about, and accepting of, the relationship between climate change and wildfires than local Oklahoma fire managers.
5. There exists a knowledge gap between local fire managers and established climate change science.
6. Climate change considerations, long-term planning, and supportive policy are not adequate at any organizational level.
7. When communicating or discussing wildfire risk and fire management challenges, more recognition needs to be given to human-related impacts on land management as this is of utmost concern to fire managers and a primary factor in risk production, rather than framing the conversation around climate change.
8. To improve long-term planning, staffing and funding issues need to be addressed and stabilized at all levels, as the cyclic nature of funding is a critical barrier.
9. Public communication, education, and fuel and land management need to be prioritized to reduce wildfire threats and relieve pressure on fire managers.

Table 2 summarizes comparisons between the various organizational levels to call further attention to the key themes that unfolded in the surveys and focus groups:

| | Organizational Level | |
|---|---|---|
| | **Federal, State, and Regional** | **Local within Oklahoma** |
| View on Climate Change and the Human Role | • Roughly half moderately to extremely concerned about climate change<br>• Larger majority concerned about climate change and its relationship to wildfire risk<br>• Half of respondents moderately or very confident climate change is primarily caused by human activity | • Majority do not think climate change exists or can be attributed to wildfire risk<br>• Climate change impacts, rephrased as drought or extreme weather events, observed by most<br>• Majority do not think climate change is human-caused as most deny climate change existence |
| Wildfire Risk Perception | • Increasing; primarily severity | • Increasing; primarily severity |
| Additional Primary Risk Concerns | • WUI; human-environment interaction<br>• Fuel and land management<br>• Staffing | • WUI<br>• Population growth- increased exposure<br>• Fuel and land management<br>• Land fragmentation |

| | | |
|---|---|---|
| Top Organizational Pressures | <ul><li>Funding</li><li>Immediate threat to life and property</li><li>Politics</li><li>Staffing</li></ul> | <ul><li>Public pressure and influence</li><li>Landowner pressure</li></ul> |
| Primary Challenges or Barriers | <ul><li>Staffing</li><li>Funding</li></ul> | Operational:<ul><li>Staffing</li><li>Resources</li><li>Funding</li></ul>Land Management:<ul><li>Public land management and prescribed burn exposure and understanding</li><li>Staffing</li><li>Resources</li><li>WUI; land fragmentation</li></ul> |
| Primary Information Sources | <ul><li>National Weather Service</li><li>Mesonets</li></ul> | <ul><li>National Weather Service</li><li>Mesonets (+OK-FIRE)</li></ul> |
| Primary Weather Variables | NA | <ul><li>Relative humidity</li><li>Wind speed and direction</li><li>Temperature</li><li>Fuel moisture</li></ul> |
| Weather Forecast Periods (listed in order or importance) | <ul><li>Day-of</li><li>3-day</li><li>Weekly</li><li>Much less or moderate importance of monthly or multi-month outlooks</li></ul> | <ul><li>Current-hourly (monitoring and response purposes)</li><li>1-2 days</li><li>Day-of</li><li>1-2 weeks</li><li>Majority of decisions made 1-2 days in advance</li></ul> |
| Long-Term Planning | <ul><li>Limited</li></ul> | <ul><li>Very limited</li></ul> |
| Policy and Actions | <ul><li>Limited</li><li>Public outreach, education, and training</li><li>Messaging or mass communication campaigns (e.g., Smokey the Bear)</li><li>Increased fuel and land management focus</li><li>Community planning, and adaptation and mitigation programs</li></ul> | <ul><li>Very limited</li><li>Burn plan development</li><li>Landowner membership or subscriptions to fire departments or burn associations</li><li>Upgrading gear or equipment</li><li>Instituting WAR Days</li></ul> |

Table 2. Summary of organizational views.

Given these takeaways and the concerns expressed by fire managers, there are opportunities to address these areas that need improvement in a variety of organizational ways. One clear implication is for enhanced public education and outreach programs organized by U.S. Forestry, wildlife or conservation departments, prescribed burn associations, cities, schools, fire departments, or a collaboration between such entities. These programs can specifically target fuel and land management, prescribed burning, wildfire risks, and grow interest in areas of fire management and natural resources among youth. Such programs would also have potential to increase staff recruitment. Improving messaging, education, trust, and communication regarding wildfire risks and necessary mitigation efforts to not only the public, but local and federal funding sources as well, would encourage increased funding.

For the fire management training that does exist, such as OK-FIRE, there is also room for refinement. With concern growing over fuel and land management, fire management workshops and trainings need to emphasize the practical application and practice of prescribed burning and wildfire risk reduction. To make it more relevant and enhance hands-on learning, there needs to be more implementation of case studies, drills, and prescribed burn techniques that allow fire management attendees to practice real-world efforts, management, and response. Ideally, this would include a walk-through of assessing the fire environment, filling out a burn plan, and going through the process of burns from start to finish. In addition, while trainings are often geared toward prescribed burn or wildland fire managers, such trainings could become more inclusive to both "frontstage" and "backstage" fire managers. By incorporating individuals that identify within these various roles, collaboration, communication, relationship-building, and a deeper

understanding of the link between science and application can be made for all fire managers.

With regard to contrasting perspectives on climate change, organizations and the public would benefit from improved science communication. For Oklahoma fire managers in particular, the political context and culture of the state in which they reside, as well as their immersion in communities that share like-minded information and perhaps a disinclination to the climate change phenomenon, influences their viewpoints. While the hesitancy around climate change could be a deep-seated ideological issue, responses suggest that most fire managers are open to the concept. Additional information, communication, and training as standalone initiatives will not necessarily alter that viewpoint. However, increasing fire managers' trust in information sources would be a significant factor in influencing perceptions on wildfire risk and climate change.

Efforts should focus on accessible and relevant data and information sharing, as well as building a relationship of trust between those who disseminate the information and those who use it. This would require tackling the "otherness" of research agencies by having them work more closely with communities and immerse themselves in local fire management needs and operations. It is also paramount for science communicators to engage with local culture and communities and create partnerships, whether that be in the form of participating in prescribed burns; on-the-ground assistance before, during, or after wildfire events; school outreach events; or town halls. Provided that wildfire risk and concerns are primarily attributed to fuel and land management practices by fire managers, there is also strong indication that climate change is not a necessary talking point when addressing the increase in wildfire risk. Given the hesitancy on climate change, it is likely

more beneficial to communicate the risk as a human problem. The symptoms of the disease can be treated, per se, by addressing the most immediate and perceived threats as they relate to fuel management, prescribed burning, public perception of fire, and land use practices. Tackling the latter threats may also offer more attainable objectives. No matter how the topic is framed; however, trust, partnerships, and relationship-building as they pertain to science communication are critical to the success of wildfire risk reduction.

Also crucial to wildfire risk reduction is long-term planning and policy, which fall short at all organizational levels. Barriers to these efforts, such as staffing and funding in particular, need to be alleviated. In its current state, most fire management organizations only have the resources to address immediate threats and problems. Stabilizing and increasing funding would improve staffing and allow for fire managers to prioritize planning and policy development by dedicating more resources to those efforts. As emphasized by Carroll & Jones Stater (2008), "Organizational survival is contingent upon the ability to acquire and maintain resources (p. 948)." One recommendation would be to create a more diversified revenue portfolio. This is often suggested for nonprofit organizations, and while there is acknowledgement that larger organizations have more capacity to accomplish diversification, it has been found to work for small organizations as well, making it ideal for local fire managers. Diversifying funding at the local level, rather than depending solely on county, city, or sales tax, would provide additional stability.

To assist in locating various funding sources, there exists an opportunity for the development of an institution whose goal is to work with fire managers to pursue grants and alternative sources of funding. Equally as important, organizations should incorporate

financial management training to use the funds efficiently (Carroll & Jones Stater, 2008).

Giving attention to the management and allocation aspect of funds is just as critical to the longevity, success, and efficiency of an organization as the dollar amount provided. Financial diversification and training would reduce the cyclic nature of funding for fire managers at all levels, which was stressed as a significant challenge. To further improve funding barriers, Chambers et al. (2014) discussed the significance of funders being transparent about their processes and how they prioritize needs. Organizations should dedicate focus to understanding and researching how funding sources prioritize projects and push funding agencies to be more transparent. These commitments and goals could be outlined in a consortium and would expand the potential for better funding among fire management organizations.

Expanding on the concept of a consortium, it may be advantageous to cultivate and strengthen partnerships with other groups to foster resource development and sharing. According to Lim (2013), who references this common practice in the medical industry, consortia are beneficial by offering "a partnership framework that provides neutral and temporary collaborative environments for several, oftentimes competing, organizations and leverages the aggregated intellect and resources of stakeholders so as to create versatile solutions (p. 1)." Research initiatives are often highlighted in consortiums, but the concept can be applied to leveraging partnerships and collaborations for additional funding, pooling of resources, and increasing negotiating power (Lim, 2013). While this is often practiced in academia and other research institutions, consortia should be explored more in fire management. Combined efforts and partnerships among local, state, federal, and regional fire managers can create benefits like those experienced by other consortia.

Nevertheless, pursuing the consortium approach does come with some potential drawbacks. The organizations involved may have competing priorities and goals, as well as differing opinions on how to address certain issues. Furthermore, dependance on other groups can hinder efficiency as bureaucracy and the speed of response may be slow (Souder & Nassar, 1990). Adding to these challenges are the personnel and time commitment necessary for such partnerships, as well as ensuring effective coordination, communication, and logistical arrangements (Gazley & Brudney, 2007). An alternative option would be to delegate specific roles to individual agencies as they pertain to planning and preparation, mitigation, and response. While this option may lack the benefits of pooled resources, combined professional expertise, promotion of shared goals, etc., it has its own advantages (Gazley & Brudney, 2007). Practicing delegation over centralization allows organizations to maintain their autonomy, increase efficiency without red-tape barriers, and speed up decision-making processes (Kala, 2019). This ultimately streamlines and accelerates projects without having to achieve consensus among multiple parties. Since consortiums and delegation each come with distinct pros and cons, fire management organizations should assess the cost-benefit of these approaches and identify the best strategy for their goals.

To promote fire management goals, funding, and planning, there have also been several program initiatives that should be explored and expanded across the country. Programs such as the Collaborative Forest Landscape Restoration Program and the Joint Chiefs Landscape Restoration Partnership were created to support a "national process for prioritizing funding" that can be used for fuel management, prescribed fire, and other restoration efforts (Schultz & Moseley, 2019, p. 38). Underscoring the significance of

consortiums and collaborations, the proposals for these programs are highly collaborative and bring together fire and land managers from various organizational levels, scientists, community groups, and more. Development of similar programs that operate on multiyear funding commitments would assist in the cyclic challenges of current funding barriers, provide stability, and support long-term planning (Schultz & Moseley, 2019). More programs of this nature need to be established and promoted, as well as development of new grant opportunities. Furthermore, there needs to be a way to share these opportunities more broadly with fire managers across the country, alerting them to potential funding programs they may not otherwise be aware of. With an increase in funding, there would be more prospects for improved land management practices, planning, and staff recruitment and retention, ultimately stabilizing and improving fire management at the federal, state, regional, and local level. Revenue diversification, financial training, consortiums, and programs that support funding initiatives are examples of potential ways to alleviate current barriers to successful fire management.

Overall, this research carries several implications and recommendations for improving fire management and reducing the wildfire threat. This dissertation fills a knowledge gap by framing risk perceptions, decision-making, policy, and pressures around fire management organizations, as well as discerning how different organizational levels compare. The study identifies many areas and barriers in fire management that can be improved upon, which can be tackled at both the organizational level and through research endeavors. This research offers practical insights and leaves space for additional research initiatives.

## 5.4 Limitations

Like any research endeavor, it is important to recognize the limitations that are present. Although my mixed methods approach provided valuable insights, there are aspects that could be improved upon. One of the common drawbacks of surveys is the inability to clarify questions for participants. Within my survey in particular, some respondents expressed uncertainty about terms like "risk" and "catastrophe". While I welcomed the idea of letting participants determine their own definitions based on their unique understanding, this approach led to an array of interpretations that were sometimes difficult to categorize or compare. However, this feedback helped me identify areas needing clarification during the focus groups. Furthermore, due to the nature of surveys, I did not have the opportunity or ability to ask clarifying questions or explore responses as in-depth as I did during the focus groups. In retrospect, it would be beneficial to conduct this study again with identical questions in both the surveys and focus groups. This would allow for better one-to-one comparisons between the data gathered from the different methods.

For the focus groups, I was fortunate to have a diverse mix of fire management roles represented. The focus group sizes were also optimal for meaningful discussions, allowing for an environment where participants built upon each other's responses. However, I would have preferred more representation in the southwest focus group, as only one fire manager was able to participate, as well as more gender diversity among participants. It is important to note that the local fire managers in Oklahoma are not wholly representative of other local fire management organizations. Local managers in other states may have differing opinions, experiences, decision-making approaches, and perceptions.

Additionally, it is crucial to acknowledge the potential for geographical bias in participant recruitment, given the professional network I utilized and its bias toward Oklahoma connections. Furthermore, the open-ended questions and coding analysis in both the surveys and focus group discussions introduce an element of subjectivity. Despite these potential limitations, the large quantity of data generated from these two methods leaves ample opportunity for additional analysis and the exploration of various research angles. For instance, given additional time, deeper analysis on policy development and implications, as well as connecting regional differences among responses, would make this research more practically relevant. While these limitations are not all-inclusive, addressing them can contribute to refining and enhancing future research.

**CHAPTER 6: CONCLUSION**

The likelihood and scale of U.S. wildfires due to climate change has been drastically increasing, with projected warming and a reduction in precipitation expected to further exacerbate the problem (USGCRP, 2023). Impacts from this increasing wildfire threat can be felt through various facets of our everyday life. The extent and severity of wildfires has led to recreational, health, cultural, economic, and other various impacts, which are only anticipated to worsen (USGCRP, 2023). Such devastating impacts continue to climb in frequency, which has been evident in recent wildfire events. One of the largest wildfires in U.S. history and the largest in Texas state history occurred in February 2024. Known as the Smokehouse Fire, the wildfire burned more than 1 million acres, resulting in the loss of hundreds of structures, thousands of cattle, and three fatalities (Del Rey, 2024). Further compounding this issue is a growing population, land-use and land management changes, infrastructure development, and expanding housing development in the wildland urban interface (Modaresi Rad et al., 2023).

To combat the future potential of these catastrophes and to successfully coexist with fire, society must learn how to effectively manage, mitigate, adapt, and respond to this growing threat. Fire managers are central to this effort as they are at the frontlines of the growing wildfire threat, serving in various research, response, suppression, natural resource, and management capacities as it relates to wildfire risk and activity. To improve the effectiveness and efficiency within this field, my research investigated aspects of risk perception, decision-making, challenges, pressures, and policies that influence fire management at different organizational levels. Intent on better understanding these aspects

among federal, state, regional, and local fire managers, as well as how they navigate the complexities of climate-induced wildfires, I used a mixed-method approach.

Following the most logical and economical method in reaching federal, state, and regional fire managers across the country, surveys were sent out through email. With the feasibility of being able to immerse myself in more intimate conversations in my home state of Oklahoma, I then facilitated five focus groups with local fire managers. This resulted in input from 264 federal, state, and regional fire managers, and 20 local fire managers. Via these two methods, participants were asked how they perceive wildfire risk, its relation to climate change and humans, and what influences their decision-making. Within these topics were additional questions on policy, planning, challenges, pressures, priorities, and tools. Results from the surveys and focus groups were rich and insightful, providing clarity on organizational perceptions, operations, similarities, and differences in fire management across various organizational levels. For reference, the previous chapter summarizes some of these key comparisons (Chapter 5, Table 2).

Among the primary findings were that the increase in wildfire risk is acknowledged and felt by fire managers at all organizational levels, especially the increase in severity. The majority of fire managers across all levels also believe wildfire risk is predominately due to fuel and land management, human activity, and population growth. This was a prominent concern, in particular, among local fire managers. To reduce risk and relieve public pressure on decision-making, communication, education, and fuel and land management need to be prioritized among fire management organizations, as well as the creation of programs that support these efforts.

Concerning the topic of climate change, FSR managers are much more concerned about, and accepting of, its relationship to wildfires than local Oklahoma fire managers. Apart from the political and cultural context of Oklahoma, reasons for this point to poor communication with local managers, the source of climate change information, and the relevance to on-the-ground operations. Both experience and trust in information sources were also found to be influential in shaping perceptions on wildfire risk and anthropogenic climate change. While a knowledge gap or disconnect between research and users may exist, the level of trust between the two groups is highly determinative of whether the science is effectively communicated. Furthermore, when communicating or discussing wildfire risk and fire management challenges, more recognition needs to be given to human-related impacts on land management. Framing wildfire risk as a human problem as it relates to fire response, fuel and land management, human activity, and public perception, rather than emphasizing the term climate change, would be a more successful strategy in addressing fire management efforts.

With regard to climate change considerations, long-term planning and policy are not adequate at any organizational level. To improve all facets of long-term planning in fire management, staffing and funding issues need to be addressed and stabilized at all levels. Recommendations included revenue diversification, increased collaboration or use of consortiums, and funding source transparency, among others detailed in Chapter 5. Increasing not just the funding value, but the *cyclic* nature of funding was determined to be the most critical barrier to planning and staffing. Incorporating financial management training to properly and efficiently allocate funds, as well as increase funding stability would alleviate barriers to progress, planning, and success.

Recommendations regarding collaboration, outreach, improved communication, and securing stable funding underscore the advantages of approaching fire management and the wildfire problem through an organizational lens. This framework helps to overcome barriers and improve effectiveness across different organizational levels and brings to light organizational social structures, challenges, priorities, and motivations. Furthermore, viewing individual perceptions and concerns as a collective, draws on Organizational theory to show how an organization's efficiency and decision-making is shaped by these individual perceptions as well as the environment in which it operates. Addressing communal concerns at organizational levels can lead to improved functionality and break down operational barriers. Understanding such organizational barriers, pressures, and concerns would also more effectively address the wildfire problem given that fire management, risk communication, and community resilience are heavily influenced by institutional dynamics across different levels (Abrams et al., 2015; Boholm, 2019).

While fire management organizations are separate, they are interconnected, interacting within a broader political, social, and cultural context. Analyzing both internal and external pressures unique to these organizations helps pinpoint where roadblocks lie. These pressures affect decision-making within organizations and can, therefore, be tackled at that same level. Funding, staffing, public action, and public perception, for example, can be addressed with organizational programs or initiatives to improve organizational functionality. Comparing strengths, barriers, and opportunities across different fire management levels can also reveal areas for potential partnerships and collaborations, and inform which projects or focus areas need to be prioritized. Furthermore, this approach can

be used to show how to leverage strengths and partnerships among organizations, particularly regarding funding opportunities, messaging, and communicating wildfire risk and the importance of fuel and land management to a general public.

Although I highlight the advantages of using an organizational lens for fire management and risk perception, it is crucial to acknowledge its limitations. For one, there are individual nuances within organizational social structures that may be lost in the broad brushing of organizational needs. Additionally, as discussed in Chapter 2, organizations are not isolated systems; there are areas of ambiguity, ever-fluctuating experiences and perceptions, and overlaps between organizational goals and roles. Given that organizations are influenced by a dynamic environment, the lessons we learn may change as external influences, like politics and the economy, evolve.

While not exhaustive, this approach and its related findings are thick with information and potential. However, there is always more that can be done, as well as aspects of this current research that could have been done better. The wildfire problem is incredibly complex, especially when you add the human component to it. Risk perceptions, decision-making, and fire management coupled with societal perceptions and actions are ever evolving. To improve this understanding, there needs to be additional research that focuses on regional differences in fire management that includes not only physical geography, but the unique nuances of human activity and perceptions as they pertain to different locations. As one state cannot be a singular voice for all local fire managers, additional focus groups should be similarly done throughout other areas of the country.

Moving forward, additional connections and angles can be analyzed. My research skims the surface of policy development and influence, but more needs to be done to assess

current policy and pilot new, community-based outreach initiatives and land management policies. Furthermore, how do the demographics of fire managers influence risk perception? There is opportunity to dive deeper into gender, age, and position (i.e., entry-level, mid-level, or senior roles) as they relate to decision-making, challenges, pressures, and perceptions. With the recognition and concern over transient "weekend warriors," tourists, and non-locals moving part-time into rural areas, there also needs to be additional focus on their activities, perception of risk, and wildfire and land management knowledge. The latter is an area of study that needs to be expediently addressed to reduce the alarming potential for a wildfire catastrophe.

With many opportunities to follow-up and expand on my research, the insights, lessons-learned, recommendations, and limitations discussed in the previous chapter create a starting point. This research also provides the potential benefit of informing state-specific policy and organizational decision-making. Furthermore, these research results can be leveraged to identify strengths, weaknesses, and opportunities related to agency practices, structures, processes, policies, and resource allocation. Improving support for fire managers and understanding their needs will, in turn, better serve their communities. Wildfire risk is an undeniably complex problem, but recognizing it is a human problem driven by perception, actions, and decisions that can be addressed, is a crucial step toward mitigating future risks.

## Appendix A: Survey Questionnaire

**Q1.** Consent to Participate in Research

**Q1.** Gender:

- o Male
- o Female
- o Non-binary/third gender
- o Prefer not to say

**Q2.** Age:

- o 18-24
- o 25-34
- o 35-44
- o 45-54
- o 55-64
- o 65+

**Q3.** How would you best describe your role in fire management? Check all that apply.

Emergency Management
Firefighter
Land and/or Fuel Management
Fire Program Manager
Planner and/or Analyst
Other:

**Q4.** Please describe in your own words what your day-to-day role in fire management looks

like:

**Q5.** At what organizational level do you work?

- o Federal
- o Regional
- o State
- o Neighborhood
- o Tribal
- o Municipal
- o County
- o Other:

**Q6.** How many years of experience do you have in fire management?

**Q7.** What level is your current position?

- o Entry-level
- o Mid-level
- o Top-level (Examples: Director or Organization Head)
- o Other:

**Q8.** In what state does your organization, or headquarters of your organization, reside?

**Q9.** How concerned are you about climate change?

- o Not at all concerned
- o Slightly concerned
- o Somewhat concerned
- o Moderately concerned
- o Extremely concerned

**Q10.** How concerned are you that climate change will increase wildfire threats?

- o Not at all concerned
- o Slightly concerned
- o Somewhat concerned
- o Moderately concerned
- o Extremely concerned

**Q11.** Please rank the potential fire-related threats in order from what concerns you most

(rank #1 placed at the top) to what concerns you least (rank #5 placed at the bottom). Drag

and drop the options to create your rankings.

- _ Wildfire frequency
- _ Wildfire severity
- _ Wildfire size
- _ Wildfire season length
- _ Natural/vegetative fuel for wildfire

**Q12.** Are there any risks not mentioned above that you are worried about? Please describe.

**Q13.** How confident are you that climate change is caused primarily by humans?

- o Not at all
- o Somewhat

o   Neutral
o   Moderately
o   Very

**Q14.** How strongly do you agree that your view on climate change has changed over the

years?

o   Strongly disagree
o   Somewhat disagree
o   Neither agree nor disagree
o   Somewhat agree
o   Strongly agree

**Q15.** How responsive do you believe your organization has been in addressing wildfire

threats driven by climate change?

o   Not at all
o   Somewhat
o   Neutral
o   Moderately
o   Very

**Q16.** How frequently do you use climate change forecasts in decision-making or planning?

o   Never
o   Sometimes (about 25-30% of the time)
o   About half the time
o   Most of the time (about 70-75% of the time)
o   Always

**Q17.** How would you rate the risk associated with wildfires?

o   No risk
o   Some risk
o   Neutral
o   Moderate risk
o   High risk

**Q18.** Have past fire events changed your view on wildfires?

o   Yes
o   No

o   Not sure

**Q19.** Have you ever experienced (personally or professionally) a catastrophic fire event?

If you answer "no", you will skip questions 20 and 21, and proceed to question 22.

o   Yes
o   No

**Q20.** If you have experienced a catastrophic fire event, how many years has it been since

your last event?

o   <1 year
o   1-2 years
o   3-5 years
o   6-10 years
o   11-20 years
o   20+ years

**Q21.** Please describe the catastrophic fire event(s) you have experienced.

**Q22.** How have past fire events changed your views on wildfires?

**Q23.** How have past fire events changed your approach to fire management?

**Q24.** How often does your organization communicate to the public?

o   Never
o   Sometimes (about 25-30% of the time)
o   About half the time
o   Most of the time (about 70-75% of the time)
o   Always

**Q25.** What methods of communication does your organization use with the public? Check

all that apply.

Public Information Officer
Social Media
Email
Phone
Television Media
Radio
Print Media

Other:

**Q26.** How often does your organization communicate with other fire management organizations?

o Never
o Sometimes (about 25-30% of the time)
o About half the time
o Most of the time (about 70-75% of the time)
o Always

**Q27.** What methods of communication does your organization use with other organizations? Check all that apply.

Public Information Officer
Social Media
Email
Phone
Television Media
Radio
Print Media
Other:

**Q28.** With what other levels of organizations does your organization collaborate with? Check all that apply.

Municipal
State
Regional
Federal
County
Tribal
Neighborhood
Other:

**Q29. #1** Rank the importance of the following forecast periods: - Day-of Forecast

_ Not Important
_ Slightly Important
_ Neutral
_ Moderately Important

    _  Very Important

**Q29. #2** Rank the importance of the following forecast periods: - 3-Day Forecast

    _  Not Important
    _  Slightly Important
    _  Neutral
    _  Moderately Important
    _  Very Important

**Q29. #3** Rank the importance of the following forecast periods: - Weekly Forecast

    _  Not Important
    _  Slightly Important
    _  Neutral
    _  Moderately Important
    _  Very Important

**Q29. #4** Rank the importance of the following forecast periods: - Monthly Forecast

    _  Not Important
    _  Slightly Important
    _  Neutral
    _  Moderately Important
    _  Very Important

**Q29. #5** Rank the importance of the following forecast periods: - Multi-Month Forecast

    _  Not Important
    _  Slightly Important
    _  Neutral
    _  Moderately Important
    _  Very Important

**Q30.** Please describe some of the tools (e.g. web products and websites) your organization

uses in decision making.

**Q31.** How often do you or your organization use external tools to aid in decision-making?

For example, the use of maps, workshops, websites, procedural guideline documents, on-

line planning guides, etc. that were created/developed by OTHER agencies.

    o  Never

- o Sometimes (about 25-30% of the time)
- o About half the time
- o Most of the time (about 70-75% of the time)
- o Always

**Q32.** How often do you or your organization use internal tools that you have created to aid in decision-making? For example, the use of maps, websites, procedural guideline documents, on-line planning guides, etc. that were created/developed by YOUR agency.

- o Never
- o Sometimes (about 25-30% of the time)
- o About half the time
- o Most of the time (about 70-75% of the time)
- o Always

**Q33.** Describe some actions that have been taken by your organization to reduce wildfire threats?

**Q34.** In your experience, to what degree do politics drive your organization's decisions?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

**Q35.** In your experience, to what degree does climate change drive your organization's decisions?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

**Q36.** In your experience, to what degree do finances drive your organization's decisions?

- o Never
- o Sometimes
- o About half the time

o Most of the time
o Always

**Q37.** In your experience, to what degree does a more immediate threat (day-of) to life and property drive your organization's decisions?

o Never
o Sometimes
o About half the time
o Most of the time
o Always

**Q38.** In your experience, to what degree does ecological well-being drive your organization's decisions?

o Never
o Sometimes
o About half the time
o Most of the time
o Always

**Q39.** In your experience, to what degree does a community's cultural beliefs drive your organization's decisions?

o Never
o Sometimes
o About half the time
o Most of the time
o Always

**Q40.** In your experience, to what degree does social/community approval drive your organization's decisions?

o Never
o Sometimes
o About half the time
o Most of the time
o Always

**Q41.** How have your organization's processes changed regarding how it makes decisions, obtains approval, responds to incidents, and prioritizes projects?

**Q42.** Please describe how your agency's funding level has changed over the past 10 years.

**Q43.** What internal and external pressures to your organization that are not already covered above influence how or why decisions are made? For example, internal pressures may be relationships or social hierarchies within your organization and external pressures are those placed on your organization from other agencies or groups of people, such as political power or threat to your agency's reputation.

**Q44.** What are some of the biggest challenges to the success of your organization?

**Q45.** What are some of your organization's strengths?

**Q46.** To what degree does your organization influence local, state, or federal policies pertaining to fire management?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

**Q47.** If applicable, please describe some fire prevention and response policies your organization has implemented.

## Appendix B: Focus Group Interview Guide

### Role in the fire management field

1. How many years have you been in fire management?

2. Can you describe your role in fire management?

3. Do these roles ever change? Does the season impact your roles?

4. Tell me about what a normal workday looks like for you.

### Perceptions of risk and climate change

*"Let's define risk before moving into the next set of questions. When I say risk, I define it as the possibility that wildfires will happen, as well as the likelihood of consequences due to them."*

1. Do you think the risk of fires and their threats are increasing, decreasing, or seem pretty much the same over the years? How so?

2. In what ways do you feel climate change is impacting wildfires?

3. What wildfire related risks are you most concerned about?

4. Has your level of concern about fires changed over the years? What has caused it to change?

5. What do you think is driving this risk? As in, why does this problem exist?

   a. Does management or climate change seem to drive any of that risk?

6. What, in your experience, have you seen cause wildfires? (prescribed burns, arson, weather, etc.)

7. Do you feel we are adequately addressing wildfire risk?

8. Have any conversations with co-workers, experts, friends, or family, or pieces of scientific information changed how you feel about the amount of risk from wildfires?

**<u>Operations and Decision-Making</u>**

1. How is your department or agency organized/structured?

   a. Who do you answer to or who makes the calls?

2. *Who* makes the decisions and sets priorities?

   a. Who has input?

3. Who sets the priorities for operations or action plans?

4. Do you practice fire suppression in your operations? How so?

   a. Does this include preventative practices like prescribed burning or fuel management?

5. Thoughts on prescribed burning?

6. How far does your jurisdiction or prescribed burning practices extend?

7. Do you do long-term planning, short-term planning, both (mitigation, fuel treatment [prescribed burns], reforestation, suppression, forecasting for events)?

8. Would you consider your operations proactive or reactive?

9. Do you or did you participate in any mitigation, prevention, or educational messaging to the public?

10. Do you think your agency is doing enough with regard to planning, preparing, and response?

    a. Is there more you would like to be doing?

11. How has wildfire management changed over time? How has prescribed burning changed over time?

12. Given what you or your agency have <u>experienced</u>, have policies or procedures changed based on those experiences?

13. How have your organization's processes changed regarding how it makes decisions, obtains approval, responds to incidents, and prioritizes projects?

    *[tools, different things driving decisions, technology, covid, red tape, more data driven]*

14. Do you think your objectives are attainable? If not, how so?

15. Is there a want or a will to change current procedures or planning?

    a. Is that possible to do/do you have the means or resources? If not, why?

16. Do you collaborate with any other groups or agencies (federal, state, local)?

    a. How would you describe these relationships with other agencies?

**<u>Tools</u>**

1. What primary tools (for example forecasts or computer tools) do you use to make decisions?

2. What variables do you look at specifically?

3. Is there something you like and/or something you don't have that you would like?

4. Using these tools or forecasts, how far in advance do you make decisions or make plans?

**<u>Barriers/Challenges/Successes</u>**

1. Are there any pressures (within your department or from the outside) that influence how or why decisions are made?

*[budget; policy; interagency coordination; legal constraints; power struggles; communication; agency competition; public/community interference; organizational structure; administration]*

2. Can relationships within your department, among colleagues, and even colleagues with different levels of power, impact how decisions are made?

3. Among co-workers, does everyone have a say? Do folks usually agree on priorities and operations?

4. Do social and political impacts play a role in fire management?

5. Curious, do you belong to a union? Does that ever impact decisions?

6. How have funding levels changed over the years?

   a. What causes those changes? (Congress, for example? Fire events?)

7. Are there limitations to what you can use funding for?

8. What resources do you have at your disposal? Staffing, funding, equipment, outside assistance, etc.?

9. Are there certain resources or needs that aren't being met that can impact your ability to do your job?

10. What are some strengths in your agency?

# REFERENCES

Abatzoglou, J. T., & Kolden, C. A. (2013). Relationships between climate and macroscale area burned in the western United States. *International Journal of Wildland Fire*, *22*(7), 1003–1020. https://doi.org/10.1071/WF13019

Abrams, J. B., Knapp, M., Paveglio, T. B., Ellison, A., Moseley, C., Nielsen-Pincus, M., & Carroll, M. S. (2015). Re-envisioning community-wildfire relations in the U.S. West as adaptive governance. *Ecology and Society*, *20*(3), art34. https://doi.org/10.5751/ES-07848-200334

Ager, A. A., Kline, J. D., & Fischer, A. P. (2015). Coupling the biophysical and social dimensions of wildfire risk to improve wildfire mitigation planning. *Risk Analysis*, *35*(8), 1393–1406. https://doi.org/10.1111/risa.12373

Aldrich, H. E. and Pfeffer, J. (1976) Environments of organizations. *Annual Review of Sociology, 2,* 79–105.

Alexandrian, D., and Esnault, F. (1998). *Report on public policies affecting forest fires: Public policies affecting forest fires in the Mediterranean basin.* (Paper No. 138). Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/3/x2095e/x2095e00.pdf

An, H., Gan, J., & Cho, S. J. (2015). Assessing climate change impacts on wildfire risk in the United States. *Forests*, *6*(9), 3197–3211. https://doi.org/10.3390/f6093197

Arkin, D., & Blackman, J. (2023, June 8). Canadian wildfire smoke disrupts U.S. air travel. *NBC News.* https://www.nbcnews.com/news/canadian-wildfire-smoke-disrupts-us-air-travel-rcna88335

Baxter, J. (2016). Case studies in qualitative research. In I. Hay (Ed.). *Qualitative research methods in human geography* (4th ed., pp. 130-146). Don Mills, Ontario: Oxford University Press.

Berke, P. R., & French, S. P. (1994). The influence of state planning mandates on local plan quality. *Journal of Planning Education and Research*, *13*(4), 237–250. https://doi.org/10.1177/0739456X9401300401

Bertrand, J. T., Brown, J. E., & Ward, V. M. (1992). Techniques for analyzing focus group data. *Evaluation review, 16*(2), 198-209.

Boholm, Å. (2019). Lessons of success and failure: Practicing risk communication at government agencies. *Safety Science*, *118*, 158–167. https://doi.org/10.1016/j.ssci.2019.05.025

Bosco, F. J., & Herman, T. (2010). Focus groups as collaborative research performances. In DeLyser, D., Herbert, S., Aitken, S., Crang, M., and McDowell, L. (Eds.), *The SAGE Handbook of Qualitative Geography* (pp. 193-207). London: SAGE Publications Ltd.

Brenkert-Smith, H. (2010). Building bridges to fight fire: the role of informal social interactions in six Colorado wildland–urban interface communities. *International Journal of Wildland Fire 19*(6), 689–697.

Brock, F. V., Crawford, K. C., Elliott, R. L., Cuperus, G. W., Stadler, S. J., Johnson, H. L., & Eilts, M. D. (1995). The Oklahoma Mesonet: A technical overview. *Journal of Atmospheric and Oceanic Technology, 12*(1), 5-19. https://doi.org/10.1175/1520-0426(1995)012<0005:TOMATO>2.0.CO;2

Burton, I., & Kates, R. W. (1964). The perception of natural hazards in resource management. *Natural Resources Journal, 3*(3), 412-441.

Calef, M. P., McGuire, A. D., & Chapin, F. S. (2008). Human Influences on wildfire in Alaska from 1988 through 2005: An analysis of the spatial patterns of human impacts. Earth Interactions, 12(1) http://dx.doi.org.ezproxy.lib.ou.edu/10.1175/2007EI220.1

Cameron, J. (2016). Focusing on the focus group. In I. Hay (Ed.). *Qualitative research methods in human geography* (4th ed., pp. 203-224). Don Mills, Ontario: Oxford University Press.

Cardille, J. A., Ventura, S. J., & Turner, M. G. (2001). Environmental and social factors influencing wildfires in the Upper Midwest, United States. *Ecological Applications*, *11*(1), 111–127. https://doi.org/10.1890/1051-0761(2001)011[0111:EASFIW]2.0.CO;2

Carlson, J. D., Bidwell, T., Wolfinbarger, M., Blackburn, S., & Jabrzemski, R. (2011). *OK-FIRE: A Weather-Based Decision Support System for Wildland Fire Managers in Oklahoma.* Fire Science Brief. https://www.firescience.gov/projects/briefs/05-2-1-81_FSBrief127.pdf

Carlson, J. D., Bidwell, T., Wolfinbarger, M., Blackburn, S., & Jabrzemski, R. (2011). *OK-FIRE: A Weather-Based Decision Support System for Wildland Fire Managers in Oklahoma.* Final Report. https://www.firescience.gov/projects/05-2-1-81/project/05-2-1-81_jfsp_final_report_05-2-1-81_ok-fire.pdf

Carroll, D. A., & Jones Stater, K. (2009). Revenue diversification in nonprofit organizations: Does it lead to financial stability? *Journal of Public Administration Research and Theory*, *19*(4), 947–966 https://doi.org/10.1093/jopart/mun025

Chambers, I., Bracken, M. B., Djulbegovis, B., Garattini, S., Grant, J., Gulmezoglu, A. M., Howells, D. W., Ioannidis, J. P., & Oliver, S. (2014). How to increase value and reduce waste when research priorities are set. *The Lancet, 383*(9912), 156-165. https://doi.org/10.1016/S0140-6736(13)62229-1

Champ, P. A., & Brenkert-Smith, H. (2016). Is seeing believing? Perceptions of wildfire risk over time. *Risk Analysis*, *36*(4), 816–830. https://doi.org/10.1111/risa.12465

Chapin, F., Rupp, T., Starfield, A., DeWilde, L., Zavaleta, E., Fresco, N., Henkelman, J. & McGuire, A. (2003). Planning for resilience: Modeling change in human-fire interactions in the Alaskan boreal forest. *Frontiers in Ecology and the Environment, 1*(5), 255-261. doi:10.2307/3868013

Chapin, F., Trainor, S., Huntington, O., Lovecraft, A., Zavaleta, E., Natcher, D., Mcguire, A. D., Nelson, J., Ray, L., Calef, M., Fresco, N., Huntington, H., Rupp, T., Dewilde, L., & Naylor, R. (2008). Increasing wildfire in Alaska's boreal forest: Pathways to potential solutions of a wicked problem. *BioScience, 58,* 531–540.

Charnley, S., Spies, T. A., Barros, A. M. G., White, E. M., & Olsen, K. A. (2017). Diversity in forest management to reduce wildfire losses: Implications for resilience. *Ecology and Society*, *22*(1), art22. https://doi.org/10.5751/ES-08753-220122

Cope, M. (2021). Organizing, coding, and analyzing qualitative data. In I. Hay and M. Cope (Ed.). *Qualitative research methods in human geography* (5th ed., pp. 355-375). Don Mills, Ontario: Oxford University Press.

Cova, T. J., Dennison, P. E., Li, D., Drews, F. A., Siebeneck, L. K., & Lindell, M. K. (2017). Warning triggers in environmental hazards: Who should be warned to do what and when? *Risk Analysis, 37*(4), 601–611. https://doi.org/10.1111/risa.12651

Del Casino, V. J., Grimes, A. J., Hanna, S. P., & Jones III, J. P. (2000). Methodological frameworks for the geography of organizations. *Geoforum*, *31*(4), 523–538. https://doi.org/10.1016/S0016-7185(00)00019-1

Del Rey, M. (2024, March 18). Smokehouse Creek fire, largest in Texas history, contained. *Independent.* https://www.independent.co.uk/news/world/americas/smokehouse-creek-texas-wildfire-b2514066.html

Dennison, P. E., Brewer, S. C., Arnold, J. D., & Moritz, M. A. (2014). Large wildfire trends in the western United States, 1984–2011. Geophysical Research Letters, 41(8), 2928–2933. https://doi.org/10.1002/2014GL059576

Dombeck, M. P., Williams, J. E., & Wood, C. A. (2004). Wildfire policy and public lands: Integrating scientific understanding with social concerns across landscapes. *Conservation Biology*, *18*(4), 883–889. https://doi.org/10.1111/j.1523-1739.2004.00491.x

Dong, M., Malsky, B., Gamio, L., Bloch, M., Reinhard, S., Abraham, L., González Gómez, M., Jones, J., & Murphy, J. (2023, June 9). Maps: Tracking air quality and smoke from Canada wildfires. *The New York Times.* https://www.nytimes.com/interactive/2023/us/smoke-maps-canada-fires.html

Drucker, P. F. (1992). The New Society of Organizations. *Harvard Business Review,* 11, 95-104.

Everett, Y., & Fuller, M. (2011). Fire safe councils in the interface. *Society & Natural Resources, 24*(4), 319–333.

Faulconbridge, J. R., & Hall, S. (2009). Organizational geographies of power: Introduction to special issue. Geoforum, 40(5), 785–789. https://doi.org/10.1016/j.geoforum.2009.09.003

Fischer, A. P., Spies, T. A., Steelman, T. A., Moseley, C., Johnson, B. R., Bailey, J. D., Ager, A. A., Bourgeron, P., Charnley, S., Collins, B. M., Kline, J. D., Leahy, J. E., Littell, J. S., Millington, J. D., Nielsen-Pincus, M., Olsen, C. S., Paveglio, T. B., Roos, C. I., Steen-Adams, M. M., … Bowman, D. M. (2016). Wildfire risk as a socioecological pathology. *Frontiers in Ecology and the Environment*, *14*(5), 276–284. https://doi.org/10.1002/fee.1283

Gabbert, B. (2016, October 21). *Criminal investigators receive award for their work on the fatal Iron 44 Fire helicopter crash*. Wildfire Today. https://wildfiretoday.com/tag/iron-44/

Garvin, T. (2001). Analytical paradigms: The epistemological distances between scientists, policy makers, and the public. *Risk Analysis*, *21*(3), 443–456. https://doi.org/10.1111/0272-4332.213124

Gazley, B., & Brudney, J. L. (2007). The Purpose (and Perils) of Government-Nonprofit Partnership. *Nonprofit and Voluntary Sector Quarterly, 36*(3), 389-415. https://doi.org/10.1177/0899764006295997

Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review 98*(2), 341-354.

Gigerenzer, G. (2021). Embodied heuristics. *Front. Psychol, 12*(711289), 1-12. https://doi.org/10.3389/fpsyg.2021.711289

Harvey, B. J. (2016). Human-caused climate change is now a key driver of forest fire activity in the western United States. Proceedings of the National Academy of Sciences, 113(42), 11649–11650. https://doi.org/10.1073/pnas.1612926113

Henderson, M., Kalabokidis, K., Marmaras, E., Konstantinidis, P., & Marangudakis, M. (2005). Fire and society: A comparative analysis of wildfire in Greece and the United States. *Human Ecology Review, 12*(2), 169-182. Retrieved December 4, 2020, from http://www.jstor.org/stable/24707531

Henson, B. (2024). New warning system could save lives during wildfires. *Yale Climate Connections.* https://yaleclimateconnections.org/2024/03/new-warning-system-could-save-lives-during-wildfires/

Hoff, D. L., Willa, R. E., Zoua, C. B., Weir, J. R., Gregory, M. S., & Lillie, N. D. (2018). Estimating increased fuel loading within the Cross Timbers forest matrix of Oklahoma, USA due to an encroaching conifer, Juniperus virginiana, using leaf-off satellite imagery. *Forest Ecology & Management, 409,* 215-224. https://doi.org/10.1016/j.foreco.2017.11.003

Holt, L. (2023, June 7). *90 million Americans under air quality alerts due to Canadian wildfire smoke* [Video broadcast]. NBC News. https://www.nbcnews.com/nightly-news/video/90-million-americans-under-air-quality-alerts-due-to-canadian-wildfire-smoke-180934213865?cid=referral_taboolafeed

Hudson, M. (2011). Fire Management in the American West: Forest Politics and the Rise of Megafires. United States: University Press of Colorado.

Jones, G. (2013). *Organizational theory, design, and change*. Upper Saddle River, New Jersey: Pearson.

Joseph, M. B., Rossi, M. W., Mietkiewicz, N. P., Mahood, A. L., Cattau, M. E., Denis, L. A. S., Nagy, R. C., Iglesias, V., Abatzoglou, J. T., & Balch, J. K. (2019). Spatiotemporal prediction of wildfire size extremes with Bayesian finite sample maxima. *Ecological Applications*, *29*(6), e01898. https://doi.org/10.1002/eap.1898

Kahlor, L., Dunwoody, S., Griffin, R. J., Neuwirth, K. and Giese, J. (2003). Studying heuristic-systematic processing of risk communication. *Risk Analysis, 23*, 355-368. https://doi.org/10.1111/1539-6924.00314

Kala, N. (2019). The impacts of managerial autonomy on firm outcomes. *IDEAS Working Paper Series from RePEc,* 1-69. https://thedocs.worldbank.org/en/doc/2e26e7b80865e1cfb65a3b98d7ce35e7-0050022022/original/The-Impact-of-Managerial-Autonomy-on-Firm.pdf

Kennedy, B., & Johnson, C. (2020, February 28). *More Americans see climate change as a priority, but Democrats are much more concerned than Republicans.* Pew Research Center, Washington, D.C. https://www.pewresearch.org/short-reads/2020/02/28/more-americans-see-climate-change-as-a-priority-but-democrats-are-much-more-concerned-than-republicans/

Kinoshita, A., Chin, A., Simon, G. L., Briles, C., Hogue, T. S., O'Dowd, A. P., Gerlak, A. K., & Albornoz, A. U. (2016). Wildfire, water, and society: Toward integrative research in the "Anthropocene". *Anthropocene, 16*, 16-27. https://doi.org/10.1016/j.ancene.2016.09.001

Kluckhohn, F. R., & Strodtbeck, F. L. (1961). *Variations in value orientations.* Row, Peterson and Company.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change; Dordrecht*, *77*(1–2), 45–72. http://dx.doi.org.ezproxy.lib.ou.edu/10.1007/s10584-006-9059-9

Lemos, M. C., & Morehouse, B. J. (2005). The co-production of science and policy in integrated climate assessments. *Global Environmental Change*, *15*(1), 57–68. https://doi.org/10.1016/j.gloenvcha.2004.09.004

Lim, M. D. (2014). Consortium sandbox: Building and sharing resources. *Science Translatinal Medicine, 6*(242), 1-7. DOI:10.1126/scitranslmed.3009024

Lindley, T. T., Speheger, D. A., Day, M. A., Murdoch, G. P., Smith, B. R., Nauslar, N. J., & Daily, D. C. (2019). Megafires on the Southern Great Plains. *Journal of Operational Meteorology*, 164–179. https://doi.org/10.15191/nwajom.2019.0712

Litschert, S. E., Brown, T. C., & Theobald, D. M. (2012). Historic and future extent of wildfires in the Southern Rockies Ecoregion, USA. *Forest Ecology and Management*, *269*, 124–133. https://doi.org/10.1016/j.foreco.2011.12.024

Liu, Y., L. Goodrick, S., & A. Stanturf, J. (2013). Future U.S. wildfire potential trends projected using a dynamically downscaled climate change scenario. Forest Ecology and Management, 294, 120–135. https://doi.org/10.1016/j.foreco.2012.06.049

Lounsbury, M., & Ventresca, M. (2003). The New Structuralism in Organizational Theory. *Organization*, *10*(3), 457–480. https://doi.org/10.1177/13505084030103007

Mansvelt, J., & Berg, L. D. (2016). Writing qualitative geographies, constructing meaningful geographical knowledges. In I. Hay (Ed.). *Qualitative research*

*methods in human geography* (4th ed., pp. 394-421). Don Mills, Ontario: Oxford University Press.

Martin, W. E., Martin, I. M., & Kent, B. (2009). The role of risk perceptions in the risk mitigation process: The case of wildfire in high-risk communities. Journal of Environmental Management, 91(2), 489–498. https://doi.org/10.1016/j.jenvman.2009.09.007

McCaffrey, S. (2004). Thinking of wildfire as a natural hazard. *Society & Natural Resources*, *17*(6), 509–516. https://doi.org/10.1080/08941920490452445

McGee, T.K., McFarlane, B.L., Varghese, J. (2009). An examination of the influence of hazard experience on wildfire risk perceptions and adoption of mitigation measures. Society & Natural Resources 22, 308–323. doi:10.1080/08941920801910765.

McGuirk, P. M., & O'Neill, P. (2016). Using questionnaires in qualitative human geography. In I. Hay (Ed.). *Qualitative research methods in human geography* (4th ed., pp. 246-273). Don Mills, Ontario: Oxford University Press.

McLafferty, S. (2010). Conducting questionnaire surveys. In N. Clifford and G. Valentine, eds, Key Methods in Geography, 77-88. London: Sage

McPherson, R. A., Fiebrich, C. A., Crawford, K. C., Kilby, J. R., Grimsley, D. L., Martinez, J. E., Basara, J. B., Illston, B. G., Morris, D. A., Kloesel, K. A., Melvin, A. D., Shrivastava, H., Wolfinbarger, J. M., Bostic, J. P., Demko, D. B., Elliott, R. L., Stadler, S. J., Carlson, J. D. , & Sutherland, A. J. (2007). Statewide monitoring of the mesoscale environment: A technical update on the Oklahoma Mesonet. *Journal*

*of Atmospheric and Oceanic Technology*, *24*(3), 301-321. https://doi.org/10.1175/JTECH1976.1

McWethy, D. B., Schoennagel, T., Higuera, P. E., Krawchuk, M., Harvey, B. J., Metcalf, E. C., Schultz, C., Miller, C., Metcalf, A. L., Buma, B., Virapongse, A., Kulig, J. C., Stedman, R. C., Ratajczak, Z., Nelson, C. R., & Kolden, C. (2019). Rethinking resilience to wildfire. *Nature Sustainability*, *2*(9), 797–804. https://doi.org/10.1038/s41893-019-0353-8

Modaresi Rad, A., Abatzoglou, J.T., Kreitler, J., Reza Alizadeh, M., AghaKouchak, A., Hudyma, N., Nauslar, N. J., & Sadegh, M. (2023). Human and infrastructure exposure to large wildfires in the United States. Nature Sustainability, 6, 1343–1351. https://doi.org/10.1038/s41893-023-01163-z

Moritz, M. A., Batllori, E., Bradstock, R. A., Gill, A. M., Handmer, J., Hessburg, P. F., Leonard, J., McCaffrey, S., Odion, D. C., Schoennagel, T., & Syphard, A. D. (2014). Learning to coexist with wildfire. *Nature*, *515*(7525), 58–66. https://doi.org/10.1038/nature13946

Nagy, R. C., Fusco, E., Bradley, B., Abatzoglou, J. T., & Balch, J. (2018). Human-related ignitions increase the number of large wildfires across U.S. ecoregions. *Fire*, *1*(1), 4. https://doi.org/10.3390/fire1010004

Narayanaraj, G., & Wimberly, M. C. (2012). Influences of forest roads on the spatial patterns of human- and lightning-caused wildfire ignitions. Applied Geography, 32(2), 878–888. https://doi.org/10.1016/j.apgeog.2011.09.004

National Interagency Fire Center (2022). Statistics. Retrieved 10 June 2022, from https://www.nifc.gov/fire-information/statistics/wildfires

National Interagency Fire Center. (2022). *Total Wildland Fires and Acres (1983-2022).*
Boise, Idaho: National Interagency Fire Center.

National Park Service (2024, March 5). *Firefighting orders and watchouts situations.*
https://www.nps.gov/articles/firefighting-orders-watchout-situations.htm

Neale, T., & May, D. (2020). Fuzzy boundaries: Simulation and expertise in bushfire
prediction. *Social Studies of Science, 50*(6), 1-23. https://doi-
org.ezproxy.lib.ou.edu/10.1177/0306312720906869

Parks, S. A., Miller, C., Holsinger, L. M., Baggett, L. S., & Bird, B. J. (2016). Wildland
fire limits subsequent fire occurrence. *International Journal of Wildland Fire*,
*25*(2), 182–190. https://doi.org/10.1071/WF15107

Paveglio, T. B., Edgeley, C. M., Carroll, M., Billings, M., & Stasiewicz, A. M. (2019).
Exploring the influence of local social context on strategies for achieving fire
adapted communities. Fire, 2(2), 26. https://doi.org/10.3390/fire2020026

Prestemon, J. P., Shankar, U., Xiu, A., Talgo, K., Yang, D., Dixon, E., McKenzie, D., &
Abt, K. L. (2016). Projecting wildfire area burned in the south-eastern United
States, 2011–60. *International Journal of Wildland Fire, 25*(7), 715–729.
https://doi.org/10.1071/WF15124

Radeloff, V. C., Helmers, D. P., Kramer, H. A., Mockrin, M. H., Alexandre, P. M., Bar-
Massada, A., Butsic, V., Hawbaker, T. J., Martinuzzi, S., Syphard, A. D., &
Stewart, S. I. (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

Schultz, C. A., & Moseley, C. (2019). Collaborations and capacities to transform fire management. *Science, 366*, 38-40.DOI:10.1126/science.aay3727

Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology, 24*(4), S35–S40.

Slovic, P. (2016). Understanding perceived risk: 1978-2015. *Environment: Science and policy for sustainable development, 58*(1), 25-29.

Smith, A. M. S., Kolden, C. A., Paveglio, T. B., Cochrane, M. A., Bowman, D. M., Moritz, M. A., Kliskey, A. D., Alessa, L., Hudak, A. T., Hoffman, C. M., Lutz, J. A., Queen, L. P., Goetz, S. J., Higuera, P. E., Boschetti, L., Flannigan, M., Yedinak, K. M., Watts, A. C., Strand, E. K., … Abatzoglou, J. T. (2016). The science of firescapes: Achieving fire-resilient communities. *BioScience*, *66*(2), 130–146. https://doi.org/10.1093/biosci/biv182

Souder, W. E., & Nassar, S. (1990). Choosing an R&D consortium. *Research Technology Management*, *33*(2), 35–41. http://www.jstor.org/stable/24124818

Thompson, P. (2014) Social, institutional, and psychological factors affecting wildfire incident decision making. *Society & Natural Resources, 27*(6), 636-644. https://doi.org/10.1080/08941920.2014.901460

Travel Oklahoma. (2023). *Oklahoma's diverse ecoregions*. https://www.travelok.com/articles/oklahomasdiverseecoregions

Treisman, R. (2023, August 15). Maui's wildfires are among the deadliest on record in the U.S. Here are some others. *NPR.* https://www.npr.org/2023/08/15/1193710165/maui-wildfires-deadliest-us-history

Tyrl, R. J., Bidwell, T. G., Masters, R. E., Elmore, R. D., & Weir, J. R. (2017, March 1). *Oklahoma's native vegetation types - Oklahoma State University*. Oklahoma's Native Vegetation Types. https://extension.okstate.edu/fact-sheets/oklahomas-native-vegetation-types.html#top

USGCRP. (2018). Fourth National Climate Assessment. https://nca2018.globalchange.gov/chapter/6/

USGCRP. (2023). Fifth National Climate Assessment. https://nca2023.globalchange.gov/chapter/7/

Voggesser, G., Lynn, K., Daigle, J., Lake, F. K., & Ranco, D. (2013). Cultural impacts to tribes from climate change influences on forests. Climatic Change, 120(3), 615–626. http://dx.doi.org/10.1007/s10584-013-0733-4

Winchester, H. P. M., & Rofe, M. W. (2016). Qualitative research and its place in human geography. In I. Hay (Ed.). *Qualitative research methods in human geography* (4th ed., pp. 3-28). Don Mills, Ontario: Oxford University Press.