

Prescribed fire culture in the tallgrass & mixed-grass prairie of Kansas

by

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B.S., Oklahoma State University, 2020

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Communications and Agricultural Education
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2025

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Abstract

Human-prescribed fire, or the deliberate use of fire as a tool to shape landscapes, has been practiced for thousands of years. Within the past few centuries, the use of prescribed fire declined sharply. Prescribed fire has become a taboo for many communities in the United States due to the prominence of fire suppression policies adopted by the U.S. government. Despite prescribed fire's benefits related to land conservation and reducing wildfire risk and intensity, many people still do not apply it. The purpose of this study was to explore pro-prescribed fire perceptions in two regions: the tallgrass ecoregion of eastern Kansas, where a culture of prescribed burning is prevalent, and the mixed-grass region of central Kansas where prescribed burning occurs but is less prevalent.

Grounded theory guided the research. We used qualitative semi-structured interviews to collect data. In 2019, a separate research team interviewed 34 pro-prescribed fire ranchers in the tallgrass ecoregion of Kansas, one of the largest tracts of remaining native tallgrass prairie. In 2023, we analyzed and coded those interview transcripts as part of this study. During the spring to summer of 2024, I interviewed 15 pro-prescribed fire ranchers and key informants from the mixed-grass region of Kansas. We analyzed and coded mixed-grass participant transcripts in the same manner as the tallgrass group. Interview questions for both groups focused on motivations, demotivations, and challenges they faced in applying prescribed fire, as well as their perceptions of their communities' attitudes toward prescribed fire. Once we finished coding all interviews, patterns emerged and were refined into themes, describing viewpoints held by the majority of participants in each of the two regions.

A major motivation for most burners of both regions is the pragmatic need to maintain rangeland from invasive encroachment through the cost-effective use of prescribed fire. Risk is a major caveat to burners due to unexpected weather changes right before or during a burn, along

with fear of liability from losing control of a prescribed fire and the potential for causing harm to life and property. In the tallgrass region, culture, tradition, and experience were important for the long-term prevalence of burning in the region. Most participants in the tallgrass region had decades of experience and exposure to fire across multiple generations, which helped to strengthen a long-term culture and pride in the preservation of land and profitability from the practice. Tallgrass rancher participants were highly motivated to control invasives, supported by their long-standing tradition of applying prescribed fire. For mixed-grass rancher participants and key informants, those who burn were highly motivated in countering invasive species encroachment in the region. In the mixed-grass region, key informants were highly motivated to and important in providing information about burning and coordinating with prescribed burn associations (PBAs). Mixed-grass burner participants diligently assessed and mitigated risks involved with burning.

We recommend more qualitative and quantitative human dimensions of prescribed fire research be conducted, especially in the mixed-grass and short-grass ecosystems. Qualitative research should involve stakeholders who do not burn, such as county commissioners, to better understand outside perspectives in applying and promoting prescribed burning. There is a need to establish PBAs in communities without a recent history of prescribed fire, to include highly motivated leaders supported by state and federal agencies. There is also a need to support non-governmental organizations in providing education, equipment, and personnel to conduct burns in a safe and productive manner. Science-informed, long-term social practices of prescribed fire are vital in countering invasive species encroachment, supporting cost-effectiveness in agricultural operations, and preserving remaining grassland prairies.

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Acknowledgments

The list of people who have helped me get through my schooling and have shaped my thoughts is numerous. To start, I'd like to thank my mom and dad for raising me with an open mind and experiencing life with curiosity that follows me to this day. I'd like to thank Erica Jensen for her dedication in making our long-distance relationship work through all these years with our busy school schedules. I'm forever grateful for your love, support, and wisdom. With your support and impeccable wit, no challenge is too great. I'd like to thank my advisor, Dr. Starzec, for helping me every step of the way in this meticulous process. Your passion for diving into both the science and the mind of the participant constantly guided the direction of this thesis. I couldn't ask for a better mentor and friend. Your excitement for every process of this project was a constant reminder of how important and gratifying learning and research can be. I'd like to thank my committee member Dr. Hill. Your expert knowledge and mastery in public speaking and writing is something I will always look back on. I'm honored to have received guidance from such an expert communicator. I'd like to thank my committee member, Dr. Joslin. The concise knowledge you brought with your expert understanding of everything fire greatly helped with the direction of this learning process. You three always provided positive affirmation but also helped me to push myself to understand this multi-disciplinary adventure to the best of my ability. I'm grateful for the support from the coders who helped to interpret the data: Dr. Starzec, Claire Geiger, and Kassie Pechanec. Thank you to everyone from the faculty and staff in the department for always being cheerful and welcoming every day that I've come into Umberger. I'd like to thank Dr. Carol Baldwin for the opportunity to use her team's tallgrass participant data as part of the foundation for my thesis. I'd like to thank my long-time mentor from Oklahoma State University, Dr. Adam Cobb, for inspiring me in our shared pursuit of a better and greener world. I thank my friends who I've kept in constant contact and shared my thoughts and

struggles with through the years: T.K., Drayke, Karsten, both Noahs, Jett, Brandon, Ben, Zane, Dylan, Stone, Makenna, Aiden, Samuel, Dan, Jeff, and Heath. I'd also like to thank all my graduate peers in the office for enduring the challenges of a graduate student, as well as sharing many laughs being in the same office together nearly every day. I'm forever thankful for the rich experiences I've had in life and look forward to the long journey ahead. I welcome it with an open mind.

Dedication

This study is dedicated to my mom and dad, Beatriz and Mike Sulivant. They raised me to have an open mind about the world around me, to embrace both the arts and sciences, and to always be curious and questioning of everything. I'm forever grateful to my parents for their encouragement and for letting me choose my own path in life.

Chapter 1 - Introduction

Wildfire, fire suppression, and prescribed fire have been used by humans throughout history for a variety of tasks such as hunting, making travel easier, and encouraging plant regrowth (Bird et al., 2008). Humans shaping and modulating landscapes was as prominent in the past as it is today (Bird et al., 2008; Gowlett, 2016). The anthropogenic usage of fire as a landscape tool can be traced back 1.5 million years (Gowlett et al., 1981; Shimelmitz et al., 2014). Historical data indicates an increased use of fire during the Pleistocene period, which was 300,000 to 400,000 years ago (Gowlett et al., 1981). Regular, natural, and deliberate burning practices in the United States shifted to fire suppression over the past century, which has led to a dramatic increase in wildfire outbreaks, especially in the Great Plains (Twidwell et al., 2021). Fire suppression would become common in the United States starting in the mid to late 19th century when the United States Army was assigned to manage the first national parks (van Wagtenonk, 2007). Due to the lack of manpower, fire suppression was the primary strategy to protect populated areas, while wildfires in isolated regions were left to burn (van Wagtenonk, 2007). The negative consequences of federal agencies prioritizing suppression policies can be seen with the substantial increase in wildfire occurrences in recent decades due to years of fuel load accumulation and other factors (Burke et al., 2021). Fire suppression is a prevalent practice globally; however, the tallgrass region of Kansas, situated within the tallgrass prairie ecosystem, uniquely has maintained consistent and long-term use of prescribed fire across the landscape (Allen & Palmer, 2011). The tallgrass ecoregion of Kansas is unique in that fire is not suppressed as there is a long-term legacy of prescribed burning as a land management practice (Allen & Palmer, 2011; Middendorf et al., 2009).

Tallgrass and Prescribed Fire

Grasslands are among the most vulnerable and least protected ecosystems in the world (Carbutt et al., 2017). Before modern agriculture, grassland and savannah ecosystems covered nearly 40% of the Earth; today about 20% of grasslands and savannahs remains (Mishra & Young, 2020). Around 64% of the planet's historic grasslands have converted into cropland primarily for the growing of grains (Mishra & Young 2020). With intensive farming and urban settlement, remaining grasslands are degraded and are at risk of further loss or ecological transition (Mishra & Young, 2020). In addition to human pressures, encroachment from invasive tree species has endangered many species, especially nesting grassland-dependent birds (Ceballos et al., 2010). Since 1970, avian populations in North America have declined substantially, with losses greater than 70% occurring in grasslands (Rosenberg et al., 2019). Compared to other biomes in North America, grassland biomes have experienced a greater avian population loss (Rosenberg et al., 2019). This is due, at least in part, to fire being needed to maintain the open ground necessary for ground-nesting bird species. To maintain ecological diversity at large, grassland ecosystem health depends on grazing in conjunction with regular fire intervals (Ratajczak et al., 2016; Ratajczak et al., 2022). Typical fire intervals for the maintenance of tallgrass prairies range from one to three years (Ratajczak et al., 2016). Beyond tallgrass regions, research is lacking regarding how prescribed fire may affect other grassland ecoregions, including mixed grass (Vermeire & Russell, 2018).

Invasive Encroachment in Grasslands

Grassland ecosystems have seen a major decline in area due to fragmentation and land use conversion to intensive agricultural practices (Ceballos et al., 2010). The decline has harmed native species due to increased competition from invasive species that also change fire behavior and how invasive species as well as altered fire landscapes impact ecosystems (Kelly et al.,

2020). Invasive species in the tallgrass and mixed-grass prairies range from woody and herbaceous to other grasses. Woody and herbaceous species include eastern red cedar (*Juniperus virginiana*) and sumac (*Rhus glabra* L.) (Gaskin et al., 2021; Hajny et al., 2011). Prominent invasive grass species include Kentucky bluegrass (*Poa pratensis*), bermudagrass (*Cynodon dactylon*), and more than one hundred other listed invasive grasses throughout the Great Plains (Gaskin et al., 2021). Prescribed burning followed by herbivory can reduce invasive plant populations and help native plant and animal species adapted to fire (Sherrill et al., 2022). Without fire, endangered species in grassland-type ecosystems run a higher risk of extinction (Bowman et al., 2009; Kelly et al., 2020).

Statement of the Problem & Need for Research

Prescribed burning can protect against severe wildfire and promote ecological resilience (Kolden, 2019). There is research available on the generalized effects of both wildfire and prescribed burning, however, there are few studies investigating people's perception towards prescribed fire and private landowner practices in prescribed fire (Clark et al., 2022). There are also few, if any, studies that describe a group of people with a continuous pro-fire culture. There is also a lack of comparative studies describing neighboring regions that either do not have an interest in fire as a management tool or have an emerging community beginning to reintroduce fire into their land management practices. The majority of fire research has revolved around wildfires. Substantially less research has focused on the usage and basic science of prescribed burning. Finally, very little literature focuses on the social science lens of prescribed fire (Dup  y & Smith, 2018). With the annual cost of fire damage ranging from \$63.5 to \$285 billion dollars a year, it is important for qualitative researchers to explore and provide perspective on how people view both prescribed fire and wildfire in their region (Thomas et al., 2017). Global fire risk is increasing due to a history of fire suppression, placing more people in the path of danger (Jolly et

al., 2015). With a growing number of PBAs in parts of the United States outside of the Great Plains, it is important to advance our social understanding of people's motives and detractors of using fire as a land management tool in order to facilitate fire policy (Dup  y & Smith, 2018; Weir et al., 2016). Producers practicing burning are an important group to interview in order to better our understanding of their motivations to burn. Despite the Kansas tallgrass region having a long and well-established fire culture, it has managed to do so without needing PBAs in order to promote, train, and provide equipment to private landowners in the region. Understanding how tallgrass landowners continue their fire tradition may help make PBAs more active in the long term. Additionally, fire risk has been a frequently studied perspective, however much of the literature around risk has been on wildfires (Dup  y & Smith, 2018). Studying the scope of fire requires an interdisciplinary approach or pyrogeographic point of view, both of which are needed to examine social challenges when it comes to human coexistence to fire (Bowman et al., 2013). Despite the importance of risk and the growing body of literature that focuses on social theory around risk, there is a lack of literature attempting to capture the perspectives of those living in the tallgrass, mixed-grass, and surrounding regions about fire culture and the potential effects of climate change on fire culture. This area of research is important to understanding how fire culture emerges, and how it may be applied to other areas where fire may play a significant role in ecosystem preservation as well as mitigating fuel available for much larger and more dangerous fires. Because fire management issues are social topics, there is a need to expand our knowledge and address various research gaps in the literature (McCaffery & Olsen, 2012).

Purpose of Study

The purpose of this study is to explore fire culture and the use of fire as a landscape management tool among prescribed fire proponents in two distinct ecoregions in Kansas. Our

goals are 1) to explore private landowner perceptions of using prescribed burning and 2) compare perceptions and practices in a continuous pro-fire-culture region to perceptions and practices in an adjacent region where prescribed fire is re-emerging as a land management practice. In order to understand the motivations and ways to promote fire culture to other regions, our goals were to compare and contrast similarities and differences between tallgrass producers (tallgrass ecoregion) and central Kansas producers (mixed-grass region), their perspectives of risk, how fire and their use of fire influences their production decision making, the consequences of losing the ability to burn, and finally, examine whether their history and future projections of climate may affect their culture or establishment in the future.

Research Questions

The research questions and objectives used to guide the study are as follows:

1. What are tallgrass pro-prescribed fire ranchers' perceptions toward prescribed burning?
2. What are the mixed-grass pro-prescribed fire ranchers and key informants' perceptions toward prescribed burning?
3. Research objective: Describe the similarities and differences between tallgrass pro-prescribed fire participants' perceptions of prescribed fire and mixed-grass pro-prescribed fire participants' perceptions of prescribed fire.

Study Area

Kansas is home to a wide range of ecoregions, with Eastern Kansas primarily consisting of tallgrass prairie vegetation, Central Kansas being a mixed-grass prairie, and Western Kansas consisting of shortgrass prairie (Axelrod, 1985). Kansas follows a high-to-low rainfall gradient from east to west (Rahmani et al., 2013). The separation between the tallgrass region and the

mixed grass region of Kansas is not evenly divided by county, however the transition between the tallgrass and mixed-grass Kansas begins at the eastern most point of the city of Salina in Saline County and eastern Sedgwick County near the city of Wichita. The mixed-grass region extends from Eastern Saline and Sedgewick County to the High Plains region of the western third of Kansas where the mixed-grass transitions to shortgrass along the High Plains region.

Tallgrass and Prescribed Fire

Within the tallgrass ecoregion, a subregion known as the Flint Hills exists with a historic range reaching from Eastern Kansas to Northeastern Oklahoma across four million acres (Wilgers & Horne, 2006). The Flint Hills received its name from the distinguishable prevalence of cherty limestone on or near the surface (Macpherson, 1996). As a result of the resilient limestone and flint, cultivation for farming practices is nearly impossible in many areas, making ranching the primary viable agricultural practice in the region (Hickey & Webb; 1987; Macpherson, 1996). The Flint Hills contain the largest area of unplowed native grassland on the North American continent (Wilgers & Horne, 2006). The native grassland ecosystem is partially preserved through prescribed fire. Prescribed fire, also known as a planned or controlled burning, is the deliberate act of burning a landscape (Ditomaso et al., 2006). The benefits of prescribed fire include controlling invasive species, improving forage quality, and managing habitat (Ditomaso et al., 2006). An average of two million acres of land in the Flint Hills are prescribed burned annually (Scholtz et al., 2020). The Flint Hills is unique in having a continuous anthropogenic fire regime that did not see a substantial decline or removal in its transition from Native American land management to colonial settlement (Allen & Palmer, 2011). An important characteristic of how fire benefits the Flint Hills is through its role in areas such as soil health, hydrology, and vegetation, depending on fire intensity (Stavi, 2019). In our study, we looked at

interviews with ranchers who conduct prescribed burns on grasslands across the tallgrass region from 3a through 3g as shown in figure 1.1.

Mixed-grass

The mixed-grass region covers regions 2a, 2b, and 2c according to figure 1.1 below. The mixed-grass region of Kansas receives less annual rainfall on average than the tallgrass region, leading to a change in plant diversity with a greater mix of shortgrass and tallgrass plant species compared to the tallgrass to the east and the shortgrass to the west. Unlike the tallgrass region where ranching is predominant, the mixed-grass region agricultural practices favor farming more so than ranching (Coupland, 1992).

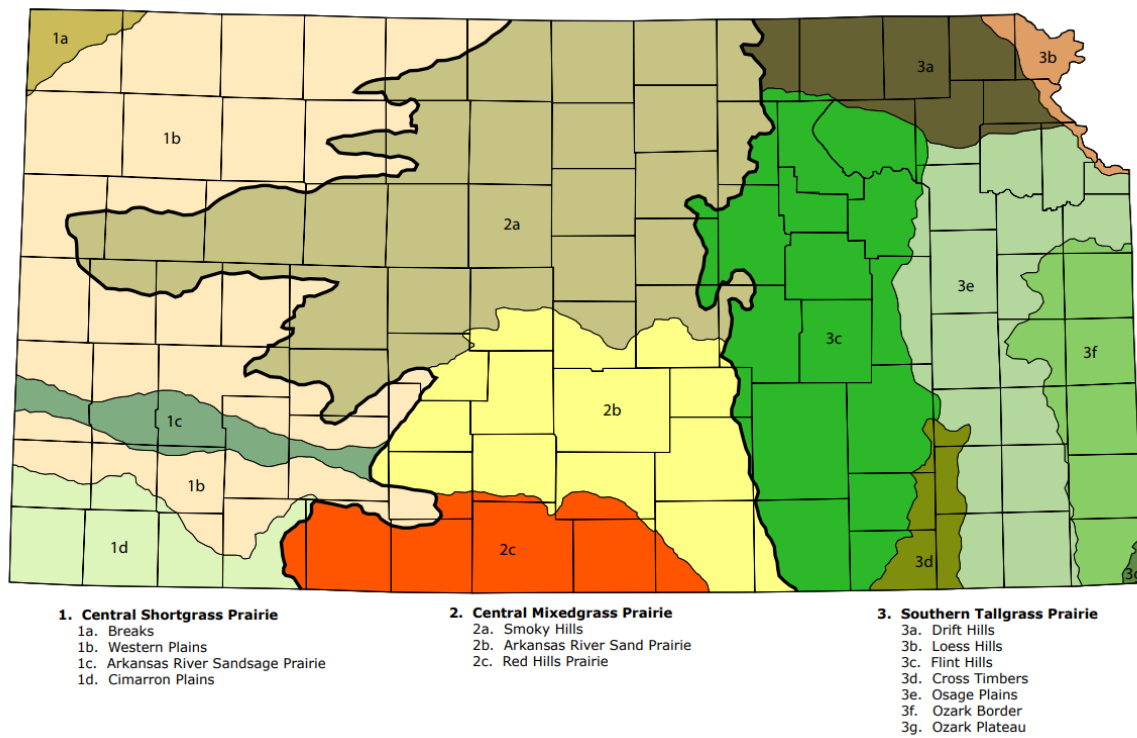


Figure 1.1 Map of Ecoregions of Kansas (Map source: Taggart, Kansas Herpetofaunal Atlas)

Limitations of the Study

The main limitation of this study is the smaller pool of potential participants in the mixed-grass region compared to the tallgrass region. With 34 tallgrass interviews and 15 mixed-grass interviews, the mixed-grass participant number was lower due to time constraints, the difficulty of contacting potential participants, and because there are fewer burners in the mixed-grass region compared to the tallgrass region. The topic of fire is more controversial in the mixed-grass region compared to the tallgrass region; fewer people may be willing to openly discuss their viewpoints and concerns regarding fire. Compared to the tallgrass region, there are fewer people in the mixed grass region of Kansas and there are altogether fewer people who use prescribed fire as a land management tool. This led to the need to contact additional participants in the mixed-grass region who come from scientific disciplines who assist in promoting and prescribing fire. An additional challenge was coordinating time to interview participants due to constraints with farmers being busier during the growing season. The tallgrass interviews were conducted in person by a separate research team and were recorded on camera compared to the mixed-grass group who were interviewed and recorded by phone. Among mixed-grass participants, due to participants either driving or being in rural areas, some conversations were choppy at times resulting in missing information in response to the questions asked. We must also acknowledge that Kansas has experienced extensive droughts in recent years, which may have affected participants' answers to interview questions.

Basic Assumptions

Researchers in this study assumed the participants understood the goals of the study and the questions asked throughout the interviews. It was assumed participants answered questions honestly and concisely so their feedback could be used to progress the discipline of prescribed fire and improve agricultural and ecological outcomes of grassland ecosystems. Additionally, it

was assumed that pro-fire individuals believed the benefits outweighed the potential risks of applying prescribed fire. Finally, it was assumed that burners would continue to apply fire as a regular practice. This information was verified throughout the interviews.

Definition of Terms

Burner: One who uses prescribed fire as a land management tool.

Culture: Learned norms and behaviors that are shared by a group of people (Oatey, 2012).

Cattle Gains: Body weight increase of cattle through feed intake (Freetly et al., 2020).

Fire Boss: Person leading the prescribed burn. In the tallgrass, they are often the oldest and most experienced individuals.

Fire Ecology: The study of how combustion and combustible materials shape and interact with an ecosystem (Cochrane & Ryan, 2009).

Flint Hills: Tallgrass prairie ecoregion in the Great Plains with the largest tract of unplowed land in North America (Wilgers & Horne, 2006).

Fragmentation: The separation and isolation of a habitat from its greater part, often resulting in decreased species richness (Didham, 2010).

Gunny sack: Burlap sack made from coarse fabric to transport goods.

Invasive Species: Any species of nonnative origin, which can cause economic or environmental harm to an ecosystem and people in them (USDA, n.d. Executive Order 13112 - Invasive Species)

Key Informant: An expert in a particular discipline who can provide unique insight based on their experiences position, and understanding of the subject (Marshall, 1996).

Mechanical removal: Thinning, removal, or the moving of fuel sources using mechanical tools (Miller et al., 2020).

Mixed-Grass Prairie: Ecological boundary between shortgrass and tallgrass prairie receiving moderate rainfall and a mix between shortgrass and tallgrass plant species.

Pleistocene: A period of history from 1.8 million years to 11,000 years ago climatological cold event (Post, 2003).

Prescribed Burning: A deliberate burn used as a land management tool to reduce fuel loads or provide other ecological services (Ryan et al., 2013).

Prescribed Burn Association (PBA): A network of locals with the mutual goal to apply and promote prescribed fire to their local landscape. PBAs provide locals with training, equipment, and personnel needed to conduct a burn (Weir et al., 2016).

Prescribed/Controlled burn: Pyrogeography: The multidisciplinary study of fire through fire interacting with biology, human culture, and the geophysical environment of fire (Bowman et al., 2013).

Short-Grass Prairie: Ecosystems dominated by short-grass plant species due to lower rates of precipitation compared to mixed and tallgrass prairie (Changnon et al., 2002).

Smoke Plume: Smoke from fire that can travel high in altitude and far from the source of the fire (Martin et al., 2012).

Tallgrass Prairie: Grass dominated ecosystem that depends on frequent fire intervals as part of its ecological process (Wilgers & Horne, 2006).

Woody Encroachment: Woody plant species extending beyond their native and into the Great Plains, resulting in an ecological shift to more woody ecosystems, often due to the lack of regular fire intervals present (Twidwell et al., 2013).

Chapter 2 - Review of Literature

Fire has been an important part of human history as both a practical tool as well as a cultural symbol across the world (Pyne & Goldammer, 1997). Early hominin and human usage

of fire dates back many millennia. Some records indicate fire usage dating back nearly 1.5 million years, with records of extensive usage beginning during the Pleistocene period 300,000 to 400,000 years ago (Gowlett et al., 1981; Roebroeks & Villa, 2011). Since then, fire usage has continued to be an important means of land use manipulation across many parts of the world by Indigenous peoples, ranging from Australia to the Americas, until European colonization promoted fire suppression regimes (Eriksen & Hankins, 2014). Understanding early human usage of fire may provide a staging point in understanding some modern human usage of landscape-scale fire that may or may not have been retained in modern times.

Grassland ecosystems have declined substantially, with the most intact ecosystems remaining in North America (Scholtz & Twidwell, 2022). The loss of fire in the landscape speeds up the ecological transition from prairie ecosystems to woody ecosystems. This process is difficult to reverse (Ratajczak et al., 2022). Within the tallgrass ecoregion, the Flint Hills is a unique region and largely remains intact ecologically due to the geological features of flint, making plowing and farming nearly impossible and cattle grazing a favored use of the productive grassland (National Park Service, n.d.). Although cattle grazing has largely helped to facilitate the continued existence of the tallgrass prairie, cattle are only half as effective as native bison in maintaining plant species richness (Ratajczak et al., 2022). The mixed grass prairie, transitioning west from the tallgrass prairie ecoregion, has experienced a great loss in native species density and diversity due to long term row cropping and natural resource extraction such as oil and gas (Soulodre et al., 2022).

Fire Suppression

Fire has many practical applications in modern agricultural operations. In farming and ranching, prescribed fire practices are beneficial in regions with woody invasive species threats. The most prominent invasive woody species are eastern red cedar (*Juniperus virginiana*), grass

species such as Kentucky bluegrass (*Poa pratensis*), and bermudagrass (*Cynodon dactylon*) to name a few (Gaskin et al., 2021). Natural fires help to maintain ecological stability by making the landscape more heterogeneous, with shorter and younger as well as older and taller grasses at different heights available for nesting habitats and high species richness (Hovick et al., 2015). Many native plant species and soil microorganisms rely on regular fire intervals, with plant species seeds being dispersed and germinating from fire depending on the fire intensity (Barreiro & Diaz-Ravina, 2021; Kelly et al., 2020). Some downsides to fire are short-term erosion risk following burn intervals and subsequent rain events as well as the risk to smoke exposure or immediate fire danger (Stavi, 2019; Thomas et al., 2017). Fire intervals between one to three years are necessary for the maintenance of grassland ecosystems. Without fire, ecosystems will transition to shrubland and eventually woodland within a decade without fire (Ratajczak et al., 2016).

Fire has historically been an important tool in reducing wildfire fuel loads. Recently, however, when looking at regions such as California, the driving factors toward increased wildfire depend on whether they are dominated by an accumulation of high fuel loads, or other poor management strategies such as human infrastructure development, human-caused wildfires, or natural factors (Keeley & Syphard, 2019). Using a historic lens, certain patterns around human fire regime changes tend to correlate with a change in techno-economic conditions (Coughlan, 2015). As a society becomes more economically and technologically developed, there is a shift toward fire suppression strategies (Bowman et al., 2013; Coughlan & Petty, 2012).

Other regions outside of North America managed to maintain fire continuity and their historical fire culture. Australia is a prime example where Aboriginal people have maintained and continue to reintroduce burning practices to facilitate long-held ecological landscape

management (Eriksen & Hankins, 2014). Fire suppression resulted in the loss of endemic species in Australia due to a long-standing anthropogenic tradition of Indigenous fire usage coming to an end during the 20th century (Bird et al., 2016). Current fire management practices in Australia are reflective of scientific and professional training largely in firefighting; however, this process seems to be changing with a growing emphasis on incorporating native cultural knowledge into fire education (Eriksen & Hankins, 2014). Other regions that once had or have retained some kind of fire tradition today are Portugal, East Africa, and Brazil (Butz, 2009; de Oliveira et al., 2023; Pivello, 2011).

It is important to recognize the significance of fire due to a long-recorded history of human usage which shaped culture, religion, and other practical uses seen today such as cooking and industrial processes (Gowlett, 2016). Indigenous populations' inability to burn was a major loss to their autonomy and connection to their natural environment largely due to European colonization and enforcement of fire prevention norms (Eriksen & Hankins, 2014). Human anthropogenic fire and its wider ecological effects in North America are historically considered controversial due to the debate on whether sparse populations could make large ecosystem impacts (Marlon et al., 2013). The lack of consistent historical data available on this subject makes it difficult to know with certainty whether Indigenous populations could greatly influence their surrounding ecosystems (Marlon et al., 2013). In contrast to the viewpoints suggesting Native Americans did not significantly alter ecosystems using fire, more recent data acquired from charcoal layers suggest small groups of nomadic people can make substantial changes to their surrounding ecosystems using fire (Roos et al., 2018).

Fire Intensity and Frequency

Effects of high-intensity fires, which tend to be wildfires, can be long-lasting by disrupting the soil chemistry, vegetation, and microbiome of the affected area for decades (Dove

et al., 2022). Low-intensity fire disturbance has a faster recovery turnaround, especially for fire-adapted ecosystems which historically would encounter more frequent, lower-intensity fire intervals (Dove et al., 2022). Low and moderate-intensity fires are not without certain short term negative consequences, however. The soil will often have lower aggregation making it vulnerable to erosion and land degradation if cattle are placed in recently burned areas shortly after (Stavi, 2019). There is currently a lack of information regarding how prescribed fire or wildfire alters an ecosystem at a larger scale (Hunter & Robles, 2020).

Many factors affect the likelihood and frequency of fire such as drought conditions, fuel load, adequate weather, and a means for the fire to ignite (Pausas & Keeley, 2021). With this consideration in mind, grasses have the capacity to regrow and recover from frequent fires (Archibald et al., 2013). Without frequent burning, a high fuel load may lead to high intensity wildfire. According to Zouhar (2021), prescribed fire usage tends to be low-intensity due to their high frequency of application (Zouhar, 2021). Another factor often not discussed that aids in fuel load reduction is the presence of domestic animals, such as cattle, and wild, such as deer, herbivores to the environment (Rouet-Leduc et al., 2021).

Challenges in Prescribed Fire Application

Prescribed fire research is underfunded and less recognized in its importance compared to wildfire research (Hiers et al., 2020). This is compounded with the lack of social science research on prescribed fire (Hiers et al., 2020). Other challenges faced in promoting prescribed burning practices are due to the federal government. Well-intended environmental laws such as the Clean Air Act, the Clean Water Act, as well as the Endangered Species Act can present conflicts of interest toward burning practices that may have overall long-term benefits to ecosystems that exist due to fire (Ryan et al., 2013). Liability is often a concern that can limit the use of prescribed fire in management to those who are educated on the subject (Wonkka et al., 2015).

The Prescribed Fire Acts helped promote prescribed fire usage across the American Southeast by changing liability standards to help protect private landowners and promote responsible usage of an important ecological process (Wonkka et al., 2015). Models such as the Fire and Smoke Model Evaluation Experiment are important tools that may help state and federal agencies coordinate with fire managers on when to burn (Liu et al., 2019). Models can give day by day metrics of the plume height and direction of the smoke, which combined with other weather conditions may aid in reducing risk when conducting burns (Liu et al., 2019). Without a change in liability, many people will not feel inclined to burn; however, through educating the public on the different risks between wildfire and prescribed fire, where prescribed fire reduces extreme fire scenarios, can improve community perceptions toward the private application of prescribed fire (Weir et al., 2019).

Prescribed Burn Associations & Promotion of Fire

Prescribed Burn Associations (PBAs) are a vital component in a community transitioning from an anti-fire to pro-fire stance. PBAs provide firsthand experience and knowledge for private landowners to become competent in the usage of prescribed fire (Kreuter et al., 2008; Twidwell et al., 2013). Within the Great Plains, there has been an increasing number of prescribed burn cooperatives, such as PBAs, have helped to promote policy change and education opportunities, while also allowing the sharing equipment among members to lower overhead costs (Twidwell et al., 2013). Despite the short amount of time some of these PBAs have been in place, members tend to have a high degree of trust in each other, and that trust is expected to increase over time (Toledo et al., 2014). Kansas land is 97% privately owned (Kansas Department of Wildlife, Parks, and Tourism, 2015). With most Kansas lands being private, it is primarily up to landowners to manage their lands. PBA members, being primarily landowners, have the opportunity to build social capital with each other and their community through interactions

within their association and proof of successful and safe prescribed burns (Toledo et al., 2014). This building of trust through community interactions and burning success encourages the future use of prescribed fire as an ecologically beneficial tool (Toledo et al., 2013).

When looking at a recent expansion of PBAs, California is an important testing bed for the benefits, challenges, and limitations local establishments may face. Although prescribed burning cannot entirely remove the chance for wildfire, prescribed burns can help by reducing fuel loads which lessens the threat they have on the long-term stability of ecosystems (Fernandes & Botelho, 2003; Toledo et al., 2014). PBAs also provide equipment, training, and personnel, which greatly increases the capabilities for landowners to apply burn management practices safely and effectively (Toledo et al., 2014).

Other nations can be used as an important basis for how to approach future fire challenges (Pandey et al., 2023). Looking at countries such as Australia, South Africa and the nations within the umbrella of the European Union (EU) may help provide insight into their unique challenges and how different policies and management strategies may benefit those in the United States and other parts of the world. In Australia, the long-held burning practices of the Indigenous peoples has gained traction as part of their traditional norms and maintenance of the ecosystems they use (Smith et al., 2021). Despite this, Indigenous communities in Australia face policy barriers from the Australian government due to difficulties navigating bureaucratic channels and cultural differences (Smith et al., 2021). The Australian government approaches prescribed fire as both a conservation tool for their ecosystems and a means to protect communities vulnerable to extreme fire events (Lange & Gillespie, 2022). In the EU, their main initiatives focus on community resilience toward wildfire threats (Pandey et al., 2023). More specifically, nations such as France promote community involvement to mitigate wildfire risk (Pandey et al., 2023). Within the French Pyrenees, the ethnically Basque people have a fire

tradition passed down over many generations within their agricultural practices (Roos et al., 2016). By comparison, Italy approaches its management from a regional level and focuses on fire suppression as their strategy to protect their ecosystems and communities (Pandey et al., 2023).

Within the past decade in Australia, policy has been challenging due to different interest groups expressing concerns with a lack of a scientific backing as a driving force either in support or opposition toward prescribed burning (Halliday et al., 2012). Finally, for prescribed burns to be effective in Australia, 5-10% of a landscape must be burned on a yearly basis (Fernandes, 2015). This shows that burns need to be conducted on a large scale and frequently, which will require funding, equipment, training, and liability protections to encourage enough people to adopt these practices safely and effectively.

Fire in Kansas

Compared to many regions where fire usage has been suppressed, the use of prescribed fire in the Flint Hills has largely remained consistent for the past few hundred years through rangeland management practices for cattle grazing (Allen & Palmer, 2011). In terms of age, the Great Plains is a recent ecological phenomenon that has existed for the past 10,000 years (Courtwright, 2007). Despite a continued tradition of fire regimes in the Flint Hills, the possibility for the region to transform into shrubland is predicted to increase due to longer fire intervals or gaps between using prescribed fire, allowing shrubs and other woody plant species to establish and spread (Ratajczak et al., 2016). Those who live on the edge of the Flint Hills tend to burn less frequently due to there being more forested areas and fewer grasslands to maintain (Mohler & Goodin, 2012). Another consideration that needs to be made is with the timing of when to do prescribed burns. Burning earlier in the spring may provide better long-term results for plant growth and management, as well as improve air quality over a longer period, however,

more research needs to be done on earlier timing to come to a conclusion (Towne & Craine, 2016).

Woody invasion, in particular, eastern red cedar (*Juniperus virginiana*) presents a major threat to the stability of Flint Hills grasslands (Ratajczak et al., 2016). Unfortunately, due to the establishment and spread of eastern red cedars across the tallgrass region further fragmentation of these remaining prairie ecosystems is expected as they transition into woody areas over the next few decades (Briggs et al., 2002; Ratajczak et al., 2016; Twidwell et al., 2013). The establishment of eastern red cedars is due to its biological competitiveness, as well as deliberate human planting (Smith, 2011). Aside from their high capacity to produce seeds and grow quickly, they are also commonly used as windbreaks (Smith, 2011). The fast growth and spread of invasive plant species can cause significant economic damage from wildfire.

Risks in Wildfire and Prescribed Fire

Although mortality directly related to fire is low, the health risk from smoke is high, but difficult to quantify (Thomas et al., 2017). People diagnosed with asthma are particularly at risk as smoke may cause respiratory illness (Reid et al., 2016). There is a lack of literature on how smoke may affect people, such as in areas of cardiovascular health, mental well-being, and those exposed while pregnant (Reid et al., 2016). It is important for the public to be informed and aware of the potential health risks of fire and the production of smoke, from both prescribed fires and wildfires (Cascio, 2018; Liu et al., 2014; Kopplitz et al., 2016)

On a global scale, wildfire risk is becoming a growing concern with the length of wildfire season increasing as well as increases in the area burned from 1979-2013 (Jolly et al., 2015). By 2100, wildfire risk will increase as a result of rural and semi-rural population growth (Knorr et al., 2016). The population of Kansas is projected to increase by 25%, or from 3 million to 3.5 million, by 2066 (Hunt & Panas, 2018). Manhattan and Junction City, two urban centers in the

Flint Hills of Kansas, are projected to have a population increase by more than 90% (Hunt & Panas, 2018).

Climate change and how it affects Kansas may have a significant influence on the future of fire regimes. Despite the variability of climate models, there are predicted to be more droughts experienced in the Great Plains region across multiple models, with more severe droughts occurring around the end of the 21st century (Cook et al., 2015; Feng et al., 2017). These drought cycles will alter soil cover, promoting erosion and reducing plant growth which may result in a decline in fire usage (Clark et al., 2002). Furthermore, extended cycles of drought will put stress on Kansas waterways (Chatterjee et al., 2018).

Wildfire poses a great economic and environmental threat to many people and the ecosystems they reside in through increased land development in fire-prone areas and the increased intensity and damage wildfires have caused in recent years (Gorte, 2013). According to the United States Congressional Budget Office (2022), the amount spent on fire suppression per year is around \$2.5 billion dollars, with disaster relief spending ranging up to \$5 billion dollars and rising each year. The United States Department of Agriculture (2023) released the budget for 2024 to combat increasing fire risk to the USDA as well as the Department of the Interior with more than \$4.2 billion dollars between them. The overall economic cost of wildfire in the United States is estimated to be \$71.1 billion dollars to \$347.8 billion dollars per year (Thomas et al., 2017). Wildfire poses a great economic and environmental threat to many people and the ecosystems they reside in through increased land development in fire-prone areas and the increased intensity and damage wildfires have caused in recent years (Gorte, 2013).

Fire Policy: Liability in the United States

Prescribed burning is a conservation and rangeland management process farmers and ranchers have conducted at increasing intervals since the mid-1990s. Since then, prescribed

burns have nearly surpassed wildfire burns by acreage per year. Wildfire burning by acreage averages around 7.2 million acres per year, whereas prescribed burning equaled around 10 million acres in 2020 (Hoover & Hanson, 2022). A study looking at wildfire data globally from 1971-2013 shows both the area and number of fire days continues to increase (Jolly et al., 2015). By 2100, it is expected that wildfire risk will be much higher for those living in rural and semi-rural areas (Knorr et al., 2016). Although prescribed burning would not eliminate the risk of wildfire, by reducing fuel load and woody encroachment it can reduce the danger toward people and the environment. Looking for public support relating to public perception toward prescribed burning appears to be limited to small regions, meaning there is a lack of a large-scale American awareness of prescribed burning in general. One study in California indicated vulnerable populations recognized the importance of prescribed burning when they were provided with information to better understand how to protect themselves from smoke pollution (Rappold et al., 2023).

Prescribed burn liability has been a significant detriment in private landowner motivation to conduct prescribed burning (Clark et al., 2022). Some states include ways to reduce the consequences of liability for runaway fires so long as a certain set of guidelines and requirements are met (Clark et al., 2022). The subject of liability appears to be one of the major factors that keep potential landowners from burning by being concerned about potential repercussions from the unlikely event of a fire running away from their property onto another. The subject of liability is largely dependent from state to state. In the U.S., four states have gross negligence laws, 20 have applied simple negligence, five have applied strict liability, and 21 states have undefined liability standards, with Kansas being one with undefined liability despite having a large prescribed burning presence (Clark et al., 2022).

The History of Prescribed Fire

Native Americans have been practicing deliberate burning long before the arrival of the first Europeans (Roos et al., 2018). The Great Plains experienced many dynamic changes following the arrival of Europeans and the introduction of horses to Native American tribes in the region. With horses, the use of fire could spread to a greater area at a faster rate compared to moving and settling in different regions for more time by foot. Due to the introduction of the horse and the ability to burn more extensive landscapes, it makes it difficult to differentiate between natural and human-caused burning from the 1700s onward (Roos et al., 2018). Most Native American displacement in Kansas occurred before the passing of the Homestead Act and the moving of Europeans into the region (Wilm, 2020). Europeans began to arrive in Kansas in numbers just before the Civil War due to the passing of the Homestead Act, with a larger influx following the war (Bradsher, 2012). Following the European settlement of Kansas, prescribed fire became and remains a controversial land management tool due to the transition from Indigenous to European practices. There are large gaps in the history of fire in the tallgrass region and there are few recordings of intentional fire west of the tallgrass region, other than news articles and accounts describing damage done by wildfire. Kansas settlers in the late 19th century would promote fire suppression and native cultural suppression at the same time through subversion by stating fire as going against Euro-American centric viewpoint. This viewpoint would be used as burning was historically conducted by the Indigenous people of the region and therefore should be feared and suppressed (Courtwright, 2011). The desire to suppress the burning of Kansas grasslands was so extreme that the consequences of deliberate burning were often followed with threats of lynching as late as 1940 (Courtwright, 2011).

Ranchers from Texas noticed the additional weight gain their cattle would receive when eating grass on recently burned areas (Hoy, 1989). Farmers in the tallgrass region practiced

prescribed burning, however, Texas ranchers encouraged more frequent burns early in the spring to maximize cattle weight gain (Isern, 1985). Eventually, ranchers would buy up much of the remaining farmland in the tallgrass region following major drought in the 1880s (Wibking, 1963). Despite the changes in private ownership in the tallgrass region, prescribed fire would remain mostly a continuous practice as the land tenure transitioned from the Native tribes to the Europeans (Hoy, 1989; Kollmorgen & Simonett, 1965). Disagreement about the usefulness of prescribed burning for cattle gain was disputed among ranchers as well as scientists in Kansas at least since the 1920s (Hensel, 1923). Opposition from researchers would reach a tipping point during the 1950s to the early 1970s, with many researchers in the tallgrass region in opposition to prescribed burning. Despite the scientific opposition, many ranchers would continue their burning practice during the opposition period (Hoy, 1989). Compared to the past where researcher viewpoints toward prescribed burning were mixed, the literature today generally views prescribed burning as having more beneficial than detrimental effects on prairie ecosystems and an overall benefit (Towne & Craine, 2016). Regular burning would return to the tallgrass region due to the increased woody encroachment and publication from Owensby et al. (1973) supporting the need to burn in order to slow woody encroachment (Towne & Craine, 2016).

Ranchers in the tallgrass were resilient to the short-term narrative in the mid-1900s against burning; the resilience and tradition prevented a sudden loss of prescribed burning and further invasive woody encroachment. The narrative of the tallgrass burning season being limited to the spring has been around for the past 40 years, with a growing change in mindset as more literature comes out on year-round, or any time of year burning (Towne & Craine, 2016). More recent practices such as patch burning and the burning of smaller plots of land around unburned pasture have received attention in recent years but have not yet been widely implemented

(Bruckerhoff et al., 2020; Rosen et al., 2022). Beyond the tallgrass culture, other regions in the Great Plains would see an increase in pro-prescribed fire initiatives in recent decades.

Prescribed Burn Associations (PBA) are a grassroots movement that started in the mid-1990s in Nebraska and quickly spread across the Great Plains with the mission to promote prescribed burning as a land management practice (Weir et al., 2016). PBAs are often formed at the county level and provide local burners or practitioners of prescribed burning with the means to conduct prescribed burns safely through training programs, loaning and sharing equipment, as well as providing the necessary manpower to conduct a prescribed burn safely (Weir et al., 2016). Kansas has both PBAs as well as a Prescribed Fire Council. PBAs are county-wide groups of landowners who share resources and are provided with experience and the people required to safely conduct burns. A Prescribed Fire Council is a statewide group that promotes fire policy across the state. The PBA movement has been largely successful and has since begun to spread to regions at high risk for wildfire outside of the Great Plains (Weir et al., 2016). The promotion for prescribed burning has a growing presence internationally, such as in Canada, Australia, South Africa, and parts of Europe (Pandey et al., 2023). A common challenge most regions face has to do with their considerations for risk.

Historically, fire was a major part of many cultures in the Americas before the arrival of the Europeans. Although historical data is present, it is hard to accurately measure the degree of burning conducted by people versus burns being done through natural processes before European arrival (Leys et al., 2015). This is important to consider as Native Americans were vital in maintaining the plains landscape of Kansas as well as demonstrating some of these practices that would be adopted later by farmers and ranchers in the region. In the late 19th and through the 20th century, the U.S. approach to fire management was nearly a century of fire suppression across the state and federal organizations (Higuera & Abatzoglou, 2020).

Upon its establishment, the early forest agency in the 1890s would make fire suppression a major component that has followed the Forest Service and wider fire policy up until recent decades (Pyne, 1982). This early precedent set the stage for the many long-term consequences being faced today across the United States, with Kansas being largely an outlier in the tallgrass due to the present fire culture. As described by Carle (2002), in the beginning of the 2000s, talk about deliberate burning within the Forest Service became more open, though there was stiff resistance present among other members in the Forest Service at the time. Despite the nearly century-long promotion of fire suppression, there have been some instances in isolated parts of the nation where prescribed burning was used or recommended. Despite certain initiatives for understory burning in the 1920s, as well as the first prescribed burn on federal land in the 1940s, prescribed burns were greatly hampered by the Clarke- McNary Act in 1924 which promoted further fire suppression to protect landowners as well as the forests for their timber resources (Clar, 1959; Show & Kotok, 1924). As shown above, many of the fire suppression policies were enacted by the federal government and were not challenged by the state or private landowners to any great degree until recent years. From the 1960s to the 1990s, the number of acres of federal land being burned had increased, and the costs of suppressing fire ballooned to over a billion dollars a year (NIFC, 2004).

The U.S. Forest Service recognized the need to apply prescribed burning on wild landscapes in the early 1970s, however, a lack of funding, being a low-priority task, and reluctance to apply it slowed its adoption for decades (Johnson & Hale, 2002). There is an ecological need to burn in the Great Plains due to the rapid transition for a grassland to become a wooded area from a lack of burning. It is predicted in the tallgrass region that continual fragmentation will accelerate the transition toward woody vegetation over the next few decades (Ratajczak et al., 2016). Despite the paradigm shift, other ecological and environmental

challenges made burning policy difficult to implement, such as the risk toward wildlife and the pollution produced from smoke (United States General Accounting Office, 2003). Pro-prescribed fire landowners across the nation, especially in Kansas, are faced with a barrier due to a lack of protections or current legal framework in whether they are liable for damages in the rare event that a fire may go beyond their intended area, be it on someone else's property, or a state or federal property.

Prescribed Fire and Wildfire Risks

The main risks present in prescribed fires and wildfires, for most people, are not directly from the fire itself, but the smoke fires produce (Cascio, 2018). Smoke from burning can be carried a long distance. Some wildfires, depending on atmospheric conditions, intensity, and scale, can cause smoke to travel up to thousands of miles from the source if the smoke reaches high enough into the atmosphere (Dempsey, 2013). Although prescribed fires are not the same scale or intensity as wildfire, smoke carried by wind can have a negative impact on people nearby and a long distance from the fire. Children and the elderly are at particular risk to smoke-related illness from exposure to wildfire (Liu et al., 2014). Despite literature showing how smoke can carry health risks, the degree of harm it can cause to people is not conclusive (Thomas et al., 2017). With smoke risks in mind, there are tools available to aid burners in minimizing smoke, from meteorological forecasts and predictions that can be found online by the Kansas Department of Health and the Environment (KDHE) with smoke management plans available and smoke forecasts to minimize the spread and smokes effects on air quality (Kansas Department of Health and the Environment, n.d.).

Wildfire is not only a dangerous phenomenon for people and ecosystems, but they can be financially costly as well. Losses overall from wildfire destruction ranges from \$63.5 to \$285 billion dollars annually (Thomas et al., 2017). With approximately 97% of Kansas being private

property, the physical and financial risk of wildfires for landowners is high (Kansas Department of Wildlife & Parks, 2015).

Grounded Theory

At the time of this study, there were 74 prescribed and wildfire studies in the United States focused on peoples' perspectives toward fire, and 40% of the 74 included a social theory (Dup  y & Smith, 2018). Only 5% of the studies used theory of planned behavior and another 5% used protection motivation theory. The remaining 83% of studies used a different theory once or twice. Around 7% of prescribed fire and wildfire studies used grounded theory to drive their research process (Dup  y & Smith, 2018). Grounded theory is a systematic inductive process for developing frameworks and theories as they emerge from data and data analysis (Birks & mills, 2011). The process provides researchers with the means to build a theory with a flexible base to inductively interpret themes emerging from the data (Tie et al., 2019). Using the grounded theory data collection and analysis method allowed us to build our theory through rigid data analysis (Tie et al., 2019). Our use of grounded theory comes from the overall lack of qualitative and comparative interview-based studies in prescribed fire in the tallgrass and mixed-grass regions of Kansas. Grounded theory was chosen over other theories because its methodology to inductively guide our research without preconceived ideas was favored over established theories (Turner & Astin, 2021). Grounded theory was preferred because qualitative studies in fire literature whereas inconsistent in the kinds of theories being used or not used at all (Dup  y & Smith, 2018). Grounded theory is a favored methodology and method when studying in disciplines lacking in prior literature (Turner & Austin, 2021).

The founding of grounded theory came from Glaser et al.'s (1968) publication describing the theory's development. Grounded theory emerged as a way through interviews to describe the experience and process of dying and was first used in Glaser and Strausse's publication of

Awareness of Dying in 1965 (Glasser et al., 1968). The emergence of grounded theory as a design was significant by providing social researchers the means to develop new theories rather than use current theories (Birks & Mills, 2011). Grounded theory would experience eight iterative changes following changing viewpoints in social science (Birks & Mills, 2011). These viewpoints were methodological differences based on variability in epistemic and ontological positionalities among researchers approaching grounded theory (Birks & Mills, 2011). Despite these movements and differing viewpoints in using grounded theory, there is no one method superior to another (Birks & Mills, 2011). As a result of these differences, it is important for researchers using grounded theory to account for and describe their positions and viewpoints with consistent reflexivity throughout the research process (Birks & Mills, 2011).

Interviews are done using various interviewing styles with varying degrees of broad to focused questions to cover a wide range of topics in order to gain an in-depth view into understanding participant thoughts and perspectives (Charmaz, 2012). When interviewing participants, it is important to prioritize participants' comfort levels toward the questions being asked, while looking for opportunities to ask follow-up questions without forcing a desired response or discomfort (Charmaz, 2012).

Initial coding is the early selection of finding important words and phrases using, or words verbatim from participants (Birks & Mills, 2011). Following the initial coding process, researchers collect initial data through purposive and theoretical sampling (Birks & Mills, 2011). This method requires researchers to analyze part of the data before moving on to the rest as part of the iterative process until saturation is met (Birks & Mills, 2011). Memos are important in providing an audit trail for the researchers throughout the entire research process (Birks & Mills, 2011). Memoing is used to record the researchers' thoughts and develop their ideas in how they come up and internalize their ideas (Charmaz, 2012). Lempert (2007) describes memoing as,

“the methodological link, the distillation process, through which the researcher transforms data into theory” (p.245).

Through memoing, constant comparative analysis is necessary and continuous until a grounded theory is developed either inductively or abductively as a theory is developed from the interpretation of the data (Birks & Mills, 2011). Theoretical sensitivity is the reflection of the researcher's personal views and thoughts ranging from their intellectual background, familiarity with the selected research literature, and how it is incorporated into the research process (Birks & Mills, 2011). Once the previous steps are followed and integrated into the research process, researchers move onto the second stage of grounded theory methods which is intermediate coding.

Intermediate coding is met through categorizing and sub-categorizing data that were previously more abstract from the initial coding phase (Birks & Mills, 2011). From intermediate coding, researchers will then start to come up with a core category that is used as the foundation for the grounded theory (Birks & Mills, 2011). Once the core category is found, researchers begin the final stage of the iterative process through advanced coding and theoretical integration. An important component to reaching theoretical integration is the saturation of the main coding categories (Birks & Mills, 2011). Developing a storyline, or narrative, is an integral part in developing a grounded theory (Birks & Mills, 2011). In generating the grounded theory “... a study is not grounded theory if it does not reach a high level of conceptual abstraction that is beyond the level of description” (Birks & Mills, 2011, p. 115). In addition to this, it is not expected that the researcher can convey all the data available to them (Birks & Mills, 2011). Variation is also encouraged with the development of a storyline; negative cases, or the inclusion of data that does not fit the theory, helps in building a final theory (Birks & Mills, 2011). The

inclusion of negative cases is an important component of developing a theory (Bryant & Charmaz, 2007).

Grounded theory has been used to address qualitative studies examining the perspectives of experts and other participants to better address and understand challenges faced in conservation. Sharaftmandrad and Shahraki (2025) used grounded theory to better understand the management challenges faced by 15 experts on rangeland desertification. Grounded theory was used to better understand the risk of desertification and how sustainability approaches can mitigate climate related challenges for rangelands. Grounded theory was selected by the researchers to generate theory from their data due to the many variables causing desertification to rangelands. Following the process of semi-structured interviews and increasingly complex levels of coding, they found that the loss of vegetation, lower soil quality, and the threat and disruption to pastoral livelihoods to be the main takeaways from their study.

Grounded theory was also used to investigate challenges from invasive woody encroachment of pine and eucalyptus trees grown for harvesting invading small scale agricultural operations (Braun, 2021). Grounded theory was used by Braun (2021) due to it being effective in exploratory rural research and its ability for the researcher to better understand the participants motivations in order to find the main causes for conflict between the forest industry and agricultural landowners. The author found that the forest industry negatively impacted small landowner livelihoods through increasing risk for forest fire and waste left from forestry and the water usage from large scale tree planting. The largest impact seen however is the perception that the forest industry is a direct sense of being threatened by the forest industry's encroachment on their lives.

Chapter 3 - Methods

Research Design

This study uses a qualitative research design to provide a descriptive analysis of the participants' words in the interviews. A qualitative research design was chosen as published quantitative research on prescribed burning exists, but fewer studies have examined prescribed burning from a qualitative perspective (Bonner et al., 2021; Clark et al., 2022). It is important to include qualitative research to address variables that cannot be easily examined from a quantitative lens (Creswell & Poth, 2018). To aid in qualitative analysis, grounded theory was used as part of the research design in order to develop a framework to generate a theory (Birks & Mills, 2011). Due to the lack of prior qualitative research in prescribed fire culture, grounded theory was chosen in favor of other social theories so the data would guide us in the interpretative process of the interviews in a structured manner to describe a lesser-known research area (Tie et al., 2019). We collected data through interviews and built our codes from a basic framework to advanced codes once we reached data saturation. This method of examination allowed us to create and verify concepts as we coded more interviews (Charmaz & Thornberg, 2020). The data collected are the responses from conversations with the participants, and the coding process revealed thick, rich descriptions of codes and themes via the transcribed data. Thick descriptions provide qualitative researchers with enough information to show the data rather than tell the reader what to make of it (Tracy, 2010).

Tallgrass Participant Recruitment and Data Collection

Data for this study was collected in two phases by two different research teams. First, interviews with tallgrass ranchers were conducted in person in 2019 by a separate research team, which I will refer to as the tallgrass research team. The tallgrass research team's goal was to

produce a video documentary to show the challenges tallgrass burners face when conducting prescribed burns. The tallgrass research team recruited their participants with the help of county and regional Extension staff through personal invitation. Interviews were often conducted on the participant's property. Tallgrass participants were included in the study if they viewed fire as an integral part of their operation or land management strategies. Individuals who worked within a state or federal agency, or a business, were included into the study if they had influence regulating or interacted with fire in some kind of way (C. Baldwin, personal communication, March 19, 2024). Study participants were provided with written consent forms before participating in the interviews. We selected and analyzed 34 out of 45 interview transcripts for the tallgrass portion of our study. Thirty-four were selected because they used fire in their operation, while the eleven excluded were Extension agents or worked in other occupations where burning was not applied as a private landowner. The interview lengths ranged from 7-60 minutes. Of the 34 interviews, the majority of individuals were aged 65 and older, with only six reporting being under 65 years of age. Of the 34 interviews, three participants were women, with two of them being interviewed alongside their spouse, with the third woman being interviewed as the sole participant. Tallgrass participants were asked about the benefits and challenges of applying prescribed burning, and what can be done to improve their ability to burn. The tallgrass research team provided our research team, which consisted of myself, my research advisor, and one undergraduate researcher, with their interview data, which included video and audio transcripts of the interviews, in vivo.

Mixed-Grass Participant Recruitment and Data Collection

The second phase of data collection involved expanding data collection to pro-prescribed-fire ranchers and others directly involved in burning in the mixed-grass prairie region. Participants in the mixed-grass region of Kansas were recruited using purposive and snowball

sampling. I contacted K-State Extension personnel who provided us with initial contacts who would have connections with burners in the mixed-grass region. From the initial list of names and contact information, potential participants were either called by phone and/or emailed. I conducted the mixed-grass prairie interviews over the phone between January and June 2024. Once communication was established, participants were asked whether they were land managers who regularly applied prescribed burning in the region. As participants were recruited, snowball sampling was used by asking participants at the end of the interview for additional contacts who applied burning in the mixed-grass region. Due to difficulties with recruiting because of the low number of burners in the region and challenges in contacting potential participants, the Natural Resources Conservation Service (NRCS), Kansas Forest Service (KFS) and non-governmental organization (NGO) key informants were later included and recruited for a larger sample size. A total of fifteen participants were recruited, with ages ranging from 20-40 to 60+ years. Of the 15 participants, two were female. Ten of the participants managed a production operation in the mixed-grass region. The remaining five participants resided in the mixed-grass region and conducted or helped conduct prescribed burns, but were key informants and not land managers.

Participants were given the option of being emailed consent forms or provided verbal consent after the interviewer read the consent form at the beginning of the interview. I did not ask whether the mixed-grass participants were part of a PBA, however, more than half of the participants shared they had some kind of direct involvement with their local PBAs. All the key informants had varying degrees of involvement in supporting burners either through PBAs or on a case-by-case basis. There were multiple instances in overlap with sampling in terms of recruiting participants. Some participants either recommended individuals who had already been interviewed or recommended by another burner, including one instance where a burner from the 2019 tallgrass sample was recommended. We avoided repeat interviews and interviewing people

outside our target region. Interviewing ended on June 26th, 2024 once the 15th mixed-grass participant interview had been conducted. At that point, I was confident that data reached saturation, indicated by my initial understanding of the data during data collection.

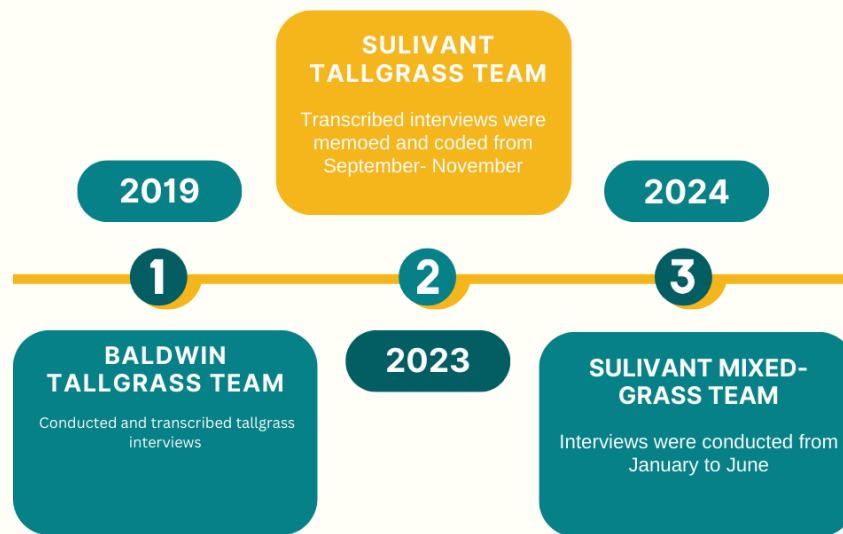


Figure 3.1 Research Timeline

Key informants were recruited to make up for the low sample size available for burners in the mixed-grass region of Kansas. The benefit of including experts from state, federal, and private organizations is that they shared their own challenges in promoting prescribed burning, while echoing similar concerns ranchers and other land managers face. Key informants also provided some comments that counter perspectives of ranchers and land managers, and those difference in data add to data richness. Although key informants may not accurately represent or depict the viewpoints of the group they may assist, they do provide a great deal of context when

time or when recruiting participants is limited (Marshall, 1996). Table 3.2 describes the key informants we interviewed in the mixed-grass region.

Table 3. 1 Key Informant Backgrounds

Expertise	Description	No. of interviews
Nongovernmental organization	Nongovernmental experts involved in assisting and promoting prescribed fire: Pheasants Forever, Prescribed Burn Association Officer, Kansas Grazing Land Coalition	3
State agency	Kansas Department of Wildlife & Parks	1
Federal agency	Natural Resources Conservation Service	2
Contractor	Private contractor planning and assisting prescribed burns	1

The mixed-grass interviews lasted between 25 minutes to 60 minutes. These interviews were semi-structured, and I used an interview guide that I had minimally modified from the interview questions provided and used by the tallgrass team. Some questions were modified to increase the clarity of the questions being asked. In the opening of the interview, I altered the questions for the personal perceptions toward prescribed fire section with open ended questions regarding participant operation, location, acreage and other basic questions before asking more in-depth questions. If participants were brief with their questions, I would ask the question either phrased somewhat differently or follow up with their response to have more context to their initial response when appropriate. Interview questions were a mix of both open and closed-ended and covered topics of personal perceptions toward prescribed fire, community perceptions toward prescribed fire, economics, experience toward prescribed fire, information acquisition, and demographics at the end of the interview. The interview guide for the tallgrass study can be viewed in Appendix C, and the interview guide for the mixed-grass study can be viewed in Appendix D. Both phases of the study were approved by the Kansas State University Institutional Review Board (IRB) before the interviews were conducted. The IRB form for the

tallgrass portion is 11165 (see Appendix A), while the mixed-grass form is 10952 (see Appendix B).

Ethical Considerations

The consideration for ethics is important in this study because risk and emotionally distressing topics could come up during the interviews. The interviews conducted in the tallgrass had participants bring up subjects such as people who have heard of or know someone who may have died by a wildfire or prescribed fire. Other difficult subjects that came up were liability or potential legal disputes landowners may have with neighbors. In order to minimize harm and provide confidentiality and anonymity for participants, the data is protected using password-protected laptops and cloud services. I provided participants with the option to sign a consent-to-interview sheet or to indicate verbal consent for being recorded and interviewed, or both. The mixed-grass participants did not mention stories of deadly incidents like in the tallgrass region, however, there were some instances discussing legal subjects. Uncomfortable topics were not anticipated for the study, however, the head interviewer reassured participants that they did not have to expand on any potentially uncomfortable or harmful dialogue.

Researcher Roles

Lead Researcher

As the lead researcher, I, along with my advisor, led the coding portion for both the tallgrass and mixed-grass participant groups in drafting questions that guided our memoing and theme development. The tallgrass participant group interviews, question design, and transcriptions were done by a separate team in 2019, however, my advisor and I would conduct the memoing and coding ourselves, along with an assistant undergraduate coder. The mixed-grass primary data research would follow the same interview question design. I made minor changes to some questions so that they would be more easily understood by the participant while

keeping the question idea the same. I reached out to researchers in the tallgrass and mixed-grass region who could provide me with contact information of pro-fire burners and later pro-fire key informants to interview. I called and emailed prospective participants and either provided them with consent forms or would ask for their verbal consent before and at the beginning of the interview after reading to them their privacy and any risks associated with the study. I conducted and recorded all the interviews for the mixed-grass group. After all the interviews had been conducted, I went back to the transcription software, Otter.ai and went through multiple rounds of listening over the recordings, making corrections to the transcriptions. Once transcriptions were corrected, my advisor, the undergraduate assistant coder, and I conducted the memoing and then the coding at the same time.

Coding Advisor

My advisor helped to lead the coding process due to their years of experience coding and advising social science research. They helped to thoroughly scrutinize our codes and memos to minimize bias and to allow data to emerge as we became more familiar with the transcripts, eventually developing our themes into the overarching findings of the study.

Assistant Coders

Assistant coders (one undergraduate for the tallgrass data, and a graduate researcher for the mixed-grass data) memoed, coded, and assisted in the development of codes into eventual themes in the study. They familiarized themselves with the fire literature, coding process, and helped synthesize the memos into themes. One of the two assistant coders also helped to include pseudonyms for the participants in the tallgrass.

Data Analysis

All participant names were changed to pseudonyms to preserve their confidentiality. We used grounded theory to analyze the data, which required constant comparative analysis of the

data and results to establish a coherent and reliable qualitative study (Birks & Mills, 2011). We established validity by having a team of three: a graduate researcher, a professor, and an undergraduate student, who were all familiar with fire literature, to accurately code the transcribed interviews. We developed an inductive coding scheme for the first phase of our investigation (tallgrass participant interviews) based on our understanding and observations made around prescribed burning. These codes were iteratively revised as transcripts were read, coded, and reflected in three to four-week intervals to compare codes and develop major themes. For the second phase of the investigation (mixed-grass participant interviews), the same data analysis process was used. Reliability was established through the iterative process of checking and cross-checking codes throughout the analysis. Each coder would crosscheck each other's codes for consistency at every meeting. Any disagreements coders had throughout the coding process were resolved once an agreement between all three coders was met. This process helped to minimize bias from any individual and provide constructive dialogue to support decisions made in rich descriptions of codes (Birks & Mills, 2011). We compared results from similar fire-related studies to compare findings for consistency in the themes that emerged (Birks & Mills, 2011)..

Grounded theory researchers typically develop a theory as follows: Initial coding and data categorization, data generation or collection and analysis, the writing of memos, theoretical sampling, continuous comparative analysis, theoretical sensitivity, intermediate coding, core category identification, and finally, advanced coding and theory integration (Birks & Mills, 2011). Figure 3.1 provides a broad outline of the grounded theory process. As information is acquired and patterns in data emerge, researchers eventually have the information necessary to develop a theory reflective of their findings.

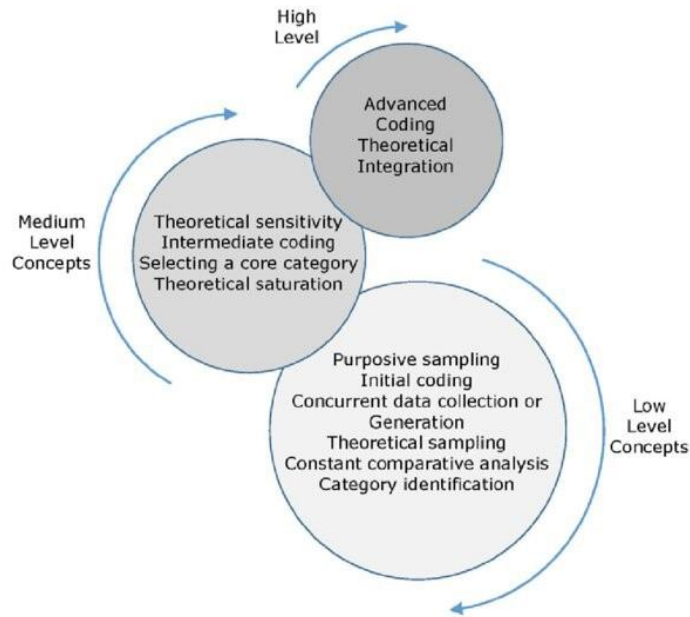


Figure 3.2 Grounded Theory Process (Birks & Mills, 2011).

Tallgrass

Interviews in the tallgrass region were video recorded by the tallgrass research team and later audio transcribed using Transcription Star. We analyzed the transcribed interviews using NVivo 14 software. Our research team, including the lead researcher, first coded the same 7 interviews to develop an initial codebook. Once we had our initial codebook developed, the three of us met to compare our initial findings and come to an agreement where we all overlapped. By the end of this meeting, we had an initial codebook that would continue to be refined each meeting for consistency. Then, we split up the coding responsibilities, each examining 17 total interviews in order for all code members to finish coding in a reasonable time. Throughout the iterative memoing and coding process, frequent meetings were conducted to make changes to the research questions, refine codes, and later generate themes from the codes. Code frequency

comparisons were done throughout the process for consistency between the researchers. Once finished, each researcher's codes would be compiled to finalize the themes for the results section.

Mixed-Grass

The mixed-grass set of interviews followed the same coding process as the tallgrass interviews. All 15 mixed-grass interviews were recorded by phone using Otter.ai and Zoom and were then transcribed using Otter.ai. Once all interviews had been conducted, the interviewer reviewed the initial transcripts while listening to the audio recording to make corrections from the Otter.ai software. Using NVivo 14 software, the transcripts were first memoed by all three coders, following the same process as the tallgrass analysis process before moving onto the initial coding phase. An initial codebook was developed between each of the three researchers until a second shared iteration of the codebook was agreed upon. An initial codebook was made using memos to provide a foundation for initial proposed codes. Two of the three mixed-grass coders also coded the tallgrass interviews; we acknowledged that findings and themes from the tallgrass interviews would influence our data analysis of the mixed-grass interviews. Interviews were first coded in sets of three to four until reaching 15 coded interviews. Codes would be added, removed, and adjusted depending on the data that emerged as more interviews were coded. To remain consistent, if code changes were made, previously coded interviews were reviewed to add or make changes agreed upon by the team. Once we met to discuss consistency between the codes and the frequency of codes, the final set of 8 interviews were coded. Coders met over multiple meetings after coding to establish the codes into advanced codes and finally, overall themes which emerged from the data.

Table 2. 2: Tallgrass Participant Age & Percentage Income from Ranching

Code Name	Age	Gender	% Income from Ranching
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Aaron & Leslie	40-60		76-100
Adam	60+	M	76-100
Andrew	60+	M	76-100
Anthony	60+	M	0-25
Arthur	60+	M	76-100
Benjamin	60+	M	76-100
Charles	40-60	M	76-100
Daniel	40-60	M	76-100
David	60+	M	76-100
Elijah	60+	M	76-100
Evan	60+	M	76-100
Garrett	60+	M	76-100
George	60+	M	Not collected
Henry	60+		76-100
Ian & Silas	60+, 20-40		76-100
Jake	40-60		51-75
James	60+		25-50
Jesse	60+		76-100
Joel	60+		76-100
Julian	60+		0-25
Linda & Kent	60+		76-100
Louis	60+		76-100
Luke	60+		Not collected
Mark	60+		0-25
Mary	60+		76-100
Mason	60+		51-75
Myles	60+		76-100
Nathan	40-60		76-100
Robert	40-60		76-100
Samuel	60+		51-75

Scott	Not collected	Not collected
Susan	60+	51-75
Will	60+	76-100
Wyatt	40-60	76-100

Table 2. 3: Mixed-Grass Participant Age & Percentage Income from Ranching

Code Name	Age	% Income from Ranching	Producer or Key Informant
Alexander	60+	51-75	Producer
Andrew	40-60	0-25	Producer
Benjamin	60+	26-50	Producer
Christopher	60+	51-75	Producer
David	60+	0-25	Key Informant
Evelyn	40-60	0-25	Key Informant
James	60+	51-75	Producer
Jonathan	20-40	0-25	Key Informant
Kevin	40-60	51-75	Producer
Liam	40-60	0-25	Producer
Matthew	40-60	0-25	Key Informant
Nicholas	60+	26-50	Key Informant
Ryan	60+	76-100	Key Informant
Sophia	20-40	0-25	Key Informant
Thomas	40-60	0-25	Producer

Reflexivity Statements

Lead Researcher

I acknowledge that the perceptions toward my research have changed as I have conducted interviews and listened to the stories of these producers. As someone who did not come from agriculture and grew up with a nature-oriented mindset, I view and still hold the belief that the

future of humanity and agriculture will not be sustained on a profit-driven motive and mindset. I have, however, seen that there are a great deal of producers who care and will put the future of the environment, their children, and grandchildren ahead of profitability. However, there were still many who did not seem to care about the consequences of their actions outside of the immediate profitability from their land management decisions. In order to build trust as part of the outgroup, I openly discussed our project goals, and my personal goals for fire research, and openly encouraged participants to ask questions before beginning the interview process. I am also aware of the potential barriers that may have occurred due to the age gap I have with the people I interviewed. I do not believe it was apparent as I interviewed the participants by phone, but it is possible assumptions were made that I am a young researcher at K-State. In addition to this, my epistemic and ontological points of view reflect those of other post-structuralists. I do not believe there is one finite and reducible answer to the questions we ask as researchers and therefore should be open to multiple interpretations of questions being answered. My goal for this research is not to arrive at a particular conclusion or desired answer, but to share a perspective and open a dialogue for an area I feel is both interesting, overlooked, and needs more attention to address the limitations people face when applying prescribed burning.

Coding Advisor

I am an assistant professor who has studied Flint Hills ranchers and Kansas farmers in other contexts related to natural resource management. Entering into this research and coding process, I acknowledge that I am pro-prescribed fire in the Flint Hills, and I am aware of some of the benefits of prescribed fire. I am particularly interested in the natural resources benefits of prescribed fire, and I am motivated to continue learning about fire and its landscape benefits. I am also aware of the pre-European, historical use of fire in the Flint Hills, which is a lens through which I viewed the data. I am not as aware of fire use in drier areas of the state, and I

have heard of the fear of wildfires and overall risks in drier areas of the state. I have respect for the ranching community and lifestyle, and I also recognize ranching and production as a business to maintain. I entered into this project with curiosity and a desire to learn more about people's stories related to prescribed fire. I guided the research and coding process, while encouraging all coders to discuss their differences of opinion and pushing them to challenge my own opinions.

Assistant Undergraduate Coder 1 (helped with Tallgrass interview coding)

As someone who has been around production agriculture my entire life, I'm interested in opportunities and research that support this industry. I've also planned and taken part in prescribed burns, which has influenced my perceptions of the practice and its purpose in a tallgrass prairie ecosystem. My experiences living in a rural community also play a role in how I perceive data concerning similar agrarian populations.

Assistant Graduate Coder 2 (helped with mixed-grass interview coding)

I come from an agriculture background primarily in Central Kansas. My background in agricultural communications and personal experiences may influence this research. I have personally never participated in prescribed burning but have witnessed it from an outside point of view. I have talked with farmers about why they burn as well as have experienced the smoke and affects from prescribed burning. Along with prescribed burning I have also witnessed wildfires that were not planned and have caused a large amount of destruction. In central Kansas where I am from weather plays a large role in when farmers and producers tend to operate. Drought is one of the largest concerns pertaining to weather. With my vast background I have made a effort to be as open minded as possible.

Chapter 4 - Findings and Discussion

The purpose of this study was to explore fire culture and the use of fire as a landscape management tool among prescribed fire proponents in two distinctly different ecoregions in Kansas. Using the tallgrass ecoregion and the mixed-grass ecoregion of Kansas, we explored how and why burners in two ecologically distinct regions had similar or differing perspectives on their application of prescribed fire. Information in this findings and discussion chapter was organized according to the research questions:

1. What are tallgrass pro-prescribed fire ranchers' perceptions toward prescribed burning?
2. What are the mixed-grass pro-prescribed fire ranchers and key informants' perceptions toward prescribed burning?
3. Research objective: Describe the similarities and differences between Flint Hills pro-prescribed fire participants' perceptions of prescribed fire and mixed-grass pro-prescribed fire participants' perceptions of prescribed fire.

RQ 1: What are tallgrass pro-prescribed fire ranchers' perceptions toward prescribed burning?

Summary

The themes uncovered from the tallgrass pro-fire ranchers were: their pragmatic use of prescribed fire, long-term cultural use of prescribed fire, experiential influences for using prescribed fire, and balancing risk using prescribed fire. Most tallgrass participants felt strongly about a "fire culture" being present in their region and considered fire an important component to their ranching practices. They recognized the importance of prescribed fire for its practical usage economically, for both cattle weight gain and as a low-cost tool in reducing woody invasive

species encroachment. Their experiences growing up or being taught to conduct prescribed burns by family or their neighbors were very influential to most tallgrass participants. Their upbringing and experiences influence the ways in which they balance risk when applying prescribed fire. They expressed concerns for liability, safety, and climatic conditions influence how and when to conduct a prescribed burn.

Tallgrass Theme 1: Pragmatic Use of Prescribed Fire

Tallgrass burners were pragmatic in their motivations for using prescribed fire on the landscape. Participants' pragmatic usage of and benefits from prescribed burning were controlling invasive species encroachment, especially woody species; profitability and better weight gain on cattle; lower overhead maintenance cost; and a lack of adequate and cost-effective substitutes to prescribed fire.

The most common goal for fire application was to control invasive species, particularly woody plant species. Lenda and Kent, quoted below, share the consequences of not applying prescribed fire to cut back woody species populations.

Well, burning is so important because if you don't burn you get these essentially pileups of tinder that's just laying out there ready to begin a massive fire. We have more trees here than ever at any time in history. And when these fires get started in the grass and have wild winds that we sometimes have they blow into the trees and spread from there. That's how they get into housing developments and so forth like the big fires that we see in California on the West Coast. I think people don't think that could happen here. But the reality is it very much could happen here. So by prescribed burning we're cleaning up large areas in a very safe manner and preventing the possibility of disastrous fires that could occur.

Some tallgrass participants described how the existence of grassland ecosystems is dependent on regular fire intervals. Nathan recognized ecological succession toward woody tree species taking place over time from the lack of regular prescribed burning:

We use prescribed fire because we want to keep our grasslands, grasslands, that's the number one reason. There are so many different species that are creeping in on this eastern red cedar, dogwood and things like that. If we don't burn every so often, they are going to come in and invade and turn our grassland into the forest over a certain period of years. Well, the impacts on the ecosystem are number one, we're maintaining the ecosystem more than anything and where the ecosystem has kind of gone to a brushy area.

Participants were asked what they thought would be the economic consequences of losing the ability to burn for their operation. Robert, quoted below, describes both the economic and environmental harm caused if the use of prescribed fire was stopped or no longer permitted.

From an economic standpoint if I lost the use of prescribed fire, the financial income would go away. If I can't burn, I can't charge as much for putting cattle on that grass because the grass isn't good. The grass is going to get overtaken by foreign species, which means I can't stock it as heavy as I want to. And if it's full of trees unless you're a deer hunter the land values are going to go down. So it's worth a lot to me to keep the prairie, a prairie, not a jungle.

Without prescribed fire, the cost of maintaining their land would be much higher. A number of burners such as Wyatt, quoted below, described the negative outcomes of not using prescribed fire to both the profitability of their operation and impact on wildlife.

We know that historically it's been proven poorer animal performance [weight gain] on unburned pastures. You'd have increased cost as far as brush control, having to utilize

only chemical methods or mechanical methods which would both be expensive. And both expensive and sometimes not knowing all the expenses that play into some of that. So I just think the economic impact could become much greater than we could just figure.

Here if we took more time on the back of an envelope, it wouldn't take long to add up to a large amount. I think that the biggest impact would be things that we couldn't tie a dollar amount to. You know, the loss of grass and other plant species that depend on that fire to continue to thrive animal species that wildlife that depend on those open areas for them to do their best, I think those are things that it's just hard to put a number to and I wouldn't want to put a number to and they're some of the most valuable things we'd lose.

Charles, quoted below, provides a dollar amount estimate to the maintenance of invasive species such as *Sericea lespedeza* if chemical control was the only tool available: "The second impact would be the cost of the pesticide, herbicide and mechanical removal of trees and undesired species out there. *Sericea lespedeza* can cost up to \$25 or \$30 per acre to control on an annual basis."

In addition, Charles provides an estimate for profit lost per head of cattle if their ability to burn was lost: "the economic impact of not being able to use fire if cattle are gaining at 100 pounds and you're short two-tenths of a pound at a dollar a pound that's \$20 a head at the end of the summer."

Some burners have attempted to use substitutes to fire when prescribed fire is not feasible. Mary, quoted below, shares their experience attempting to use alternative methods such as mowing.

I don't believe there are substitutes for prescribed fire. And I actually proved it to myself one year in trying to mow one area because I didn't get the kind of fire I wanted, and I wanted to see if it would be the same. So in a certain area, part of it was burned and part

of it was mowed and they don't graze at the same. And the vegetative response isn't the same and therefore your ability to control woody species isn't the same. Oh, they grazed where it was burned and they didn't graze where it was mowed. And so you had no impact on the mowed area.

Nathan, quoted below, also describes the reasons why substitutes are not practical and economically viable.

Where we are in the Flint Hills, we have the option of we can spray but that's very expensive. Only a temporary fix and it's also not a very environmentally friendly fix because it not only destroys the woody species, it takes all the forbs and what have you with it, it makes it kind of a monoculture so that wildlife suffers from that. Mechanically it's terribly expensive and to even get where we want to go with a mechanical means, whether it's mowing, clipping there what have you. It's very time-consuming and just it's dangerous in places where we need to get this done.

In contrast, a minority of our tallgrass participants have seen the viability of some substitutes to fire. When asked if there were any acceptable substitutes to prescribed fire, Daniel, quoted below, describes the usability of chemical spraying, however, this still doesn't overcome the cost compared to prescribed fire:

I guess the first one I think of is chemical application. We can get rid of these brushy species without fire. There is no doubt about it. It comes with a higher out-of-pocket cost by applying that chemical. And I think it also comes with bit of a cost to some of the other needed forbs and species, plant species that we may accidentally stunt or kill by using chemical application.

Another possible alternative to fire is using more intensive grazing strategies and multispecies grazing. Only a few producers mentioned alternative methods to fire, such as Daniel, quoted below.

...it'd be managed intensive grazing that gets rid of that cover at the right time... so that's an option that we haven't used at least here for 130 or 140 years. This place used to have quite a few sheep and so I know that they would have help to control that if we had that many trees. But that's one other option is through grazing and that's a very natural and a very good way to do it. It does require quite a bit of management too though. So there are substitutes probably none as organic or as easy as what prescribed fire can be though.

Although the “pragmatic use of prescribed fire” theme encompasses different reasons for why participants apply prescribed fire, what is similar is in their thought-out justification and understanding for why applying prescribed fire is necessary. Prescribed fire addresses a practical role in tallgrass land manager practices because of the cost effectiveness of prescribed fire, and the general effectiveness of prescribed fire, especially compared to its substitutes (mechanical, chemical, or intensive grazing controls). The price per acre of burning, especially when scaled up, is recognized by participants as very efficient compared to alternatives, such as chemical and mechanical removal, which may be used in conjunction with fire or as needed. Most of the participants in the tallgrass have personally seen the positive outcome prescribed fire has on their land when it comes to both productivity and in the removal of invasive species. Participants believed that without prescribed fire, their ability to remain profitable in their operation would be either difficult or impossible.

Tallgrass Theme 2: Long-term Cultural Use of Prescribed Fire

The tallgrass region, particularly the Flint Hills in Kansas, has a long history of prescribed fire as well as a long-standing legacy that burners in the region take pride in. Fire

culture is not specifically defined in the literature. For the purposes of data analysis, we defined culture as long-term, multi-generational traditions passed on from family members to the next generation and to the surrounding community. During interviews, burners in the tallgrass told stories about their childhood and ancestors, their cultural perspective compared to non-ranchers in the region, and the historical pre-European use of prescribed fire in the tallgrass.

Many tallgrass participants come from multiple generations of burners. Robert, shared his family's multi-generational practice of prescribed burning in the region.

My great-great-grandfather settled about five miles east of where we are in the mid 1880s, and he started using prescribed fire then. And it's just come down one generation to the other. My 19-year-old son is actually in on it now too. So we got six generations of pyromaniacs in the family.

Julian, like other long-time residents of the tallgrass, first learned to conduct burns when they were a child on their family operations: "...it started when I was a little kid because I've always been around pasture burning and some of that you just kind of pick up through osmosis."

Julian went on to compare tallgrass practices toward fire to that of other parts of Kansas, such as the mixed-grass region and the recognition that burning practices are starting to emerge in that region. Julian viewed north central Kansas practices through the lens of multi-generational, pro-prescribed fire culture:

And I could add some context to that it's different in different parts of Kansas. My wife grew up in North Central Kansas, which at one time that was all prairie. They were a mix between tallgrass and medium grass prairie on a transition between tallgrass and the medium tallgrass prairie. But for whatever reason there is more farming up there. And for whatever reason, the farmers and ranchers up there did not burn. My father-in-law to my knowledge never burned a pasture, nor did his neighbors and their pastures were in

bad shape. I remember the first time I visited up there when I met my wife and I thought what is going on here. These pastures are not at great shape. They didn't burn that led to overgrazing. Just in the last 10 years up there in North Central Kansas they have kind of learned that it makes sense to periodically burn.

Evidence of shared stories and shared wisdom were a common thread within the “long-term cultural use of prescribed fire” theme. Seemingly as part of the culture of burning in the tallgrass, many burners describe fire and weather with anthropomorphized words and phrasing. Julian, quoted below, shared some wisdom from another burner about the challenges of conducting burns.

An old-timer that was a neighbor of ours at Matfield Green said that one of the laws of the universe is that when you – immediately when you throw a match to start a pasture on fire that the wind will increase in speed and change in direction. And as crazy as that sounds, that has happened to us on a number of occasions. So you have to plan for the surprises, for shifts and when increased wind volume up.

Another anthropomorphic point of view, shared by Evan, quoted below, describes the need to see fire as more friend than foe. This perspective seems to determine the extent to which a person is comfortable or willing to use fire, and sheds additional light into pro-prescribed fire users' comfort level with fire due to being raised with the practice:

I see myself as part of that tradition. I have a lot of people come and ask me to help burn, they're new landowners or things like that. One of the things that I see with people with fire is fire works for us and we have to look at it as our friend. And I see a lot of people who look at fire as an enemy or something to be scared of. And I'm not saying you shouldn't worry about it or be scared of it, but if you – when you start looking at it as

your enemy, you start putting it out too soon, you don't let it go through the – go into the brush and go through the brush, or you don't let it go to the fence line.

Although the fire culture is well established in the tallgrass, some such as Daniel quoted below contrasts his science-focused perspective with burners who are very focused on culture for how they apply fire:

But there is a lot of history, there is a lot of tradition about burning. It's always been interesting to me to watch the psychology of those who do or don't burn and annually burn verses one in two or three years. And it's, I laugh, it's almost like a religion to some people. Burning is a very, very deep tradition amongst those who use it and it's not something that they take very lightly, which is kind of interesting when something that's I look at as a scientific way or a natural way that we can actually manage our pastures, others look at it almost as an art form that has to be done this way, so it's always interesting.

Daniel continues by comparing some of the pros and cons to a cultural, traditional mindset in applying prescribed burning. Daniel's perspective shows that within a community that agrees on a particular norm, such as prescribed fire, people will commit to these norms on different levels.

...traditions are very healthy but sometimes I think we have some landowners and some users that may burn every year on this exact date or this time period not because that's what the ecology and the grass and everything else is telling us to do, but because that's the way dad and granddad did it. Yeah, it's not always the healthiest way of making those decisions but it's not – you can't argue that it is a tradition. I think a positive one and it's one that we continue to be part of. We just make sure that we use all the

knowledge that we have and all the research tells us exactly how to use that tradition and not abuse it.

The Long-term Cultural Use of Prescribed Fire is a theme exclusive to active burner participants in the tallgrass. Burners' viewpoints toward whether the rest of the community understands or accepts fire in the tallgrass were split. Some burners such as Scott, quoted below, described how they believe most tallgrass residents at least accept fire as a regular practice that isn't detrimental to their livelihood. This demonstrates that although prescribed fire is generally accepted within the rancher culture of the tallgrass, it may take time for outsiders of the region to accept or begin to understand why burning is done.

Anybody who is living in the Flint Hills very long has been introduced to prescribed burns. And I've known people who were here the first year or two that were really intrigued with it. And after they've been here a while it's just the fact of life and the spring in the year the Flint Hills are going to burn.

Others, such as Julian, quoted below, tend to believe those who either don't accept or understand why prescribed burning is done are typically those from urban areas: "what's hard to understand is why non-rural people will not trust or believe people that are managing agricultural land to know what the right thing to do is to maintain the health of prairie grasses."

Daniel, quoted below, shows how providing demonstrations and educating people unfamiliar with prescribed burning is an effective method to increase acceptance or positive attitude toward continuous and traditional burning practices in the region. This positive attitude helps keep the culture expanding, preventing it from fading or for outsiders to have a negative attitude toward it.

We've had a few groups from Wichita, one from the capital in Topeka, some elected officials down and we actually light a fire as part of that tour and we show people how

we do it and we tell people why we do it. And once we do, they're like, well, that makes all of the sense in the world. I just thought you guys were pyromaniacs and like to see big flames and then we're trying to pollute our air. And once they hear the story hey, we cut use of chemical application and this is one of the more natural things that anybody could do. And you know it's a way that we can benefit the land and hopefully keep these Flint Hills from turning into a big cedar tree landscape. Then they get it and that becomes a fairly easy decision and a fairly easy explanation. But when that smoke plume comes over at Kansas City or Wichita and no one is there to say what happened and why, then it gets a little more difficult to explain after the fact.

In terms of tallgrass participants' knowledge of history, most burners knew some context of a burning history prior to their lifespan but their reference to burning history varied greatly in terms of time span. Some mentioned the burning history dating back a few generations, while others mentioned early European settlement, the Native Americans who burned in the region, or a longer history that predates humans in North America. The most common references for fire history in general were an awareness that Native Americans conducted burns and that burning has been done for at least the past century. For some, the history of the prairie landscape, Native American culture, or their participation and family history with fire are important motivations for using fire today. Myles, quoted below, provides a summary of the history of fire in the Great Plains.

...fire has been a part of the ecology of the Tallgrass Prairie for millennia, ten thousand years and the original fires were natural or brought by the original native populations who lived here. What I'm told, not being warned, but being told that the natives were able to bring by using a judicious use of fire they could protect their homestead where the village was from wild fires which were a huge issue in that days but

they also were able by burning certain areas maybe between tributaries they could get their hunting prospects the buffalo or bison to come to them as opposed to having to travel all over to get to the bison. So they would literally lay fire out just as we did, maybe not in the same schedule and of course couldn't put it out like we did.

Over the years, the tallgrass region has not experienced many laws enforcing how prescribed fire is conducted due to their self-regulating tradition. Because of this, fire regulations for most counties in the tallgrass are minimal. For most burners, sticking to regulations involves no more than calling the sheriff's office to notify them that they will be conducting a burn. Dispatch can make recommendations for whether the burn should or should not be conducted based on the weather conditions of the day. Nathan, quoted below shared how their county regulates prescribed burns.

It's generally on a county by county basis. Before we burn here in Wabaunsee County, I have to call into the Sheriff's office to give my permit number and let them know where I'm going to be burning, how long it will take. There is also some state regulations stating I need to notify people that are within so many feet of where the fire will be. There is voluntary things that we do as far as looking at the smoke management plan to see where our smoke is going to go. And we also have to obey the local laws if there is a burn ban, we won't be burning. If I self regulate what I consider is we do consider where our smoke is going to go.

Many participants in the tallgrass felt the lack of regulatory oversight is beneficial as tallgrass burners have been largely self-sufficient in their self-regulatory practices. Jesse, quoted below, describes how future regulation is likely inevitable, but would like to see cooperation between agriculturalists and lawmakers.

...ranching is something that people are very proud of when they do it. We just don't want total government interference in it. And I understand there has to be some regulations put on and sometimes maybe the people that make the regulations aren't as in touch with what we're trying to do as we are. But as long as everybody kind of gets on the same page and talks about it and tries to work out the differences so that it'll work for those people of us who are involved in agriculture. And we know there's going to be change. I mean, that's always happened and there's going to be more of it. We just hope that everybody can work together when the change is made.

Most burners in the tallgrass see themselves as being part of and a continuation of a long-held tradition of fire. This is often a point of pride as they take their stewardship seriously, especially compared to most other places where prescribed fire has only recently been reintroduced. Most of this study's tallgrass participants grew up in the tallgrass region and were taught how to burn with their parents, grandparents, friends, and neighbors from a young age, reinforcing their connection to the land and the practice that has helped to maintain the tallgrass prairie ecosystem. The tallgrass burning tradition has also led to minimal regulation and oversight, as burners tend to be self-regulating out of experience, or out of a sense of accountability for failure without the need for the state to enforce how burns should be conducted and regulated.

Tallgrass Theme 3: Experiential Influences for Using Prescribed Fire

Burner participants shared their direct experiences in learning how to conduct prescribed burns, or their learning through the storytelling of others. Experiences that burners had in learning to conduct and utilize prescribed fire depends on a variety of factors. Some burner participants grew up using prescribed fire, while others grew up in a family who didn't burn and would adopt burning as a regular part of their management strategies when they took over the

operation. Others, such as people who moved to the tallgrass later in life, would learn about the benefits and how to use prescribed fire mostly from their neighbors. Participants mentioned resources provided by Extension services and other organizations that help inform them as they continue to learn and refine their application of fire. Experience is an important theme to consider because it affects participants' cultural narrative for how they view fire, how it should be used, and their risk assessment of prescribed fire.

Julian, quoted below, describes the knowledge he has gained from experience in recognizing the economic benefits of prescribed fire. "But I learned early in life that you get better gains on cattle and that if you don't burn every so often, your pastures get taken over by invasive species and cedar trees".

Learning by conducting prescribed fire for years is important in ensuring burns are done professionally. Some burners have their own criteria for how they self-regulate and consider the risks of burning under certain conditions. Jesse, quoted below, describes how, with experience, they have become somewhat more cautious and selective in finding ideal days to burn.

I didn't self-regulate as much as I do as an older person. Because younger, you were just more invincible, and you get a little older, maybe a little wiser and say, maybe the wind today isn't in my favor. Maybe it's a little too dry. Maybe I shouldn't be doing this today where at one time we would have just gone out and done it anyway.

A valuable resource to many tallgrass burners has been their much older burning peers. These older individuals provide practical knowledge, and often times it is the oldest individual in the group who leads a burn. Wyatt, quoted below provides an example of this:

... typically culturally usually the most senior person there in age is who makes many of the decisions on. Is it safe to burn? Is it right to burn? How are we going to do it? Trying to take advantage of that experience and always remember one year where a neighbor

who was getting all those questions, he said, do I look like the old guy? And he looked around to say yes, I guess I am now. And so you know even that you see some changes over time that many of the folks that he had sought their advice on when to do the fire or how to do it were now gone and we're relying on his expertise.

Learning from the mistakes of others can provide valuable lessons to burners who help with other people's burns, as Andrew, quoted below, describes.

Mostly, I learned prescribed burns from trial and error probably. Originally we started with a five gallon bucket and a burlap sack. So the burns were very small and I kind of evolved into like a lot of people do and then from watching other people. Primarily you learn more from somebody's mistakes sometimes you do and what they actually maybe did right that as a memory you don't forget.

For many participants, they find receiving information from various organizations to be useful; however, most participants like Arthur receive most useful information from their neighbors.

The way we find out about new fire equipment or new fire regimes is mostly through the organizations that we've talked about, KGLC or, or the NRCS sometimes the Kansas Livestock Association might have some, some information or just from the neighbors, a lot of stuff I find out just by talking to the neighbors in the cafe or you seeing them on the road. So you know there's kind of a variety of ways but I'd say the neighbors probably the number one.

There are many educational resources available for burners to learn about new information and methods around prescribed fire. Nathan, quoted below shared the resources that have been most useful for them.

Probably the Kansas State Forest Service. They have been a great help. They put out publications, other stuff through social media, work with fire training. And then there are several other grazing coalitions or what have you, grassroots organizations that work to keep us informed on different ideas on how to conduct prescribed burns.

Jesse, quoted below, mentions how technological advancement in having modern and better equipment has greatly helped burning experiences and the ability to conduct burns safely and effectively.

... the modernization of it is fabulous when you look at what we used to do when it was basically a match and a gunny sack and a rake to all of the fire equipment that your townships now have that all of the ranchers on, all of them have some type of firefighting equipment of their own. And some of the guys have built some very substantial firefighting equipment in their trucks and their spray systems. So it's just like anything else that agriculture has seen, we've moved from a horse and a plow to today, and we've just moved that way in the burning system too. It's just there's a lot more protection today with the equipment and we ever had 50 years ago when we done this.

Burners were asked what kind of information would be most useful to them for learning more about prescribed fire. For most burners, having more advanced weather resources would be valuable for planning prescribed burns. Charles, shared why better weather data would be useful.

...more in-depth information from the weather service on estimated winds that there were wind changes that day beyond that I'm not sure where any outside entity would have much impact on our decisions that day. I would say that I would receive that information best on a text or on through your cell phone or through email. If we receive something that morning, alerting us to the fact is especially during the first two, three weeks of April

wind most of our fires occur as to a front that's coming through that day when the winds are going to switch from the south to the north.

Although long-term cultural use of prescribed fire greatly influenced many burners in the tallgrass region on how they would conduct prescribed burns, most burner participants continue to expand their knowledge base from trial and error, as well as through learning workshops. Learning by doing and relying on the guidance from older and often the most experienced burners also influence how burners go about their burns. With decades of experience, some burners view themselves as being more cautious when it comes to conducting burns than when they were younger, showing that despite the knowledge they possess after years of experience, a healthy amount of caution is encouraged.

Tallgrass Theme 4: Balancing Risk Using Prescribed Fire

Balancing Risk Using Prescribed Fire is an important theme according to participant responses. Participants assessed risks based on their practical experience and tools available to them, as well as the cultural norms and viewpoints held toward a process. What was seen for the pro-burning participants in the tallgrass was a range of levels of fear and respect for fire, and the recognition that, although fire is inherently dangerous, the chance for actual danger depends on the burner's viewpoint influenced by their cultural outlook toward fire risk, as well as their experience in applying prescribed fire.

All tallgrass participants mentioned some form or forms of risk mitigation, including coordinating with neighbors, planning for a safe burn, and using their fear or respect for fire as a motivator to conduct safe, controlled burns. One method burners in the tallgrass used to mitigate risk and to have positive local community interactions is talking to neighbors to notify them when the pro-fire landowner will be burning and talk through concerns their neighbors may

have. Charles, described that being a good steward and neighbor means he is obligated to notify his neighbors of any upcoming burns.

Being a good neighbor, being a good steward of the land kind of goes hand in hand and we notify people who're going to be burning anywhere near or adjacent to their property. And just being a good steward and a good neighbor goes a long way.

Nathan, shared how he also notifies and coordinates with his neighbors to minimize their exposure to smoke from the prescribed fire.

...we want to be considerate of our neighbors around us where the smoke goes and the adjacent neighbors. We try to work with those that if they're right across the road from us that we don't blow all of our smoke right into them, right off the bat.

Due to the generally accepting nature of using prescribed fire in the tallgrass coordinating with neighbors is often an easy process since, for some participants, their neighbors are burners as well.

In contrast some participants had neighbors who were more difficult to coordinate with as they do not want to experience or be involved in prescribed burning. This presented some challenges for burners and leads to elevated risk in the burning process. Arthur, quoted below, shares how he mitigates risk with neighbors who do not want to burn.

So the constraints to fire are sometimes if your neighbors don't want to burn, that means you've got to put it out at your fence line or part of that wherever, wherever then you don't want the fire to go, which often is a difficult thing to do, especially if you're doing it on a somewhat windy day, in the early spring when everything's pretty dry and ready to burn. So you have to have a little extra help that day or you've had to put in some fire guards or something like that.

Tallgrass interviewees described evidence of diligence in planning and conducting burns safely so they can continue to be largely self-regulating. Daniel, quoted below, described one method, having a smoke management plan is a compromise for burners to remain largely independent from being regulated.

...today it's different, through the smoke management plan, which has been developed with Kansas Department of Health and Environment and then a lot of rancher and farmer groups, a lot of folks did a lot of work to make sure that a) we could still continue to burn in a fashion that hopefully benefits all farmers and ranchers that want to use that. But b) that we didn't add to the pollution and in the air quality concerns of major metropolitan area.

Daniel continued by talking about the pros and cons to the smoke management plan being incorporated into prescribed burning practices. Smoke is an important risk to consider due to the negative health effects it can cause to people with respiratory issues. In addition to this, it can be a danger to local traffic if the smoke goes over a road or highway (Abdel-Aty et al., 2011; Thomas et al., 2017).

So I think it's a compromise. Does [smoke] make a little bit more difficult to burn? Yeah, it's another level in that matrix when we decide can we or can't we burn today that we have to consider and it's become one of the more priorities. But as far as being a regulation, I guess that's kind of on our system. Nobody, the smoke police aren't driving around telling you now you realize you can't light that fire today. They aren't yet anyway. If we're not careful that may be the case someday. But I think we're probably pretty fortunate that most of our land managers are following that smoke management plan and the data shows we haven't had near as many of those of those exceedance days

in Kansas City and Wichita. Other areas at least in Kansas is what we used to have before we were participating in the smoke management plan.

For many participants, having enough equipment and keeping equipment maintained is an important procedure in the prepping phase to conduct a prescribed burn safely. Wyatt, quoted below, shares his prepping experience with his equipment.

And that's going through checking equipment, making sure the equipment that we use is ready and in good working order. Many times can be done in the early spring before it's ready. You know, if we get a few minutes it's not about a sharp project on a cold day. To make sure those sprayers are going to work, the drip torches and fire sticks are ready to go. And so that's usually first on our list to make sure our equipment is ready so that when we can burn, we're ready to burn.

Most tallgrass participants have a reasonable fear toward fire, however, it is not enough to be a demotivator in conducting a burn. For some burning participants, fear is the biggest constraint toward applying fire because of their unique circumstances such as working with neighbors. James, quoted below, shares how fear prevented him from burning.

...the fear of fire is our biggest constraint. In fact, there was a whole section of ground that I did not burn this spring because I had lost confidence in our ability to control it. ... I just didn't think we could keep it from getting into the neighbors cowherd and killing calves. So fear is the controlling factor here.

Participants described going to great lengths to keep their friends, family, and neighbors safe. Wyatt, quoted below, shares how important fire is in managing the landscape, but also how the risks weigh heavily when preparing and conducting a burn.

Again safety, I always am concerned about friends, neighbors, family members that are helping. I mean, we want to do the best we can for this area that we're fortunate enough

to look after. But their safety and it means a lot when it's your family members or your close neighbors. So we don't take that risk lightly. And I think maybe others need to realize what we're risking to manage this. And I think you could ask many people in this area that they can point to people that have been burnt or hurt few fatalities but there has been some.

A common fear described by some burners was the possibility that the fire was not entirely stopped following mop-up. Evan shares the lengthy process of making sure a fire is put out and stays out.

...I lit that fire at 9:00 in the morning and I went to bed at 4:30 am the next day. And I sat on the pickup, my – I changed the watch – the alarm on my watch every 30 minutes, and just to wake me up so I wouldn't fall asleep. And I just – I didn't – I thought it would burn out but I didn't dare leave it, so I stayed there until it did burn out.

Smoke was commonly described by participants as a major consideration when preparing to conduct a burn. Most burner participants talked about planning ahead to minimize the amount of people being exposed to smoke. Many burner participants in the tallgrass take painstaking care in being prepared for the most favorable day to burn. The variables in this can be the availability for help and perfect weather conditions such as wind before conducting a burn. Waiting for the right conditions also includes the possibility for rain overnight or the day after a prescribed burn is done.

Burners in the tallgrass region consider many risk factors and potential disruptions when preparing a prescribed burn. Most tallgrass participants coordinate with their neighbors who are pro-fire or burners themselves to notify them and prepare for a burn. For other burners, they have to work around anti-fire neighbors, or neighbors who do burn but do not plan to that year, making the process riskier and potentially lead to legal issues if a fire ends up on their property.

Participants indicated great consideration of safety for people on their fire line and checked ahead of burns to determine where the smoke from their burns will go. Participants also indicated a perception that good planning and good neighbor relations no matter whether their neighbors are pro-fire or not, will allow them to continue to burn with a positive public outlook and not warrant the need for additional regulations challenging their ability to burn.

Tallgrass Fire Culture Theory Model

For most participants in the tallgrass prairie, they consider themselves to be part of a tradition of burning. Their tradition broadly shapes the ways in which they assess and justify their usage of prescribed fire. These motivations are largely defined by their assessment for their motivations and risk of applying prescribed fire. These assessments can be a mix of internal motivations such as preserving the land for conservation purposes, keeping the land in good order to be passed down to their family or other operators, to more external motives such as minimizing overhead costs of their operation and maximizing cattle weight gain from frequent burning intervals. New information, be it from their peers, or from scientific publications, when applied may change their approach to prescribed fire over time. Advancements, new information, and other changes such as bad experiences, increased presence of homes near the property, or changing perspectives of their local community, shape their cultural narrative for how they can and should apply or not apply fire as part of their land management practice.

Based on the themes that emerged from the tallgrass interviews, I developed an initial model illustrating how fire culture drives prescribed burning in the tallgrass region. The model demonstrates how each category builds on one another. Because the tallgrass region already has a fire culture, burner perceptions are weighted on how burners view risk toward applying prescribed fire as well as their motivations for using prescribed fire, which must outweigh their perceptions of risk, otherwise they would not conduct a burn. The motivations for burners in the

tallgrass region varies, most have external motivations recognizing that without regular burning, their ranching operations would be less profitable or would cease altogether. For some burners, there are internal motivations to protect the grasslands either to pass it on to the next generation of producers, or because they have had or developed a close relationship toward the land they managed. Through decades of experience and trial and error, new knowledge emerges that is built from generations of knowledge that's been passed down, which shapes the cultural narrative that is the tallgrass fire culture.

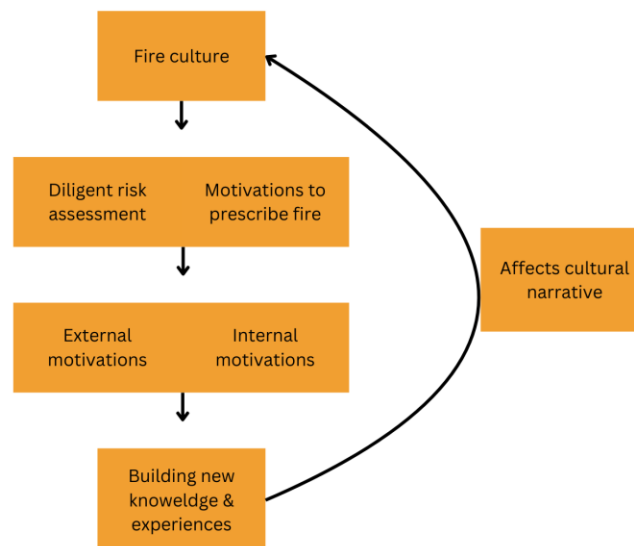


Figure 2.1: Tallgrass Theory Model

RQ2: What are the mixed-grass pro-prescribed fire ranchers and key informants' perceptions toward prescribed burning?

Summary

The overarching themes found from the mixed-grass participants were their pragmatic motivation through a gradual reemergence of a pro-fire culture, diligent assessment of risks, and intensive risk mitigation. Mixed-grass participants have a deep understanding that prescribed burning is both the most cost-effective and consistent way to cut back invasive species encroachment in the mixed-grass region. Due to not having long-term cultural backing for applying fire, and due to the mixed-grass region being in dryer conditions, mixed-grass burners are diligent in considering risk when applying prescribed fire. Mixed-grass burner consideration for risk has led to intensive risk mitigation strategies such as having thorough burn plans, making sure they have more than what they need in terms of people and working equipment when conducting a burn, and carefully considering the near-term outlook of their burned ground so it remains productive and resilient to extended dry periods.

Mixed-Grass Theme 1: Pragmatic Motivation Through a Reemergence of Fire Culture

The overarching theme for the Kansas mixed-grass ecoregion participants is in their practical motivations for using prescribed fire, even without a continuous historical application of prescribed fire. The tallgrass participant data also resulted in a “pragmatic” use of prescribed fire. There are similarities and differences between the themes for the two participant groups, which will be presented in more detail under the findings for Research Question 3. Based on my data, the mixed-grass region appears to be undergoing a slow and long-term transition away from a longtime anti-prescribed burning attitude, to a gradually neutral to pro-fire attitude. The changes in viewpoints affect the decision-making and motivation for whether or not an individual may want to apply prescribed burning. Unlike some agricultural practices, the challenges in learning how to safely conduct a prescribed burn leads to a shift in one’s identity

either quickly or gradually over time depending on accountability, regulation, and general safety risks in conducting a burn. Despite the many variables a burner faces, mixed-grass participants describe taking a practical approach in addressing challenges in their operation. This practicality has led some operators to view prescribed fire as a useful, but not an end-all, kind of tool. Alexander, quoted below, describes why he finds prescribed fire to be a useful tool, but not the only tool in managing his land:

...I'm out on the pasture every day. I feel like I have a very real feel for what is going on. I see with my own eyes what the burning does and how much time and energy is saved. Again, I'm not. I'm not saying that burning is the answer. It is a tool that has to be used along with a lot of other tools.

There is a lack of consistent historic connections in the mixed-grass region for a pro-fire culture to be established on a large scale or for an extended duration. This was seen when we asked whether burners were familiar with a history of prescribed burning or whether they see themselves as part of a tradition. James, quoted below, summarized the region's fire history and the general lack of continuous burning practices in the region. Burners motivated by the practical benefits of prescribed fire conduct the practice in a region that is not entirely pro-fire, because the practice there has not been a widespread tradition.

Well, a tradition, I don't know if that's the right word here, because traditionally, we didn't do much of it, just because dad wasn't a big fan of it, and I was pretty naive. Yeah, there was some of the old-time ranchers around here who did it. But even back in the day in this general area, it wasn't used much. Of course, you go east, you know, kind of in the Manhattan area, the Flint Hills, the Osage, you know, that was an every year occurrence. Well, around here, it was kind of a dirty word, but that that mindset has changed, you know, 100% there's still people that will never burn, just like there's people that will

never let cattle graze their wheat and just some old school thing, or not some old school but just some. You know, my granddad never did it. My dad didn't do it. This, that the other, but now where we are actively trying to control this invasion of trees that we have...

Most mixed-grass landowners we interviewed have not been burning for more than a few years. The key informants we interviewed, who have been involved in encouraging the usage of prescribed fire, on average had more deeply held feelings toward their motivation in encouraging pro-fire attitudes in the mixed-grass region. The expert knowledge and encouragement from key informants play a part in promoting fire in the mixed-grass region of Kansas. In contrast to the key informants, most mixed-grass producer participants did not frequently mention ecosystem services as an important priority or reason they used prescribed burning, other than the main benefit of reducing woody encroachment. Matthew, a key informant quoted below, represents a shared perspective among other key informants for how they see prescribed fire as more than a land management tool for producers, but as a restorative tool for ecosystems as well.

...we're really interested in keeping grasslands intact. I mean, in the ideal world, we'd love to restore some property or properties of prairie. And from what I'm understanding is, if we can keep on a burning cycle with our grasslands, we can still kind of weed out some of the non native grasses...we're mixed grass here so we get some blue stems and some of those other more prairie grasses back to a healthy population. But you know, we like to have the milkweeds and other pollination plants growing up in our stuff. So I think one thing I'd really like to get across is that just because you're not, you know, if you're a landowner and you're not running cattle or an ag production on your grass, you might have your dad's farm, you might have inherited your dad's farm grassland or whatever. You still have an obligation to care for it, even if you're not, don't have, you know, an

output goal for it. But it's still just important to keep grass on and keep the trees out of it and stuff. So I think one of the biggest takeaways that I'd like to get out of it or whatever is just to know that people other than cattle producers have an interest in managing their grasslands.

Perceived community perceptions have an influence on some mixed-grass burner participants' ability to practically use fire. These perceptions are highly variable based on the county and the perceptions of fire held by the producers and residents therein. David, a key informant, describes below how local leaders such as county commissioners can heavily influence the extent to which prescribed fire can be used in the counties they manage.

Some, communities or county commissioners are very restrictive on letting people burn.

Some county commissioners are very flexible, where there's prescribed burn associations.

They've proven themselves that they can burn in a safe manner and burn without it getting out of control. Those commissioners like to see that prescribed burned associations is a burning compared to individuals that have never done it before. So yeah, there's pros and cons. Some commissioners are very for it, and some are very against it.

PBAs have been a key resource for mixed-grass participants interested in conducting prescribed burns on their lands. PBAs provide burners with the people, training, and resources necessary to conduct a fire in a safe and efficient manner (Weir et al., 2016). PBAs allow burners to work together with their mutual goals to counter woody encroachment with prescribed fire being the most practical and effective tool at their disposal. Despite the spread of PBAs in the mixed-grass region of Kansas, there are some longtime burners who choose to not become members. Matthew, quoted below, described why some long-time burners may not be interested in participating in PBA activities.

I know that we have members who have burned there and you know for their entire lives been burning their own pastures or own fields. And I know that they're some of the land managers in the area who are really supportive of a Burn Association forming, ended up not joining it. Not because they're not interested in it, but they already have their own system and their own manpower their own stuff to do it. They just wanted other people to manage their lands with fire so I think people have been using it for a long time, and by longtime you know, a generation a couple generations.

Throughout the interviews, participants compared themselves and the mixed-grass region to the tallgrass region and its producers. Mix-grass region participants indicated an influence and spread of information from the continuous, pro-prescribed fire culture of the tallgrass region to their region to the west. Liam, quoted below, describes the different ways people treat each other between each region based on their experiences of going to college at Kansas State University in the tallgrass region, particularly in the Flint Hills.

...you know, we don't have a lot of neighbors that also burn. So, you know, whereas when I was in college and we would be in the Flint Hills, you know, we would light a fire, and when it got to the neighbors, the neighbors just let it go across them. Or, you know, there was communication there, and the culture was different. So the outlook here [in the mixed-grass region], you know, is you're kind of on your own, and so you have to be pretty conscientious about your neighbors. Because some, some neighbors aren't interested in the concept, a lot of them are concerned about the liability. So, you just team up with friends and neighbors that that are like minded and see the benefit of it and generally work with those individuals and partner with them.

Ryan, a key informant, quoted below, describes the importance of burning and the benefits it has had toward the burners in his region. He also makes a comparison to the tallgrass

with how regions that receive less rainfall, such as the mixed-grass region, have a risk of losing acquired knowledge for how to burn due to longer burning intervals required to combat invasive encroachment.

Most of them are huge proponents of burning and are very sure that they couldn't stay in business without it and have no and very much proselytize to their neighbors to do is just an ongoing way of life and no one knows who's got a better fire culture than maybe the Red Hills does. And the Smoky Hills where I'm living now in Salina. The fire culture is pretty slim. But then when you get out farther west where Yeah, it's short grass, and yeah, it doesn't need to be burned every three years or even every five years. But if you don't burn it every so often everybody forgets how or dies. Yeah, and then it's it can't happen. And what does happen is wildfires, and then everybody's here, and nobody wants to do it, or let you do it either.

Pro-burning mixed grass participants have a distinct goal in mind in their pragmatic usage of fire. Invasive species encroachment, primarily that of woody species, has become a major issue in the maintenance of pastureland to maintain productivity, but for some as well, to mitigate the risk of wildfire. Kevin, quoted below, details how he has seen woody encroachment occur on the land he grew up on while his family applied prescribed burning to a lesser degree than currently.

Well, boy, even when I was a kid, we did some, it wasn't as big a deal back then, because we didn't have we just really didn't have the encroachment we've got from the eastern cedar trees and, and the hedge is huge, you know, like my dad, my uncle, they never, didn't even know what a musk thistle was until, I don't know 70s or 80s. And now everybody around here knows what they are, and everybody has them and has to stay on top of spraying for them, and didn't have trees. I know of two places that when I was a

kid, we used to drive through, and now you can't ride a horse through there. And the trees have really, really progressed in my lifetime. And I'm sure you know, and there's a lot of the guys that are in their 70s right now, there's a lot in agriculture that has changed in their lifetime. But the grassland management just has become tougher and tougher. We've got more and more invasive species of different things all the time that are coming from every direction, it seems like.

Some of the older mixed-grass participants, like Kevin, have noticed their landscape changing over the course of decades. Some of the participants recognize the need for cost-effective invasive species mitigation as a necessary part of the modern producer practice and maintenance of their land. Nicholas, a key informant quoted below, said:

There's nothing as far as edible forage underneath the growing cedar tree. The cost of removing those cedar trees can get into the hundreds of even 1000s of dollars per acre, which is almost like trying to buy the land over again. Also, the effect on the hydrology is pretty significant. There's some research that says that cedar trees use 35 gallons of water a day if they have access to it. So just the effect on available water for cities, for example, could be impacted if we continue to let the grasslands be occupied by woody vegetation.

When asked whether substitutes would be as effective as prescribed fire, both in its benefits and cost, responses were mixed. Evelyn, a key informant quoted below, described alternatives for when applying fire is not possible, however they are not seen as an adequate substitute that seems to be a motive over applying prescribed fire.

I know NRCS is kind of always looking for a Plan B, you know if they don't get the weather and our producers aren't able to burn according to the contract terms. In my opinion, no. We do I say we, the some practices that have been done are you know, either haying the grass to try to remove that duff layer, maybe disking to kind of stir up that

mineral soil and you know, entice a vegetative response that's different than what was there just to diversify a little bit. In my opinion, they don't do it justice, but I do believe it's better than nothing. To at least, you know, try to do something to advocate a change of routine on that vegetation.

When asked about the consequences of losing the ability to burn, Christopher, quoted below described areas in the mixed-grass areas that have already been heavily encroached on by invasive woody species.

If we lost fire long term, we would lose the grassland, that's over a period of a human lifetime. Of 60, 70, 80 years, but there's enough pieces of grassland that are not being cared for today, you know, the people that like to hunt will buy a piece of grassland and let the woody species invade it. Sometimes, all you have to do is look across the fence to see what 20 or 30 years of no fire and no mechanical removal of trees and no chemical control you know what this country would look like...

When asked about motivations to burn, a few producers, such as Kevin, quoted below, have a long-term mindset for how fire plays an important role for the future of his operation to be sustainably passed down to the next generation and continue to be a productive operation.

Well, I guess as far the biggest one is sustainability. And, you know, make sure that the land, the soil, is in as good a health as we can keep it for the next generation. I'd say that's the biggest one. And also maximize efficiency of use. I guess those are the two these things.

Evelyn, a key informant, quoted below describes how consideration for applying prescribed fire as part of a producer toolset can be promoted through seeing the direct benefits from fire being applied by burners. "Seeing is believing" may be a motive for non-burners to consider using prescribed fire themselves. Although "seeing is believing" isn't an end all way for

people to recognize issues, it can help to allow participants to explore more about conservation challenges if educational opportunities are provided to them to further their understanding on issues such as fire (Houser et al., 2017). “I think overall, most people once they see it done well really see the benefits as well and they can eventually starting start to kind of reconsider their opinion on it.”

Although not generally seen as a motivation or a strong relationship, some producers mention a potential increase in wildlife, especially birds as a result of prescribed burning.

Sophia, a key informant, quoted below, describes the need for more research to be conducted outside the tallgrass regarding applying fire as a tool for woody encroachment control, control of other invasive species, and preservation of the prairie. Research in the mixed-grass region has been lacking (Vermeire & Russell, 2018).

...in Kansas are working towards doing more to fight the woody encroachment problem. But I feel like everything is focused towards the Flint Hills and on timing of things and prioritizing helping people get assistance to do things like that. But I think we need to respect the timing and the will the land needs in the different areas of Kansas, not just the Flint Hills. Because I know that I have gone out to western Kansas. And yes, they've got some fruit. They've got some. They've got some issues when it comes to woody encroachment but it's not near the caliber of eastern Kansas. And they've got other areas where they need to burn, but it's not because of trees. And I think that everything in Kansas right now is kind of focused towards getting the wood encroachment down but I feel like the different areas, different regions of Kansas really need to be respected more than what things are right now. Things are more generalized because of all the research that is out of the Flint Hills, which is amazing. It's wonderful to have the Flint Hills, I

adore the Flint Hills, but we need more research like what you're doing to be more inclusive of the other areas Kansas.

Most participants in the mixed-grass region are newer to prescribed burning compared to those in the tallgrass region. Over a relatively short amount of time, participants have quickly become competent in their use of prescribed fire. This quick learning appears to be largely reactionary to the increased danger and frequency of wildfire as woody species encroachment has become more widespread and disruptive to their ecosystems and agricultural practice. Most participants in the mixed-grass region believe that prescribed burning is the most effective tool at removing invasive species, going so far as to believing their operation would not exist without it.

Mixed-Grass Theme 2: Diligent Assessment of Risks

The risks of harming a burner's own property and neighboring properties comes with personal, social, and economic consequences. Participants in the mixed-grass region described how prescribed burning requires a firm assessment of factors such as weather conditions, the potential for a runaway fire and how to stop it, and how to mitigate risk with the right technology, equipment and enough personnel to ensure a prescribed burn is done safely. How risk is assessed by a burner can affect how their neighbors and community view fire. How they assess and plan for risk is important to developing and maintaining good relationships in order for burners to continue their practice in the mixed-grass region.

Interview responses indicated the most prevalent measure of risk in deciding whether or not to burn is based on seasonal and yearly weather conditions and the expected outcomes around those conditions. Many participants talked about how weather conditions are often the first consideration for a burner before making any other plans as timing a burn in the middle of a long drought could be detrimental to their operation and land as a whole. Drought risks include not only fire getting away from them; burner participants expressed concern about drought post-

fire preventing the grass growth needed to feed cattle. James, quoted below, covers the importance of considering future seasonal weather outcomes.

Well, last year we were scheduled to burn, but the drought would not allow us to do that. Of course, you got to make dang sure that you know that. Of course, we don't have crystal balls. We don't know if it's going to rain, but we want to set ourselves up. So okay, if they're forecasting prolonged drought, no rain, as they were last year. Well, we didn't burn and, it was a good thing, because we ended up not having any rain, and we usually have plenty of old grass in our pasture, so it's not like we don't have anything to go to out there, plus that old big grass is a pretty good mulch. When you do get any moisture, it'll help hold it. Plus you do have, okay, that cows down there, she's digging around, rooting around some green grass. She also gets a mouthful or two of old grass, so she is at least consuming something and we're still the old school of thought. Use half, leave half.

A large barrier to potential new burners from Sophia's experience, a key informant quoted below, has to do with less rainfall available in the mixed-grass region. Compared to the tallgrass, this presents an additional challenge to people who may consider using prescribed burning as a management practice for them.

... like last year, we had a pretty big drought up here and I don't think that any I mean, there was probably a couple burns but hardly anybody burns up here. And so people are kind of in the mindset. Anytime that I talk about a prescribed fire, burning, the people I think most of the time they're first. If they're open to it, their first thing that they say to me is, well I would burn if it would rain. Mostly drought, drought's on the forefront of their mind because we don't get as much rain here as the Flint Hills do. It, I cannot

remember for this region what our average is but I know that if we get single inch of rain, in oh, in a few days of rain, we're happy.

Evelyn, a key informant, quoted below, describes how from their experience, the biggest fear burners have is liability. Liability is an important component to producing a burn plan so everything surrounding the burner's property and beyond is accounted for.

...like if I burned my grass now is it going to come back in time for me to put my cattle out, you know that's like forcing on their liability is definitely close second if not number one. I always ask people kind of what's your, What are you most afraid of when we're writing a plan just so I can write that into plan if it's a neighbor's property or a highway or you know a hospital, you know whatever's around them. I always ask them you know, what's your biggest fear here? What are you most worried about something going sideways? And then we plan around that. Unfortunately, I can't predict the weather for them. So a lot of people wait, you know, either they go ahead and burn early hoping for the rain or they try to wait until it gets the moisture and then then light something off. Or they don't burn at all for a year or two or three. You know, again, waiting for that good soil moisture where they're comfortable and they're going to have some good regrowth.

Mixed-grass participant burners expressed respect for danger toward fire. Christopher, quoted below, shared some insight from a firefighter he knew about the dynamics of fire that are hard to measure, and should be approached with caution and respect.

Fire is interesting animal in itself, and that I've been involved in a number of prescribed burns, we actually had a neighbor that was a professional firefighter, he'd be in on the big forest type fires, his knowledge of how fire creates its own activity. Until you've seen a fire be changed dramatically by wind direction and wind speed and even the humidity, you've gotta be very respectful of a grassland fire, you know I've yet to experience any

type of human injury, but um, you know, you can burn some equipment up, you have a vehicle or a motorized piece of equipment that fails, fire gets out of control. Yeah there's risk involved, there's always concern, and it's always a lot of relief when the fire is over.

Participant burners expressed a sense of fear when leading a prescribed burn on their property. There is a common fear among mixed-grass participants for a fire to get away or out of control following the mop-up phase overnight. Another common consideration for risk was that toward the burners' neighbors. The participants' concern for reactions from neighbors varied drastically from those who were open to burning.

Participants' perception of pushback and public response to burning appeared to vary annually depending on weather conditions and if there have been substantial wildfires occurring in the region. Andrew, quoted below, describes their view on how non-burners and the general public perceives fire.

...I think that especially non local people they've become so concerned about the environment that they think it's just a terrible thing to see all that smoke. You know, local people, I think they're more concerned about their property and this and that. And yeah, you know, so I think I think you know, most years the local people don't really have much to say I think this year was a little bit different with that wildfire going through.

Johnathan, a key informant described in contrast to most mixed-grass burners how drought periods or other unfavorable conditions may be used as an unintended excuse to avoid burning.

...it seems like drought, drought is an easy out. So if there's any talk of a drought, or we've been in a drought, the general it's generally used as an excuse that's generally referred to as an excuse not to burn I would say, besides that, you know, I'd say I don't know that I've ever heard a landowner say, oh, it's wetter or maybe I have, I guess, but

rarely do I hear comments on you know, how much more moisture we've had and why that would be a reason to burn. It's more that drought is kind of used, it's kind of used as that scapegoat as an excuse to put it off another year. And again, I'd say that's one of those things like, is the drought really the reason you know that someone's hesitant to burn? I don't know. It, but it's a good excuse not to.

In addition to this, Sophia, a key informant, quoted below, described a similar mindset that mixed-grass burners are highly selective for when they burn for a variety of reasons. Even with a burn plan, some burners seem to have an apprehension to burning unless weather conditions are near perfect.

They've had a burn plan for the last five or 10 years that they weren't able to do. Well. Now we finally got a day and [this person's] brothers are able to help me out so we're gonna get it burnt today. That's one nice spring day. No other times. Also a thing with some people is they only want to burn in the spring. That is the only time that they think that they can burn. And so that is I want to say, a mental barrier to getting fire on the ground.

Burners have to consider many social, ecological, and economic factors before deciding on whether to conduct a prescribed burn. Most burners tend to consider how their neighbors think or will respond to seeing or being smoked out by a prescribed fire. Mixed-grass burners will often coordinate and accommodate their neighbors' concerns, so they do not cause direct harm to their neighbor and not tarnish their reputation as well. Weather is a major factor when participants begin considering when their burns might take place. Burners also consider whether based on the conditions of their land, how encroached it is, how much rainfall that they have had or will receive, and wind conditions will drive their fire and its intensity. Finally, the profitability of their fire is important to consider, especially when it comes to grazing land as the economic

benefit of burning is not as clear according to mixed-grass burners as it is compared to burning in the tallgrass region.

Mixed-Grass Theme 3: Intensive Risk Mitigation

The most effective method for participant burners to minimize risk in the mixed-grass region is through having more than enough people and equipment on hand for when the need to burn arises. Participants shared detailed descriptions of their meticulous risk-mitigation strategies. Christopher, quoted below, describes a mindset to come with as much as you can and always expect to have less help and working equipment than you think you may have before a burn.

At some point you're gonna have less help than you will deem desirable and some piece of equipment will develop a mechanical problem. So, we always try to start with more than what we need and the most favorable environmental conditions we can identify.

Several mixed-grass participants shared how important a burn management plan is to having an effective and safe burn. Burners who are part of PBAs are required to have burn plans in place (Weir et al., 2015). Matthew, a key informant, quoted below, describes the meticulous depth and preparation taken to ensure a prescribed burn goes off without a hitch and ensure safety for the burn crew.

There are several maps overviews of the area we review the burn plan. On the map we review any obstacles, we review where the extra water tanks are going to be setting in case you have to refill any escapes for the field; if there's gates that can be opened or will be accessible. Many draws, anything that might traveling person, everybody knows all that stuff before anything, before any match is lit anywhere. The burn plan also describes how two different crews will start in the same location and kind of work opposite to burn the edges. And then we have we have radios so we can communicate back and forth. So

if somebody is a little bit behind whoever's further ahead can kind of slow down and let everybody catch up. So that way, when you meet up to light the head fire, you make sure that everybody's out of the way everybody knows what's going on. And then the head fire gets lit, burns across the grass. And then after that, we just monitor the perimeter until we're certain that all the fire on the perimeter out. You might have some smoldering trees and logs on the interior but once you have all that black and char on the ground, those aren't gonna be as big issues and that's you know, part of the reason I mentioned earlier making sure your trees and brush on the on the edges are hauled in and deeper into the field.

Johnathan, a key informant, quoted below, describes how burn plans in the region are a relatively new procedure, describing how within the past couple decades, there weren't thorough and written out plans being used like there are today.

I think a lot of the agricultural community in my area does. And I think that's the reason is because, historically, and when I say historically, I'm talking within last, say our lifetimes, you know, 10-20 years or so. Generally speaking, burn plans haven't you know, most prescribed burns haven't followed very thorough plans.

As described above, for many burners, they are limited in burning due to a lack of equipment and manpower. Matthew, a key informant quoted below, describes how the PBA he is a part of has largely overcome these limitations as well as the burden of the regulatory framework they have to work within.

I think locally within my group, within my PBA, I think we've overcome the equipment and manpower issues. I think we're able to work with the regulatory framework. Even though I don't like it in some cases, we're able to work within it.

Liam, quoted below, provides a practical example for the many considerations experienced burners consider when applying prescribed burning in the mixed-grass region, as well as always being prepared for situations to come up that planning cannot account for.

...it's a fine line between needing it not to blow, and needing it to blow the right direction and needing to blow, you know, the wind speed to be the right direction, at the right wind speed. Sometimes we need it to carry sometimes you need some humidity in order to develop things not as tender. When you're doing the back burn, you know, the less tender it is, the easier it is to flare up outside your back burn. So we regulate with a good plan. Most of the people that assist me, or I assist with them, have experience in what we're doing. They know what the objective is. They understand the concept of where we're going with burn, which direction it's going to go, the caveats of areas to watch in whatever parcels of grazing land we're in and, and then the execution side of it is, is just a follow up, we go back. Somebody's always patrolling the perimeter of the fire to ensure that something from the back burn didn't flare up through a cow pie or a wind devil or something of that nature. So just self discipline enough to know that you've got to constantly keep an eye on every foot that you've burned around the perimeter of something that you're not burning consistently.

After assessing the potential risks and benefits of a prescribed fire, burners within PBAs will have burn plans in place to aid them in conducting a safe burn. Burners will plan out their burns depending on the conditions of their land, how many acres they are going to burn, and the amount of equipment necessary and available to conduct a burn safely. Finally, having more than enough assistance on the day of the planned burn is essential. It's not discouraged to cancel a burn at the last minute if conditions aren't ideal for a burn. Burning comes with many associated fears, adding to the additional levels of caution taken by burners.

Mixed-grass Theory Model

Below is an initial draft of a proposed model in order to better understand the motivations and challenges faced by burners in the mixed-grass region. More research is necessary to expand and further develop this proposed model as more qualitative studies are conducted in the region. With the long-term suppression of fire in the mixed-grass region, the danger of wildfire in the mixed-grass has increased, with more regular wildfire outbreaks occurring in recent years. According to participant interviews, with the increased number of wildfires, some residents have become more afraid of fire overall, making it difficult for solutions such as prescribed burning to takeoff. As a result of the wildfires, some residents, such as the participants interviewed recognized the need to use and learn how prescribed fire can be applied to mitigate risk of wildfire and help with their operation. The demand for prescribed fire as a solution led to the establishment of PBAs in some counties within the mixed-grass region. With the help of PBAs providing training, equipment, and the necessary amount of people to effectively apply a burn, burners with these tools feel less aversion to prescribed fire while being diligent in their assessment of fire risk.

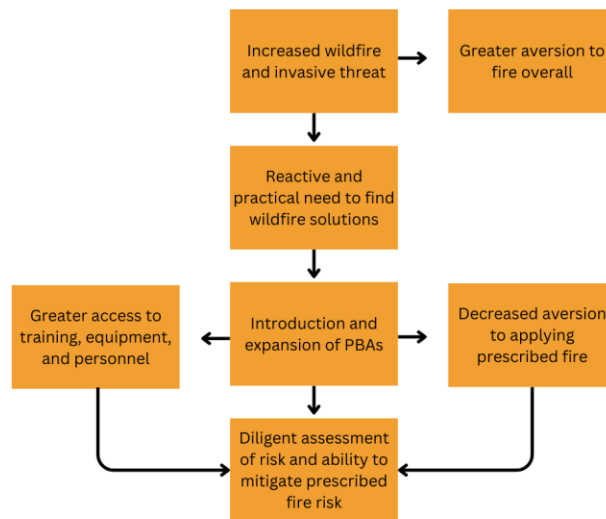


Figure 3.2 Mixed-grass Theory Model

RO3: Describe the similarities and differences between tallgrass pro-prescribed fire participants’ perceptions of prescribed fire and mixed-grass pro-prescribed fire participants’ perceptions of prescribed fire.

Pro-fire burner study participants in the tallgrass and mixed-grass region share some similarities and some differences when it comes to prescribed burning. Major similarities between both groups are in the affordability of fire as a land management tool compared to other management methods, and the need to control invasive species using prescribed burning. The two groups diverge when it comes to historical use of fire and pro-fire resources: the tallgrass group has the benefit of generational knowledge to guide their burning practice along with neighbor support and other forms of support, and comparatively, the mixed-grass group has less generational wisdom and experience of the oldest person on the team; has need for more support

and resources due to higher risk mitigation needs; and has less ongoing prescribed fire research compared to the tallgrass.

Similarities Between Tallgrass and Mixed-Grass Participant Responses

In examining the similar themes and responses from the tallgrass participants and the mixed-grass participants, two major themes were constant across the two groups: the economic benefit or affordability of prescribed fire as a tool, and the motivation to control invasive species with fire.

Similarity: Affordability of Prescribed Fire

One major constant between the tallgrass and mixed-grass participant responses is the recognition of the affordability of applying prescribed fire. Both pro-fire groups insisted that alternative land management tools, such as chemical or mechanical tool, in controlling invasive species were neither as effective or affordable compared to prescribed fire, though chemical and mechanical tools are also used as needed. Depending on the scale, prescribed burning can be conducted with minimal equipment and personnel. With prescribed fire, there is also cost savings by prescribed burn associations sharing equipment with PBA members, or tallgrass burners pooling equipment from their neighbors and other locals.

Both participating groups described prescribed fire as an important tool from a practical point of view. Comparisons between both groups share the view of how cost as well as effectiveness are considered in their decision-making process. Anthony from the tallgrass, quoted below, shares how substitutes are not practical in the tallgrass.

I don't know what you could substitute for prescribed fire that would serve the same purposes that we have been describing and you cannot, economically there is no way you can afford to go out and mow and most of this country, the Flint Hills you couldn't mow it anyhow, cutting trees down, of course you can go cut trees down, you can go and cut

cedars and you can do, I guess you could even mow down even the grass but not economic, the only way to do it, it seems to me is with fire.

Christopher, from the mixed-grass region, although more open to the potential use for substitutes, still views fire as both the most economic and successful method in his region compared to cost prohibitive practices such as chemical application and mechanical removal.

...chemical control on some of these invasive plants is an option, but it's, the cost of that is 5-10 times higher per acre. Even if you have to hire a contractor to go off your prescribed burn, you're probably going to have 5-10 dollars an acre or more. And if you used a chemical product to kind of control some of those, if you take the case of old world bluestem, an undesirable invasive grass, there are chemicals out there that you can apply that's gonna cost you, 30-40 dollars an acre if you have it professionally applied. And it's gonna almost sterilize the soil for two or three years. The fire is much more economical way to help keep grasslands, grasslands, you know you can mechanically go out and cut out the cedar trees or hedge trees or some of the other invasive larger woody plant species, but again there are costs involved, so fire is for the most part, the most economical way to keep our native grasses, truly in a grassland

Another way both regions are able to lower the overhead cost of burning is through the sharing of equipment between friends and neighbors and people present to make a safe and productive burn happen. The tallgrass has had generations for neighbors to adapt and acquire advanced equipment, from ATVs to firetrucks to better control a fire. Andrew, from the tallgrass, quoted below shows how the availability of large-scale equipment makes burning both more viable financially and safer.

Now the equipment is changed, four-wheelers are much easier than what we start out with originally, and some people have fire trucks, small fire trucks of their own. And so I'd say probably the equipment has been the major changes to make it easier and safer.

Compared to tallgrass participants describing the availability of equipment from decades of burning, the mixed-grass region doesn't yet have the same level of availability of equipment. According to mixed-grass burners and key informants, some active PBAs, businesses, and agencies have made equipment available to burners in the mixed-grass region, reducing overhead cost and minimizing the barrier for entry to start burning.

Similarity: Removing Invasive Species

Participants in both the tallgrass and mixed-grass groups recognized the need and applicability of prescribed fire when it comes to reducing invasive species encroachment. Although burning intervals are different between both groups, with the tallgrass requiring more regular burning intervals due to higher rain fall compared to the mixed-grass region (Ratajczak et al., 2016). Participants from both groups have seen a reduction in invasive species because of prescribed fire.

Daniel from the tallgrass shared how prescribed burning has impacted their ability to preserve grasslands in removing woody encroachment.

We've seen a lot of impacts to the ecology on native range by using fire. Our hope and the ideal impact is that we return it or maintain it as a native tallgrass prairie without a lot of trees, without a lot of brush, encroachment and things like that. And we've seen that.

Linda and Kent from the Flint Hills similarly shared how prescribed burning removed invasive species from their land, but also improved the quality of their ground to where they saw wildlife improvement.

Well, the fire has been tremendous in terms of bringing this pasture back to productivity.

We've gotten rid of a lot of the undesirable plants that were out there. We now have groundcover on virtually 100% of our land when we bought the place we had big patches of just bare ground and that's all disappeared. The wildlife has improved tremendously.

In the mixed grass region, the responses in regard to the positive effects are present but not as dramatic as the tallgrass, this may be because of the more recent reemergence of prescribed fire in the region. Benjamin, from the mixed-grass region, describes how prescribed burning has helped them remove invasive woody species and promote the regrowth of grass on his property.

Well, I have seen that the grass is inhibited from growing and it has a tendency if it's if it's not managed to go into more brushy types of plants like Buck brush sumac plum bushes. And so in order to maintain the grass and make it as productive as possible, we need to burn.

Kevin, from the tallgrass, shared how important removing invasive species has been, but also how encroachment has severely worsened over the past few decades and how it has changed how agricultural managers operate with changing environmental conditions.

...they didn't even know what a musk thistle was until, I don't know 70s or 80s. And you know now everybody around here knows what they are, and everybody has them and has to stay on top of spraying for them, and didn't have trees. I know of two places that when I was a kid, we used to drive through, and now you can't ride a horse through there. And just, the trees have really, really progressed in my lifetime. And I'm sure you know, and there's a lot of the guys that are in their 70s right now, there's a lot in agriculture that has changed in their lifetime. But the grassland management just has become tougher and

tougher. We've got more and more invasive species of different things all the time that are coming from every direction, it seems like.

David, a key informant in the mixed-grass region described how removing invasive species using prescribed fire has led to noticeable improvements to burned areas.

I really seen it on vegetation that we will see elimination of the cedar trees, you're seeing a lot more grass composition, and a more unique or the grass come into the areas where the cedar trees were are seeing more cedar trees are eliminated. We're seeing more grass into where the cedar tree was and water into our springs. And creeks or draws.

It's generally viewed by both mixed-grass and tallgrass participants that one of the most noticeable benefits to prescribed fire comes from its ability to reduce or slow invasive species encroachment. This is an example for how one of the most noticeable changes to applying prescribed fire is the visual change of the landscape over time from burning. Although both groups saw benefits to burning, the degree of change was not as obvious or consistent for mixed-grass participants as it was for the tallgrass participants.

Differences Between Tallgrass and Mixed-Grass Participant Responses

Although there were some major similarities between tallgrass and mixed-grass participant perceptions and applications toward using prescribed fire, we noticed more differences between the two groups. There were three main differences between the tallgrass participant responses and the mixed-grass participant responses: perceptions of risk, knowledge acquirement, and availability for support.

Difference: Perceptions of Risk

Both the tallgrass and mixed-grass regions take risk seriously. However, due to prescribed fire reemerging in the mixed-grass region, more precautions are taken and their usage of fire is more reactionary, whereas in the tallgrass, burning is more proactive given their long-

term practice of applying prescribed fire. Responses from tallgrass participants illustrated a confidence or self-efficacy in burning, where they knew that using their own knowledge and the support of their neighbors or others, they could control the fire, even if mistakes happen.

Tallgrass participants extant for risk also extends to those within immediate vicinity of the fire, including personnel assisting with the burns, to neighbors, as well as considering whether the smoke from their fires will reach highly populated areas. Mixed-grass participants differ from tallgrass participants where they are farther away from larger cities so there was no discussion over smoke being a concern to populated areas. Mixed-grass participants also differ from tallgrass participants due to drought conditions making it more difficult to safely conduct a burn. Julian from the tallgrass described how there is less sense of danger because neighbors are equipped and always ready to go “...it's important to be ready for your neighbors too because if a neighbor calls you suddenly and needs help, you need to have your equipment ready to go.” Arthur from the tallgrass showed how even if a fire gets away, because many of their neighbors burn and know how to deal with or even benefit from unexpected burns, the consequences are not potentially as risky as they are in the mixed-grass region.

Yeah, so the risk that we take into consideration mostly is whether we can control the fire or not because we certainly don't want it to get away, we have had fires that we have not been able to control. Fortunately, most of our neighbors are going to burn as well. So it's not a huge problem here if something does get away. But we really like to control the fire ourselves and not – and just burn the acreage that we want to.

There is some overlap with how risk is perceived and approached between both groups, however, participants in the mixed-grass region are more cautious because they have not burned for generations like the participants in the tallgrass region. Mixed-grass participants also have more extreme and longer lasting drought conditions. For participant burners in the tallgrass

mistakes or flare ups of intense wind are inevitable and generally accepted due to the cultural acceptance in the region. Scott from the tallgrass shared this perspective of fires eventually getting away.

There is always some fires to get away and it's usually just not because of a lack of preparation and it's just lot of is just bad luck, it just happens once in a while. But most of our ranchers are very, very aware of the problems that can be created if you don't do it the right way.

Despite concerns from some burners, most tallgrass participants described burning as not being particularly risky due to their experience, planning, and repeated successful outcome on burns. Andrew from the tallgrass shared this.

Prescribed burning generally I wouldn't call it risky as long as you have some idea of a plan. You need to plan before you start and dealing with wind speed and direction and help you have to put it out if you do have a problem. But as long as you have a good plan, no, it's not real risky.

For residents of the mixed-grass region, the challenges of drought are stressed more frequently since in the mixed-grass region, drought is a major limiting factor and adds an additional layer for if conditions are favorable for a safe burn or not, but also whether their ground would benefit from a burn if there is no rain to promote vegetation regrowth. This difference illustrates that there is risk to the profitability of mixed-grass operations due to the chance for zero or low regrowth of grass after a burn, which would limit cattle weight gain. In contrast, the tallgrass participants see fire as an economic tool to increase rates of cattle weight gain after a fire. Christopher, from the mixed-grass region shared concerns about grass regrowth.

Well there's been a few years that we, because of the drought situation, and annual rainfall being insufficient, we've chosen not to do a prescribed burn because of one concern of future rainfall, and potential to nourish the growth of the grass, and then, sometimes occasionally we see grassland that there isn't enough fuel there...

Burning is often not as well received by neighbors and others in the mixed-grass region as it is in the tallgrass. Kevin, from the mixed-grass region, describes the challenges and enhanced risk faced with neighbors who want nothing to do with prescribed burning.

They don't like smoke blowing towards their house and smelling it inside. It is not as well received around here, and we do have some neighbors that border us that refuse to even help keep it off of them a lot of time, you know we, a few years ago, neighbors burned us pasture next to us, and we didn't want to burn ours that year, we at least went and helped protect our side. And actually we ended up helping them burn the whole thing, just so, I mean, we try to be neighborly and get along with our neighbors, but we've got some around here that they won't even, they want nothing to do with it, and they'll come up there and tell you to not let it burn them. But they won't. They won't lift the finger to help you keep from burning them out either.

David, a key informant from the mixed-grass region, described how risk for burning can only be minimized, but not entirely removed no matter the experience and preparation.

The only time a burn is under control is when it's out. So there's always a risk. No matter what. You can plan for the best you can have all the people and equipment and wind in the right direction. Something can always go wrong. We plan for following a plan based off of humidity wind direction and the next day forecasts so we plan, our plan is based off of that.

Thomas, from the mixed-grass region, provided some insight as to how stressful the burning process can be. This shows how despite the risks and fear, it is still favorable over alternatives or not maintaining the land at all.

It's not that much fun. It's fun to go help somebody else. It's not that much fun when it's your responsibility. I don't sleep for a couple of nights before or a couple of nights after, you want to make sure that you have something not something that you fail to double check. I mean, the last thing anyone wants to do is call the fire department.

Liam, from the mixed-grass region, provided a comparison that contrasts how it is easier for burners in the tallgrass to burn in cooperation with their neighbors, versus in the mixed-grass region where there's less of an acceptance and understanding for prescribed fire.

We don't have a lot of neighbors that also burn. So, you know, whereas when I was in college and we would be in the Flint Hills, you know, we would light a fire, and when it got to the neighbors, the neighbors just let it go across them. Or there was communication there, and the culture was different. So the outlook here is you're kind of on your own, and so you have to be pretty conscientious about your neighbors. Because some neighbors aren't interested in the concept, a lot of them are concerned about the liability. So you just team up with friends and neighbors that that are like minded and see the benefit of it and generally work with those individuals and partner with them.

Producers such as James, from the mixed-grass region shared how not having enough people to help enhances the risk for a fire to run away due to it being difficult to manage when conditions change.

...the biggest one is getting away from you, and that is my biggest fear of a fire getting away. Now, we haven't had that happen, but I've seen it happen, you know, due to mainly lack of manpower, and that was just people thinking, okay, we can control this. We we

got this. It'll burn slow. Well, we all knows what happened when the wind switches a little bit or kicks up a little bit, and then all of a sudden you cannot control it.

Risk is generally perceived differently between tallgrass and mixed-grass participants. Both groups acknowledge that fire is inherently risky, however, due to various factors, risk is taken with different scales. In the tallgrass region, fire is a part of a long standing tradition that is generally approved of and cooperation is common among neighbors. Working with fellow burners who approve and have many years of experience as well as equipment makes risk less of a concern. Mixed-grass participants do not have the same level of support or generations of experience in the same way that tallgrass participants have. Less rainfall, longer drought, and fewer experienced people to recruit to help with a burn, as well as fewer pro-fire neighbors enhance the sense of risk for mixed-grass participants.

Difference: Knowledge Acquisition

Differences emerged with how most participants in the mixed-grass region learned and started learning how to conduct prescribed burns compared to tallgrass participants. Many participants in the tallgrass learned at a young age, or if they moved to the tallgrass, local burners would introduce newcomers to the practice. Although burners in the tallgrass also learn new techniques from burn schools, most of their knowledge comes from their family, neighbors, and local community. Participants in the mixed-grass region were introduced to prescribed burning on a more formal basis, often from burn schools or other formal training workshops and were not introduced to the practice of prescribed burning as children.

Charles from the tallgrass shared how he learned to burn from generations-worth of knowledge from family and other mentors who have burned for a long time.

I learned to burn used prescribed fire basically from my granddad and my mentors ahead of me. It's been going on for a long time and you learn by experience trial and error and

firsthand experiences. We've been doing this a long time and really feel pretty comfortable with it.

Robert, from the tallgrass similarly learned from their grandfather, as well as from other burners at a time when the technology available today was not yet developed.

I learned to conduct prescribed burning mainly from my grandfather... I'll say he was more or less a pioneer in some of the modern techniques of burning simply because he was around before we had sprayers back in the days of five gallon buckets and gunny sacks. He taught me how to do it. I've watched other people do it, but my primary source of my burning education came from my grandfather.

Andrew, from the tallgrass, like most other participants, was older and the way they learned exemplifies the changes of technology and equipment available today compared to back then: "Originally we started with a five gallon bucket and a burlap sack. So the burns were very small and I kind of evolved into like a lot of people do and then from watching other people."

Although most tallgrass participants grew up in the tallgrass and would learn from their family and neighbors at a young age, some participants who either got into burning later, or moved into the tallgrass from other regions learned to conduct prescribed burning through a mixture of formal education and training offered by K-State extension, workshops, and through their neighbors. Linda and Kent from the tallgrass learned primarily through training opportunities and continue to regularly participate in trainings whenever possible.

Through training, through the extension service and through Konza prairie. Oh, it's how we learned to control burns. Well, we like to attend continuing education classes every time they're offered with new ideas that are going to help us be more efficient and more profitable on our farm. And so that's how we learn about new techniques and equipment.

Nathan from the tallgrass similarly learned how to conduct burns from both his neighbors as well as other organizations such as the Kansas Forest Service and local fire departments.

I was not raised in the Flint Hills but when I moved here number of neighbors worked with us to kind of get the basics in and back then that was before any ATVs or stuff like that... Also, through the Kansas Forest Service that's kind of through our fire department learning how to manage fires and have fire behavior and also through other different livestock organizations.

Alternatively, most participants in the mixed-grass region learned to conduct burns through formal training rather than through family and generations of local knowledge available to them. In addition to this, other participants in the mixed-grass region learned to conduct burns through their time at K-State, working with employees from the tallgrass, or learning to conduct burns on their own with the help of online resources such as Extension information as well as videos. The key informants in the region brought their knowledge of burning from growing up around it or being formally trained in prescribed fire either before or early on when they arrived in the mixed-grass region.

Matthew, a key informant from the mixed-grass region, shared how their learning experience was mostly independent, with some help from people who were already burning in the region.

Personally I learned on the job. I learned it from the experience of others. You know once I kind of got into it I wouldn't say that I went anywhere for a resource to read I probably read a K-State a publication, I might've watched YouTube videos, but primarily my experience came from learning from more experienced people. So on the job on the job experiences where mine came from.

Christopher from the mixed-grass region shared how Extension and learning on the job helped him become proficient with burning.

K-State Extension has meetings, extension meetings where they talk about the value of prescribed burns and how to properly conduct one. Those are worth everybody's time to attend those, I found those very worthwhile. Been talking to other neighbors, helping other people conduct their burns, you know you can learn by observation, and by question answer, those who have more experience than you do.

Andrew, from the mixed-grass region learned how to conduct burning through the help of an employee they had, which shows some overlapping knowledge being carried over from people with experience from being from or working in the tallgrass taking their knowledge to other areas: "I had an employee that grew up in the Flint Hills and so that's I kind of learned from him and he kind of got us started."

Alexander from the mixed-grass region was relatively new to producing and in a short time learned and successfully applied prescribed burning to his family's land that had been mismanaged for decades and has since used his knowledge as a side business to use fire as a management tool for other producers with mismanaged land.

We had no equipment and no technology. Dad's 40 or 50 years of common knowledge [about ranching] is all I had and so I started getting into this pasture management thing and really didn't have a clue about what I was doing. But the first year I spent out here I knew I was spinning my wheels and I started actually getting involved with the NRCS, K-State. taking some classes, reading, reading more and trying to get up to speed to know what it really took to take care of the prairies out here. And we built some equipment and bought some equipment and I actually bought a half section of grass or pasture that would that had been mismanaged all of his life. And in my spare time I started working

on it. It was located along a highway, and there's a tremendous amount of traffic that went by and it seemed like I got a lot of attention. I took a pasture that was almost ungrazable and in three years turned it into one of the cleaner better pastures around and because of that got a lot of interest in people like "What we see what you're doing. Can you help us?" Well, this is turned into a full scale pasture management business now.

The Conservation Reserve Program (CRP) was mentioned a few times throughout the interviews in the mixed-grass region. CRP was not mentioned among tallgrass participants, however, CRP has helped incentivize participants in the mixed-grass region to burn. Programs such as GPGI (Great Plains Grassland Initiative) influenced Benjamin from the mixed-grass region to burn. The program's requirement to burn his land helped Benjamin to learn about prescribed burning and become a proponent for the benefits of burning in the region.

We got some financial incentive from the Agriculture Department, USDA and such part of the GPGI program is to do the things that like I explained in that last question, that whole list of things, but in order to fulfill the contract a burn must happen. So that kind of forced my hand a little bit in order to figure out how am I going to burn and then I had learned there just got a meeting about organizing the Smoky Hills Prescribed Burn Association, and I went and I listened. And then they asked for volunteers to be on the board of directors, and I volunteered. And the thing about that is that I have learned so much about burning and the effects and the value of all this and I'm really glad that I made those decisions.

Tallgrass and mixed-grass participants learn about and receive information about prescribed burning in different ways. A number of tallgrass participants learned to conduct burns from a young age from family and friends with generation of knowledge. Burners who later move to the tallgrass region of Kansas learn from their neighbors or from fire education and

workshops provided by K-State or other organizations. The mixed-grass region by comparison does not have as many long-time burners or people raised learning to conduct burns, however, through PBAs and workshops in the region, they can quickly pickup practical knowledge and training to conduct a burn. Despite prescribed burning to be a relatively new practice for some mixed-grass participants, their responses throughout the interviews showed a high priority for being knowledgeable on how to safely and effectively conduct burns.

Difference: Availability of Support

The tallgrass has had nearly a century of research around prescribed fire as well as resources provided by K-State Extension and other groups. Despite not having PBAs in the tallgrass there are numerous resources and knowledge available to guide and support burner decisions. The same cannot be said for burners in the mixed-grass region. Most PBAs in the mixed-grass region are relatively new and are in different levels of activity or have limited people, leadership or equipment available to them (Cheyney, 2024; Weir et al., 2015). Pro-fire burners and key informants in the mixed-grass region agree that more resources need to be available to sustain emerging burning practices in the mixed-grass region. Some mixed-grass participants also mentioned a need for more research to better inform burners circumstances unique to their environmental conditions compared to the tallgrass.

To illustrate availability of support in the tallgrass, Nathan from the tallgrass provided an example for the amount of support neighbors provide since they work together to effectively burn their lands together.

A lot of our pastures are located in such a manner that we burn with neighbors because there is no road or firebreak to stop that. So some of our fires get to be fairly large. We try to break them up as much as possible just for ease of control and little smoke management.

Linda and Kent, from the tallgrass also shared similar experiences coordinating with neighbors to achieve safe burns:

It's usually as oftentimes a community affair. A number of adjacent ranchers will get together and burn together so that the fire doesn't get away. You have a larger fire crew that way and the other thing is you have a larger area to plan the burn over. Our burns are really very small. Sometimes it is done as a community of ranchers...

In the tallgrass, support is more widely available due to prescribed burning being a long-term practice in the region. Support from family and neighbors provides the bulk of direct support, with Extension and state agencies take a supportive role in providing data and education to prescribed burning in the tallgrass. With fire being more widely accepted, acquiring support is easier in the tallgrass compared to the mixed-grass region. Although most participants from the tallgrass have an easy time receiving help and assisting their neighbors, some burners in the tallgrass such as Will have to work around neighbors who either don't burn or aren't wanting their land burned at a similar time to the other neighbors.

Oh well yeah, well you try to coordinate, you try and coordinate the neighborhood and get your neighbors on board to where, if you have to go backfire or something, you have to backfire and you need neighbors they know what's going on and see what they want to do whether they want to burn or they are going to use backfiring, they want to burn theirs.

There is less overall support in the mixed-grass region, paired with the need for support being greater. Johnathon, a key informant in the mixed-grass region describes how, despite the growing movement toward prescribed burning in recent years, it isn't enough at its current state to reverse the woody encroachment seen in the region.

...we're already kind of seeing that I'd say even though prescribed burning is a tool that's being applied, it's being applied at a pretty small scale, generally, in my area. I'm kind of in a fragmented landscape anyway... Most of my habitat discussions deal with not deal with, you know, the, the issues with advanced natural succession invasive species. That's a tough one for me to answer because I feel like we're already living in that world. I think if if prescribed burning went away, I don't know how much would change would depend on the year we'd probably have to narrow it down to a smaller scale, you know, maybe like to the township scale, you know, multiple sections, you know, because I do have some places where I think burning definitely has an economic and an ecological impact, a significant one.

Alexander from the mixed-grass describes the challenges burners face and the need for support from everyone involved with fire.

Again, we need the fire department. We need the sheriffs. We need their help. We need their cooperation. We need them to understand what the heck we're trying to do out here. We need their help. We need their support. And we, the struggle is real. We have enough people, we have so many things Mother Nature, we're fighting Mother Nature right now. We're going into grass season this year worse this year than last year. Our ponds have no water and we have no, we're fighting so many other things and our tax our tax dollars are paying for these services, help us understand and somehow help us get them the knowledge that so they understand it and they will be a part of the team. That's probably my biggest, biggest struggle or the biggest concern I have.

Sophia, a key informant in the mixed-grass region, describes how they receive a regular number of producers who have an interest in burning, however they lack the adequate resources necessary to implement burning as a practice to their land.

And so when I moved up here I definitely saw the difference of how people look at fire and how people look at fire, how fires used and just everything along that, like how effective fire is up here as well. So I haven't been in every single part of it. But I have tried looking into most parts of it and seeing people's perceptions. So what this was trying to get this PBA established up here. It's I get to see a little bit more and everyday in the office...Every time I turn around, there's somebody coming into the office saying well we need to burn or I wish that we could burn but I don't have the help or somebody else is suggesting that somebody needs to burn on their property. So it's, it's really necessary. It's just not as accessible or as easily done as big it could be.

Tallgrass participants generally have more experienced and willing burners who help each other with prescribed burns. Based on the tallgrass interviews, the participants don't have much difficulty in borrowing equipment or receiving the help they need for a safe burn. Finding enough support in the mixed-grass region is more difficult. PBAs are the main source for personnel and equipment necessary for burners as they don't have as many experienced burners or the years to accumulate enough equipment for large scale burns.

Chapter 5 - Summary and Recommendations

Summary

The risk for wildfire continues to increase around the globe (Jolly et al., 2015). Invasive species encroachment, particularly woody plant species increase the risk for wildfire danger and ecological transitions into more woody ecosystems in the Great Plains of North America (Ratajczak et al., 2022). Regular burning intervals are essential to the continued existence of grassland ecosystems throughout the Great Plains. The purpose of this study was to explore fire culture and the use of fire as a landscape management tool among prescribed fire proponents in two distinctly different ecoregions in Kansas. Our goals were 1) to explore private landowner and key informant perceptions of using prescribed burning and 2) compare perceptions and practices in a continuous pro-fire-culture region to perceptions and practices in an adjacent region where prescribed fire is re-emerging as a land management practice. Data collection spanned two study areas: the tallgrass ecoregion of eastern Kansas, where a culture of prescribed burning is prevalent, and the mixed-grass region of central Kansas where prescribed burning occurs but is less prevalent. The importance of this study is due to the lack of in depth interviews being conducted to describe the similarities and differences between groups with a long term fire culture, and a reemerging fire tradition.

The literature available on fire primarily focuses on wildfire, with few studies focused on applying prescribed fire. There is even less information available when it comes to social science and the perceptions different stakeholders have toward prescribed fire (Hiers et al., 2020). The tallgrass region of Kansas has a largely untouched and continuous tradition of using prescribed fire as far back as when the indigenous peoples of the region practiced prescribed fire (Eriksen & Hankins, 2014). The mixed-grass region of Kansas upon settling in the mid 19th century would

apply some prescribed fire practices that carried on, however it would, unlike the tallgrass, fade from usage early on (Hoy, 1989). In recent years, PBAs emerged in the mixed-grass region in response to the growing challenges faced from woody and other invasive species encroachment. With the lack of information available on stakeholder perceptions in both the tallgrass and mixed-grass regions, my questions aimed to better understand the similarities and differences between both regions.

My research questions and objective were:

1. What are tallgrass pro-prescribed fire ranchers' perceptions toward prescribed burning?
2. What are the mixed-grass pro-prescribed fire ranchers and key informants' perceptions toward prescribed burning?
3. Research objective: Describe the similarities and differences between tallgrass pro-prescribed fire participants' perceptions of prescribed fire and mixed-grass pro-prescribed fire participants' perceptions of prescribed fire.

My first research question regarding perceptions toward burning in the tallgrass region involved analyzing secondary data from 2019 qualitative interviews that had not yet been examined from a social science lens. The tallgrass dataset provided the foundation to ask similar questions to burners in the mixed-grass region, where there is little existing published research on the social science of prescribed fire. Having interview perceptions from both groups provided us with the means to compare the tallgrass, a proactive region where prescribed burning is understood, generally accepted, and has been a tradition for multiple generations, to the mixed-grass region which is experiencing a resurgence of prescribed fire usage as a reactive response to recent wildfire events and invasive species disruptions. The major themes that would emerge from the interviews provided us with the means to take a broad overview in

understanding some of the similarities and differences between burners in the tallgrass and mixed-grass regions of Kansas.

In the tallgrass, the major themes that were shared by most participants were the pragmatic use of prescribed fire, the long-term cultural use of prescribed fire, experiential influences for using prescribed fire, and balancing risk using prescribed fire. For tallgrass participants, the pragmatic motivation to use fire is due to how practical it is to apply on their land over alternatives such as extensive mechanical removal and chemical application. Fire is described by participants as not only being the more inexpensive option, but it is the most effective in reducing invasive species encroachment, having a positive impact on wildlife, and benefits cattle weight gain by increasing rangeland productivity. Second, prescribed fire usage has been a continuous practice for burners in the region for more than a century. Generations of experience from burners and the passing of information to burners at a young age, and to people who move to the region, have helped the practice to remain popular, effective, and meaningful to burners. In addition to this, some burners take pride in their family burning on their lands and preserving the tallgrass prairie either for intrinsic purposes or to eventually pass the land down to future generations of producers. The benefits to applying fire are modulated by the consideration for risk when burning. Producers will plan ahead of time and consider risk to themselves, their property, their neighbors, and consider the direction the smoke will go. Burners will consider these factors to make sure a burn is conducted as safely as possible, while considering factors beyond the immediate site of the burn.

In the mixed-grass region, the major themes that were shared by the majority of participants were the pragmatic motivation without an established fire culture, diligent assessment of risks, and intensive risk mitigation. Burners in the mixed-grass region recognize the benefits of prescribed fire in their region when compared to alternatives in countering

invasive species encroachment. In addition to this, prescribed fire is recognized as being the most cost-effective land management tool compared to mechanical removal and chemical application. Burners in the region are careful in assessing risk when planning a burn, often the first considerations are weather conditions immediately before, during, and after a planned burn day. Risk is also assessed by current conditions of the area being burned, how overgrown it is, and what the drought predictions are. After assessing risk, burners will mitigate risk through having a thorough burn plan, as well as having more than enough personnel and equipment in order to conduct a safe burn.

When comparing the themes and overarching conversations, similarities and differences emerged between both groups. First, the similarities are in the recognition for the affordability and effectiveness of prescribed fire as a tool. Both groups see the benefits and prioritize prescribed fire as a cost- effective way to manage the land, especially with a goal of removing invasive species. The differences between the tallgrass participants and the mixed-grass participants related to burner risk perceptions. Though most participants in the tallgrass expressed respect for fire, they also expressed comfort and confidence in using fire, believing that it is not inherently risky due to the precautions they take, the community perceptions toward burning, as well as generational knowledge, equipment, and help they receive from neighbors. The mixed-grass region participants, however, were much more cautious and concerned about conducting burns. Drought conditions and woody encroachment make it so mixed-grass participants are dependent on PBAs, NGOs, K-State Extension, and agencies for assistance due to the recent reemergence of larger scale prescribed burning. Another discernable difference between both groups is in knowledge acquirement, or how individuals in each group primarily learned to conduct prescribed burns. In the tallgrass most burner participants grew up learning about prescribed burning from family and friends at a young age. Participants who moved to the

tallgrass region later in life would be introduced to burning often from their neighbors. In the mixed-grass region, most participants learned how to conduct prescribed burning primarily from burn schools and workshops offered by PBAs, K-State Extension or other groups, while formal education or workshops about fire were more supplemental for tallgrass participants. Finally, the availability of support is a noticeable difference between groups. In the tallgrass, participants have greater neighborly support and often work together to conduct burns on each other's properties, often timing their burns to minimize smoke exposure. In the mixed-grass region, participants are more dependent on assistance in writing and preparing burn plans, some relying heavily on PBAs for training, equipment, and personnel, whereas there has not been a demand for PBAs in the tallgrass due to their well-established tradition for burning.

Recommendations

Tallgrass Recommendations

For current and interested practitioners of fire within regions without a fire culture, or a dormant fire tradition, PBAs can provide the opportunity for locals interested in burning to pool resources to make burning viable. Grassroots movements tend to be viewed more favorably than initiatives from government agencies, they can also receive equipment, funding, and training from these resources (Weir et al., 2015). For the grasslands to continue to exist, the need to promote continued fire traditions and develop new ones is important. Based on our findings, our recommendation to practitioners in the tallgrass is to continue to support and expand on how groups interacting with burners can help them in making proactive decisions when applying prescribed fire. Burners in the tallgrass are encouraged to share and pass their knowledge and stories down to the next generation of landowners and the wider communities. Whenever new policies are being considered, burners should have a place at the table for their knowledge and recommendations on the future of prescribed fire practices. Tallgrass burner participants are

experienced, highly aware of risk, and should be recognized as understanding the risks of prescribed burning. In addition, tallgrass burners, as well as all burners, need to continue to have open and timely access to accurate weather data to help with their informed burning decisions.

Mixed-grass Recommendations

Burners in the mixed-grass region emphasized the need for and importance of more and easily accessible experts in writing burn plans. Burn plans provide practical information burners can use to make sure a burn is diligently conducted and also provide a personal peace of mind in what needs to be done; burn plans also may be used to protect them from legal disputes. In the mixed-grass region, producers described challenges finding professionals who can write thorough plans, so there is a demand for more professionals who can write burn plans in the region. Burners in the mixed-grass region shared more concern for liability. We recommend that policies related to fire and liability be revisited for clarity, and for work to be done to make sure policies are easily interpreted. Burners and key informants need to build relationships with their communities and facilitate dialogue with other stakeholders such as county commissioners, emergency services, and other municipal resources. More studies should be conducted in the mixed-grass region to get more perspectives from other burners, neighbors who do not burn, and officials involved with or who make decisions relating to burning. Because we had difficulty finding information about active and inactive PBAs online during our data collection, we recommend key informants or other resources to keep up-to-date records of PBAs, their number of members, the degree of activity they are in, and record the needs of these PBAs so they continue to be active and discoverable by interested landowners.

Burners in any region need continued and regular access to weather resources to aid in their burning decision making. Burners also need continued support from state and federal agencies, as well as NGOs in order for burners to continue to protect and maintain their native

landscape and agricultural practice. State prescribed fire councils or other leading fire groups in other states should regularly contact PBAs to maintain records for the number of members in a PBA and their degree of activity. To continue to document the practice of prescribed fire, and to share information about prescribed fire, more stories about prescribed fire need to be recorded.

Future Research Recommendations

There is a need for additional qualitative research to preserve and further analyze prescribed burning practices to better understand and support those who manage landscapes via burning. There is also a need to further explore what fire culture means in different communities and how it may vary from place to place, as documenting and defining fire culture may promote continued long-term usage of prescribed burning in ecosystems that have experienced historic burns through natural and human means. More studies should be conducted on prescribed fire policy and how it shapes burner behavior and perception toward fire risk and liability. Finally, more research needs to be conducted in order to expand on current theories around prescribed fire to refine our understanding of the practice.

References

- Abdel-Aty, M., Ekram, A.-A., Huang, H., & Choi, K. (2011). A study on crashes related to visibility obstruction due to fog and smoke. *Accident Analysis & Prevention*, 43(5), 1730–1737. <https://doi.org/10.1016/j.aap.2011.04.003>
- Allen, M. S., & Palmer, M. W. (2011). Fire history of a prairie/forest boundary: More than 250 years of frequent fire in a North American tallgrass prairie. *Journal of Vegetation Science*, 22(3), 436–444. <https://doi.org/10.1111/j.1654-1103.2011.01278.x>
- Archibald, S., Lehmann, C. E., Gómez-Dans, J. L., & Bradstock, R. A. (2013). Defining pyromes and global syndromes of fire regimes. *Biological Sciences*, 110(16), 6442–6447. <https://doi.org/10.1073/pnas.1211466110>
- Barreiro, A., & Díaz-Raviña, M. (2021). Fire impacts on soil microorganisms: Mass, activity, and Diversity. *Current Opinion in Environmental Science & Health*, 22. <https://doi.org/10.1016/j.coesh.2021.100264>
- Bird, R. B., Bird, D. W., Coddling, B. F., Parker, C. H., & Jones, J. H. (2008). The “fire stick farming” hypothesis: Australian Aboriginal foraging strategies, biodiversity, and anthropogenic fire mosaics. *Proceedings of the National Academy of Sciences*, 105(39), 14796–14801. <https://doi.org/10.1073/pnas.0804757105>
- Birks, M., & Mills, J. E. (2011). *Grounded theory: A practical guide* (2nd ed.). Sage.
- Bliege Bird, R., Bird, D. W., & Coddling, B. F. (2016). People, el niño southern oscillation and fire in Australia: Fire regimes and climate controls in hummock grasslands. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1696). <https://doi.org/10.1098/rstb.2015.0343>
- Bonner, S. R., Hoffman, C. M., Kane, J. M., Varner, J. M., Hiers, J. K., O’Brien, J. J., Rickard, H. D., Tinkham, W. T., Linn, R. R., Skowronski, N., Parsons, R. A., & Sieg, C. H. (2021). Invigorating prescribed fire science through improved reporting practices. *Frontiers in Forests and Global Change*, 4. <https://doi.org/10.3389/ffgc.2021.750699>
- Bowman, D. M. J. S., Balch, J., Artaxo, P., Bond, W. J., Cochrane, M. A., D’Antonio, C. M., DeFries, R., Johnston, F. H., Keeley, J. E., Krawchuk, M. A., Kull, C. A., Mack, M., Moritz, M. A., Pyne, S., Roos, C. I., Scott, A. C., Sodhi, N. S., & Swetnam, T. W. (2011).

- The human dimension of fire regimes on Earth. *Journal of Biogeography*, 38(12), 2223–2236. <https://doi.org/10.1111/j.1365-2699.2011.02595.x>
- Bowman, D. M. J. S., O'Brien, J. A., & Goldammer, J. G. (2013). Pyrogeography and the global quest for sustainable fire management. *Annual Review of Environment and Resources*, 38(1), 57–80. <https://doi.org/10.1146/annurev-environ-082212-134049>
- Bowman, D. M., Balch, J. K., Artaxo, P., Bond, W. J., Carlson, J. M., Cochrane, M. A., D'Antonio, C. M., DeFries, R. S., Doyle, J. C., Harrison, S. P., Johnston, F. H., Keeley, J. E., Krawchuk, M. A., Kull, C. A., Marston, J. B., Moritz, M. A., Prentice, I. C., Roos, C. I., Scott, A. C., ... Pyne, S. J. (2009). Fire in the earth system. *Science*, 324(5926), 481–484. <https://doi.org/10.1126/science.1163886>
- Bradsher, G. (2012). How the West Was Settled. National Archives and Records Administration. <https://www.archives.gov/files/publications/prologue/2012/winter/homestead.pdf>
- Braun, A. C. (2021). Encroached by pine and eucalyptus? A grounded theory on an environmental conflict between forest industry and Smallholder Livelihoods in Chile. *Journal of Rural Studies*, 82, 107–120. <https://doi.org/10.1016/j.jrurstud.2021.01.029>
- Briggs, J., Hoch, G. & Johnson, L. (2002). Assessing the rate, mechanisms, and consequences of the conversion of tallgrass prairie to *Juniperus virginiana* forest. *Ecosystems* 5, 578–586. <https://doi.org/10.1007/s10021-002-0187-4>
- Bruckerhoff, L. A., Connell, R. K., Guinnip, J. P., Adhikari, E., Godar, A., Gido, K. B., Boyle, A. W., Hope, A. G., Joern, A., & Welte, E. (2020). Harmony on the prairie? grassland plant and animal community responses to variation in climate across land-use gradients. *Ecology*, 101(5). <https://doi.org/10.1002/ecy.2986>
- Bryant, A., & Charmaz, K. (2007). The sage handbook of grounded theory. *SAGE Publications Ltd.* <https://doi.org/10.4135/9781848607941>
- Burke, M., Driscoll, A., Heft-Neal, S., Xue, J., Burney, J., & Wara, M. (2021). The changing risk and burden of wildfire in the United States. *Proceedings of the National Academy of Sciences*, 118(2). <https://doi.org/10.1073/pnas.2011048118>
- Butz, R. J. (2009). Traditional fire management: historical fire regimes and land use change in pastoral East Africa. *International Journal of Wildland Fire*, 18(4), 442–450. <https://doi.org/10.1071/wf07067>

- Carbutt, C., Henwood, W. D., & Gilfedder, L. A. (2017). Global plight of native temperate grasslands: Going, going, gone? *Biodiversity and Conservation*, 26(12), 2911–2932. <https://doi.org/10.1007/s10531-017-1398-5>
- Carle, D. (2002). *Burning questions: America's fight with nature's fire*. Praeger.
- Cascio, W. E. (2018). Wildland fire smoke and human health. *Science of The Total Environment*, 624, 586–595. <https://doi.org/10.1016/j.scitotenv.2017.12.086>
- Ceballos, G., Davidson, A., List, R., Pacheco, J., Fischer, P. M., Barrera, G. S., & Cruzado, J. (2010). Rapid decline of a grassland system and its ecological and conservation implications. *PLoS One*, 5(1). <https://doi.org/https://doi.org/10.1371/journal.pone.0008562>
- Changnon, S. A., Kunkel, K. E., & Winstanley, D. (2002). Climate factors that caused the unique tall grass prairie in the central United States. *Physical Geography*, 23(4), 259–280. <https://doi.org/10.2747/0272-3646.23.4.259>
- Charmaz, K. C. (2012). *Constructing grounded theory* (2nd ed.). Sage.
- Chatterjee, S., Daniels, M. D., Sheshukov, A. Y., & Gao, J. (2018). Projected climate change impacts on hydrologic flow regimes in the Great Plains of Kansas. *River Research and Applications*, 34(3), 195–206. <https://doi.org/10.1002/rra.3249>
- Cheney, W. C. (2024). *The perceived barriers among Prescribed Burn Association members to burning on Kansas Grasslands and Conservation Reserve Program Lands* [Master's thesis, Kansas State University]. K-REx
- Clar, R. (1959). *California government and Forestry*. Division of Forestry, Department of Natural Resources, State of California.
- Clark, A. S., McGranahan, D. A., Geaumont, B. A., Wonkka, C. L., Ott, J. P., & Kreuter, U. P. (2022). Barriers to prescribed fire in the US Great Plains, part II: Critical review of presently used and potentially expandable solutions. *Land*, 11(9). <https://doi.org/10.3390/land11091524>
- Clark, J. S., Grimm, E. C., Donovan, J. J., Fritz, S. C., Engstrom, D. R., & Almendinger, J. E. (2002). Drought cycles and landscape responses to past aridity on prairies of the northern Great Plains, USA. *Ecology*, 83(3), 595–601. [https://doi.org/https://doi.org/10.1890/0012-9658\(2002\)083\[0595:DCALRT\]2.0.CO;2](https://doi.org/https://doi.org/10.1890/0012-9658(2002)083[0595:DCALRT]2.0.CO;2)
- Cochrane, M.A., Ryan, K.C. (2009). *Fire and fire ecology: Concepts and principles*. In: Tropical Fire Ecology. Springer Praxis Books. https://doi.org/10.1007/978-3-540-77381-8_2

- Congressional Budget Office. (2022) *Wildfires*. (CBO Publication No. 58212).
<https://www.cbo.gov/publication/58212>
- Cook, B. I., Ault, T. R., & Smerdon, J. E. (2015). Unprecedented 21st century drought risk in the American Southwest and Central Plains. *Science Advances*, 1(1).
<https://doi.org/10.1126/sciadv.1400082>
- Coughlan, M. R. (2015). Traditional fire-use, landscape transition, and the legacies of social theory past. *Ambio*, 44, 705–717. <https://doi.org/10.1007/s13280-015-0643-y>
- Coughlan, M. R., & Petty, A. M. (2012). Linking humans and fire: A proposal for a transdisciplinary fire ecology. *International Journal of Wildland Fire*, 21(5), 477–487.
<https://doi.org/10.1071/wf11048>
- Coupland, R.T. 1992. Mixed Prairie. In Goodall, D.W. *Ecosystems of the World 8A – Natural Grasslands, Introduction and Western Hemisphere*. (pp 151). New York, NY: Elsevier Science Publishing Company Inc
- Courtwright, J. (2007). "When we first come here it all looked like prairie land almost": Prairie fire and plains settlement. *Western Historical Quarterly*, 38(2), 157–179.
<https://doi.org/10.1093/whq/38.2.157>
- Courtwright, J. (2011). *Prairie fire a Great Plains history*. University Press of Kansas.
- Creswell, J.W. and Poth, C.N. (2018) *Qualitative Inquiry and Research Design Choosing among Five Approaches*. 4th Edition, SAGE Publications, Inc., Thousand Oaks.
- de Oliveira, E., Colaço, M. C., Fernandes, P. M., & Sequeira, A. C. (2023). Remains of traditional fire use in Portugal: A historical analysis. *Trees, Forests and People*, 14, 100458. <https://doi.org/10.1016/j.tfp.2023.100458>
- Dempsey, F. (2013). Forest fire effects on air quality in Ontario: Evaluation of several recent examples. *Bulletin of the American Meteorological Society*, 94(7), 1059–1064.
<https://doi.org/10.1175/bams-d-11-00202.1>
- Didham, R. K. (2010). Ecological consequences of habitat fragmentation. *Encyclopedia of Life Sciences*. <https://doi.org/10.1002/9780470015902.a0021904>
- Ditomaso, J. M., Brooks, M. L., Allen, E. B., Minnich, R., Rice, P. M., & Kyser, G. B. (2006). Control of invasive weeds with prescribed burning. *Weed Technology*, 20(2), 535–548.
<https://doi.org/10.1614/wt-05-086r1.1>
- Dove, N. C., Taş, N., & Hart, S. C. (2022). Ecological and genomic responses of soil microbiomes to high-severity wildfire: Linking community assembly to functional

- potential. *The ISME Journal*, 16(7), 1853–1863. <https://doi.org/10.1038/s41396-022-01232-9>
- Dup  y, L. N., & Smith, J. W. (2018). An integrative review of empirical research on perceptions and behaviors related to prescribed burning and wildfire in the United States. *Environmental Management*, 61(6), 1002–1018. <https://doi.org/10.1007/s00267-018-1031-8>
- Elmore, R.D., T.G. Bidwell, and J.R. Weir. 2010. Perceptions of Oklahoma residents to prescribed fire. Pages 55–66 in K.M. Robertson, K.E.M. Galley, and R.E. Masters (eds.). Proceedings of the 24th Tall Timbers Fire Ecology Conference: The Future of Prescribed Fire: Public Awareness, Health, and Safety. Tall Timbers Research Station, Tallahassee, Florida, USA.
- Eriksen, C., & Hankins, D. L. (2014). The retention, revival, and subjugation of indigenous fire knowledge through agency fire fighting in eastern Australia and California. *Society & Natural Resources*, 27(12), 1288–1303. <https://doi.org/10.1080/08941920.2014.918226>
- Feng, S., Trnka, M., Hayes, M., & Zhang, Y. (2017). Why do different drought indices show distinct future drought risk outcomes in the U.S. Great Plains? *Journal of Climate*, 30(1), 265–278. <https://doi.org/10.1175/jcli-d-15-0590.1>
- Fernandes, P. M. (2015). Empirical support for the use of prescribed burning as a fuel treatment. *Current Forestry Reports*, 1, 118–127. <https://doi.org/10.1007/s40725-015-0010-z>
- Fernandes, P. M., & Botelho, H. S. (2003). A review of prescribed burning effectiveness in fire hazard reduction. *International Journal of Wildland Fire*, 12(2), 117–128. <https://doi.org/10.1071/wf02042>
- Freetly, H. C., Kuehn, L. A., Thallman, R. M., & Snelling, W. M. (2020). Heritability and genetic correlations of feed intake, body weight gain, residual gain, and residual feed intake of beef cattle as heifers and cows. *Journal of Animal Science*, 98(1). <https://doi.org/10.1093/jas/skz394>
- Gaskin, J. F., Espeland, E., Johnson, C. D., Larson, D. L., Mangold, J. M., McGee, R. A., Milner, C., Paudel, S., Pearson, D. E., Perkins, L. B., Prosser, C. W., Runyon, J. B., Sing, S. E., Sylvain, Z. A., Symstad, A. J., & Tekiela, D. R. (2021). Managing invasive plants on Great Plains Grasslands: A discussion of current challenges. *Rangeland Ecology & Management*, 78, 235–249. <https://doi.org/10.1016/j.rama.2020.04.003>

- Glaser, B. G., Strauss, A. L., & Strutzel, E. (1968). The discovery of grounded theory; strategies for qualitative research. *Nursing research*, 17(4), 364.
- Gorte, R. (2013). The rising cost of wildfire protection. *Headwaters Economics*.
- Gowlett, J. A. (2016). The discovery of fire by humans: A long and convoluted process. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1696). <https://doi.org/10.1098/rstb.2015.0164>
- Gowlett, J. A., Harris, J. W., Walton, D., & Wood, B. A. (1981). Early archaeological sites, hominid remains and traces of fire from Chesowanja, Kenya. *Nature*, 294, 125–129. <https://doi.org/10.1038/294125a0>
- Hajny, K. M., Hartnett, D. C., & Wilson, G. W. (2011). *Rhus glabra* response to season and intensity of fire in Tallgrass Prairie. *International Journal of Wildland Fire*, 20(5), 709–720. <https://doi.org/10.1071/wf09127>
- Halliday, L. G., Castley, J. G., Fitzsimons, J. A., Tran, C., & Warnken, J. (2012). Fire management on private conservation lands: Knowledge, perceptions and actions of landholders in eastern Australia. *International Journal of Wildland Fire*, 21(3), 197–209. <https://doi.org/10.1071/wf10148>
- Harr, R. N., Morton, L. W., Rusk, S. R., Engle, D. M., Miller, J. R., & Debinski, D. (2014). Landowners' perceptions of risk in grassland management: Woody plant encroachment and prescribed fire. *Ecology and Society*, 19(2). <https://doi.org/10.5751/es-06404-190241>
- Hensel, R. L. (1923). Recent studies on the effect of burning on grassland vegetation. *Ecology*, 4(2), 183–188. <https://doi.org/10.2307/1929492>
- Hickey, J. V., & Webb, C. E. (1987). The transition from farming to ranching in the Kansas Flint Hills. *Great Plains Quarterly*, 244–255. <https://digitalcommons.unl.edu/greatplainsquarterly/351/>
- Hiers, J. K., O'Brien, J. J., Varner, J. M., Butler, B. W., Dickinson, M., Furman, J., Gallagher, M., Godwin, D., Goodrick, S. L., Hood, S. M., Hudak, A., Kobziar, L. N., Linn, R., Loudermilk, E. L., McCaffrey, S., Robertson, K., Rowell, E. M., Skowronski, N., Watts, A. C., & Yedinak, K. M. (2020). Prescribed fire science: The case for a refined research agenda. *Fire Ecology*, 16(11). <https://doi.org/10.1186/s42408-020-0070-8>

- Higuera, P. E., & Abatzoglou, J. T. (2020). Record-setting climate enabled the extraordinary 2020 fire season in the western United States. *Global Change Biology*, 27(1), 1–2. <https://doi.org/10.1111/gcb.15388>
- Hoover, K., Hanson, L. A. (2023). *Wildfire Statistics* (CRS Report No. IF10244). <https://sgp.fas.org/crs/misc/IF10244.pdf>
- Houser, M., Stuart, D., & Carolan, M. (2017). Is seeing believing? applying a realist framework to examine agriculture and climate change. *Environmental Sociology*, 3(4), 321–336. <https://doi.org/10.1080/23251042.2017.1335380>
- Hovick, T. J., Elmore, R. D., Fuhlendorf, S. D., Engle, D. M., & Hamilton, R. G. (2015). Spatial heterogeneity increases diversity and stability in grassland bird communities. *Ecological Applications*, 25(3), 662–672. <https://doi.org/10.1890/14-1067.1>
- Hoy, J. (1989). Controlled pasture burning in the folklife of the Kansas Flint Hills. *Great Plains Quarterly*, 231–238. <https://digitalcommons.unl.edu/greatplainsquarterly/386/>
https://doi.org/https://perspectivia.net/servlets/MCRFileNodeServlet/pnet_derivate_00004367/17.pdf
- Hunt, C. D., & Panas, J. L. (2018). A changing Kansas: Implications for health and communities. *Kansas Health Institute*. <https://doi.org/https://kansashealth.org/wp-content/uploads/2018/06/KHF-KHI-Demographic-Report-060518.pdf>
- Hunter, M. E., & Robles, M. D. (2020). Tamm review: The effects of prescribed fire on wildfire regimes and impacts: A framework for comparison. *Forest Ecology and Management*, 475. <https://doi.org/10.1016/j.foreco.2020.118435>
- Isern, T. D. (1985). Farmers, ranchers, and stockmen of the Flint Hills. *The Western Historical Quarterly*, 16(3), 253–264. <https://doi.org/10.2307/969127>
- Johnson, A. S., & Hale, P. E. (2002). *The historical foundations of prescribed burning for wildlife: a southeastern perspective*. <https://research.fs.usda.gov/treesearch/19091>
- Jolly, W. M., Cochrane, M. A., Freeborn, P. H., Holden, Z. A., Brown, T. J., Williamson, G. J., & Bowman, D. M. (2015). Climate-induced variations in global wildfire danger from 1979 to 2013. *Nature Communications*, 6(1). <https://doi.org/10.1038/ncomms8537>
- Joshi, O., Poudyal, N. C., Weir, J. R., Fuhlendorf, S. D., & Ochuodho, T. O. (2019). Determinants of perceived risk and liability concerns associated with prescribed burning

- in the United States. *Journal of Environmental Management*, 230, 379–385.
<https://doi.org/10.1016/j.jenvman.2018.09.089>
- Kansas Department of Wildlife & Parks. (2015, March 12). *Hunting private land in Kansas is a privilege*. <https://ksoutdoors.com/KDWP-Info/News/News-Archive/2015-Weekly-News/12-3-15/Hunting-Private-Land-in-Kansas-is-a-Privilege>
- Keeley, J. E., & Syphard, A. D. (2019). Twenty-first century California, USA, wildfires: Fuel-dominated vs. wind-dominated fires. *Fire Ecology*, 15. <https://doi.org/10.1186/s42408-019-0041-0>
- Kelly, L. T., Giljohann, K. M., Duane, A., Aquilué, N., Archibald, S., Batllori, E., Bennett, A. F., Buckland, S. T., Canelles, Q., Clarke, M. F., Fortin, M.-J., Hermoso, V., Herrando, S., Keane, R. E., Lake, F. K., McCarthy, M. A., Morán-Ordóñez, A., Parr, C. L., Pausas, J. G., ... Brotons, L. (2020). Fire and biodiversity in the Anthropocene. *Science*, 370(6519). <https://doi.org/10.1126/science.abb0355>
- Knorr, W., Arneeth, A., & Jiang, L. (2016). Demographic controls of future global fire risk. *Nature Climate Change*, 6, 781–785. <https://doi.org/10.1038/nclimate2999>
- Kolden, C. (2019). We're not doing enough prescribed fire in the western United States to mitigate wildfire risk. *Fire*, 2(2). <https://doi.org/10.3390/fire2020030>
- Kollmorgen, W. M., & Simonett, D. S. (1965). Grazing operations in the Flint Hills–bluestem pastures of Chase County, Kansas. *Annals of the Association of American Geographers*, 55(2), 260–290. <https://doi.org/10.1111/j.1467-8306.1965.tb00518.x>
- Kopplitz, S. N., Mickley, L. J., Marlier, M. E., Buonocore, J. J., Kim, P. S., Liu, T., Sulprizio, M. P., DeFries, R. S., Jacob, D. J., Schwartz, J., Pongsiri, M., & Myers, S. S. (2016). Public health impacts of the severe haze in Equatorial Asia in September–October 2015: Demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. *Environmental Research Letters*, 11(9). <https://doi.org/10.1088/1748-9326/11/9/094023>
- Kreuter, U. P., Woodard, J. B., Taylor, C. A., & Richard Teague, W. (2008). Perceptions of Texas landowners regarding fire and its use. *Rangeland Ecology & Management*, 61(4), 456–464. <https://doi.org/10.2111/07-144.1>
- Lange, J., & Gillespie, J. (2022). Bushfire, prescribed burning, and non-human protection. *Geographical Research*, 61(2), 169–192. <https://doi.org/10.1111/1745-5871.12558>

- Lempert, L. (2007). Asking questions of the data: memo writing in the grounded theory tradition. *The SAGE Handbook of Grounded Theory* (pp. 245-264). SAGE Publications Ltd, <https://doi.org/10.4135/9781848607941>
- Leys, B., Brewer, S. C., McConaghy, S., Mueller, J., & McLauchlan, K. K. (2015). Fire history reconstruction in grassland ecosystems: Amount of charcoal reflects local area burned. *Environmental Research Letters*, 10(11), 114009. <https://doi.org/10.1088/1748-9326/10/11/114009>
- Liew, D. V., Conner, R., Kreuter, U. P., & Teague, R. (2012). An economic comparison of prescribed extreme fire and alternative methods for managing invasive brush species in Texas: A modeling approach. *The Open Agriculture Journal*, 6(1), 17–26. <https://doi.org/10.2174/1874331501206010017>
- Liu, J. C., Pereira, G., Uhl, S. A., Bravo, M. A., & Bell, M. L. (2014). A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. *Environmental Research*, 136, 120–132. <https://doi.org/10.1016/j.envres.2014.10.015>
- Liu, Y., Kochanski, A., Baker, K. R., Mell, W., Linn, R., Paugam, R., Mandel, J., Fournier, A., Jenkins, M. A., Goodrick, S., Achtemeier, G., Zhao, F., Ottmar, R., French, N. H., Larkin, N., Brown, T., Hudak, A., Dickinson, M., Potter, B., ... McNamara, D. (2019). Fire behaviour and smoke modelling: Model improvement and measurement needs for next-generation Smoke Research and forecasting systems. *International Journal of Wildland Fire*, 28(8), 570–588. <https://doi.org/10.1071/wf18204>
- Macpherson, G. L. (1996). Hydrogeology of thin limestones: The Konza Prairie Long-Term Ecological Research site, northeastern Kansas. *Journal of Hydrology*, 186(1–4), 191–228. [https://doi.org/10.1016/s0022-1694\(96\)03029-6](https://doi.org/10.1016/s0022-1694(96)03029-6)
- Marlon, J. R., Bartlein, P. J., Danialu, A.-L., Harrison, S. P., Maezumi, S. Y., Power, M. J., Tinner, W., & Vanni re, B. (2013). Global biomass burning: A synthesis and review of Holocene paleofire records and their controls. *Quaternary Science Reviews*, 65, 5–25. <https://doi.org/10.1016/j.quascirev.2012.11.029>
- Marshall, M. N. (1996). The key informant technique. *Family Practice*, 13(1), 92–97. <https://doi.org/https://doi.org/10.1093/fampra/13.1.92>
- Martin, M. V., Kahn, R. A., Logan, J. A., Paugam, R., Wooster, M., & Ichoku, C. (2012). Space-based observational constraints for 1-D fire smoke plume-rise models. *Journal of Geophysical Research: Atmospheres*, 117(D22). <https://doi.org/10.1029/2012jd018370>

- McCaffrey, S. M., & Olsen, C. S. (2012). Research perspectives on the public and fire management: A synthesis of current social science on eight essential questions. *U.S. Joint Fire Science Program*. <https://doi.org/10.2737/nrs-gtr-104>
- Middendorf, G., Becerra, T. A., & Cline, D. (2009). Transition and resilience in the Kansas Flint Hills. *Online Journal of Rural Research & Policy*, 4(3).
<https://doi.org/10.4148/ojrrp.v4i3.109>
- Miller, R., Field, C., & Mach, K. (2020). Barriers and enablers for prescribed burns for wildfire management in California. *Nature Sustainability*, 3, 101–109.
<https://doi.org/10.1038/s41893-019-0451-7>
- Mishra, N. B., Young, K. R. (2020). *Terrestrial Ecosystems and Biodiversity*. (Wang, Y, Ed.) CRC Press. <https://doi.org/10.1201/9780429445651>
- Mohler, R. L., & Goodin, D. G. (2012). Mapping burned areas in the Flint Hills of Kansas and Oklahoma. *Great Plains Research*, 22(1), 15–25.
<https://doi.org/https://www.proquest.com/scholarly-journals/mapping-burned-areas-flint-hills-kansas-oklahoma/docview/1010819328/se-2>
- National Interagency Fire Center. (2004). *Suppression costs*. <https://www.nifc.gov/fire-information/statistics/suppression-costs>
- Oatey-Spencer, H. (2012). What is culture? *A compilation of quotations. GlobalPAD Core Concepts*, 1(22), 1-21.
- Owensby, C. E., Blan, K. R., Eaton, B. J., & Russ, O. G. (1973). Evaluation of eastern redcedar infestations in the northern Kansas Flint Hills. *Rangeland Ecology & Management/Journal of Range Management Archives*, 26(4), 256-260.
- Pandey, P., Huidobro, G., Lopes, L. F., Ganteaume, A., Ascoli, D., Colaco, C., Xanthopoulos, G., Giannaros, T. M., Gazzard, R., Boustras, G., Steelman, T., Charlton, V., Ferguson, E., Kirschner, J., Little, K., Stoof, C., Nikolakis, W., Fernández-Blanco, C. R.,
Pandey, P., Huidobro, G., Lopes, L. F., Ganteaume, A., Ascoli, D., Colaco, C., Xanthopoulos, G., Giannaros, T. M., Gazzard, R., Boustras, G., Steelman, T., Charlton, V., Ferguson, E., Kirschner, J., Little, K., Stoof, C., Nikolakis, W., Fernández-Blanco, C. R., Ribotta, C., Dossi, S. (2023). A global outlook on increasing wildfire risk: Current policy situation and future pathways. *Trees, Forests and People*, 14.
<https://doi.org/10.1016/j.tfp.2023.100431>

- Pausas, J. G., & Keeley, J. E. (2021). Wildfires and global change. *Frontiers in Ecology and the Environment*, 19(7), 387–395. <https://doi.org/10.1002/fee.2359>
- Pivello, V. (2011). The use of fire in the Cerrado and Amazonian rainforests of Brazil: Past and present. *Fire Ecology*, 7, 24–39.
<https://doi.org/http://dx.doi.org/10.4996/fireecology.0701024>
- Polo, J. A., Tanner, E. P., Scholtz, R., Fuhlendorf, S. D., Ripberger, J. T., Silva, C. L., Jenkins-Smith, H. C., & Carlson, N. (2020). Mismatches in prescribed fire awareness and implementation in Oklahoma, USA. *Rangelands*, 42(6), 196–202.
<https://doi.org/10.1016/j.rala.2020.09.002>
- Post, E. (2003). Climate–vegetation dynamics in the fast lane. *Trends in Ecology & Evolution*, 18(11), 551–553. <https://doi.org/10.1016/j.tree.2003.08.008>
- Pyne, S. J. (1982). *Fire in America: A Cultural History of Wildland and Rural Fire*.
- Pyne, S. J., & Goldammer, J. G. (1997). The culture of fire: An introduction to anthropogenic fire history. *Sediment Records of Biomass Burning and Global Change*, 71–114.
https://doi.org/10.1007/978-3-642-59171-6_5
- Rahmani, V., Hutchinson, S. L., Hutchinson, J. M., & Anandhi, A. (2013). Extreme daily rainfall event distribution patterns in Kansas. *Journal of Hydrologic Engineering*, 19(4), 707–716. [https://doi.org/10.1061/\(asce\)he.1943-5584.0000839](https://doi.org/10.1061/(asce)he.1943-5584.0000839)
- Rappold, A., Hoshiko, S., Buckman, J. R., Yeomans, K. R., Hayashi, T., Kramer, S. J., Huang, S., & French, N. H. (2023). Future health burden under a projected prescribed fire management scenario in California. *ISEE Conference Abstracts*, 2023(1).
<https://doi.org/10.1289/isee.2023.op-129>
- Ratajczak, Z., Briggs, J. M., Goodin, D. G., Luo, L., Mohler, R. L., Nippert, J. B., & Obermeyer, B. (2016). Assessing the potential for transitions from tallgrass prairie to woodlands: Are we operating beyond critical fire thresholds? *Rangeland Ecology & Management*, 69(4), 280–287. <https://doi.org/10.1016/j.rama.2016.03.004>
- Ratajczak, Z., Collins, S. L., Blair, J. M., Koerner, S. E., Louthan, A. M., Smith, M. D., Taylor, J. H., & Nippert, J. B. (2022). Reintroducing bison results in long-running and resilient increases in grassland diversity. *Proceedings of the National Academy of Sciences*, 119(36). <https://doi.org/10.1073/pnas.2210433119>

- Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical review of health impacts of wildfire smoke exposure. *Environmental Health Perspectives*, 124(9), 1334–1343. <https://doi.org/10.1289/ehp.1409277>
- Ribotta, C., ... Dossi, S. (2023). A global outlook on increasing wildfire risk: Current policy situation and future pathways. *Trees, Forests and People*, 14. <https://doi.org/10.1016/j.tfp.2023.100431>
- Roebroeks, W., & Villa, P. (2011). On the earliest evidence for habitual use of fire in Europe. *Proceedings of the National Academy of Sciences*, 108(13), 5209–5214. <https://doi.org/10.1073/pnas.1018116108>
- Roos, C. I., Scott, A. C., Belcher, C. M., Chaloner, W. G., Aylen, J., Bird, R. B., Coughlan, M. R., Johnson, B. R., Johnston, F. H., McMorrow, J., & Steelman, T. (2016). Living on a flammable planet: Interdisciplinary, cross-scalar and varied cultural lessons, prospects and challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1696). <https://doi.org/10.1098/rstb.2015.0469>
- Roos, C. I., Zedeño, M. N., Hollenback, K. L., & Erlick, M. M. (2018). Indigenous impacts on North American great plains fire regimes of the past millennium. *Proceedings of the National Academy of Sciences*, 115(32), 8143–8148. <https://doi.org/10.1073/pnas.1805259115>
- Rosen, Zoey; Henery, Giovanna; Slater, Kellin D.; Sablan, Olivia; Ford, Bonne; Pierce, Jeffrey R.; Fischer, Emily V.; and Magzamen, S. L. (2022) "A Culture of Fire: Identifying Community Risk Perceptions Surrounding Prescribed Burning in the Flint Hills, Kansas," *Journal of Applied Communications*: Vol. 106: Iss. 4. <https://doi.org/10.4148/1051-0834.2455>
- Rosenberg, K. V., Dokter, A. M., Blancher, P. J., Sauer, J. R., Smith, A. C., Smith, P. A., Stanton, J. C., Panjabi, A., Helft, L., Parr, M., & Marra, P. P. (2019). Decline of the North American avifauna. *Science*, 366(6461), 120–124. <https://doi.org/10.1126/science.aaw1313>
- Rouet-Leduc, J., Pe'er, G., Moreira, F., Bonn, A., Helmer, W., Shahsavan Zadeh, S. A., Zizka, A., & van der Plas, F. (2021). Effects of large herbivores on fire regimes and wildfire mitigation. *Journal of Applied Ecology*, 58(12), 2690–2702. <https://doi.org/10.1111/1365-2664.13972>

- Ryan, K. C., Knapp, E. E., & Varner, J. M. (2013). Prescribed fire in North American forests and woodlands: History, current practice, and challenges. *Frontiers in Ecology and the Environment*, 11(s1), 15–24. <https://doi.org/10.1890/120329>
- Sablan, O., Ford, B., Gargulinski, E., Hammer, M. S., Henery, G., Kondragunta, S., Martin, R. V., Rosen, Z., Slater, K., van Donkelaar, A., Zhang, H., Soja, A. J., Magzamen, S., Pierce, J. R., & Fischer, E. V. (2024). Quantifying prescribed-fire smoke exposure using low-cost sensors and satellites: Springtime burning in eastern Kansas. *GeoHealth*, 8(4). <https://doi.org/10.1029/2023gh000982>
- Scholtz, R., & Twidwell, D. (2022). The last continuous grasslands on earth: Identification and conservation importance. *Conservation Science and Practice*, 4(3). <https://doi.org/10.1111/csp2.626>
- Scholtz, R., Prentice, J., Tang, Y., & Twidwell, D. (2020). Improving on Modis MCD64A1 burned area estimates in grassland systems: A case study in Kansas Flint Hills tall grass prairie. *Remote Sensing*, 12(13). <https://doi.org/10.3390/rs12132168>
- Sherrill, C. W., Fuhlendorf, S. D., Goodman, L. E., Elmore, R. D., & Hamilton, R. G. (2022). Managing an invasive species while simultaneously conserving native plant diversity. *Rangeland Ecology & Management*, 80, 87–95. <https://doi.org/10.1016/j.rama.2021.11.001>
- Shimelmitz, R., Kuhn, S. L., Jelinek, A. J., Ronen, A., Clark, A. E., & Weinstein-Evron, M. (2014). ‘fire at will’: The emergence of habitual fire use 350,000 years ago. *Journal of Human Evolution*, 77, 196–203. <https://doi.org/10.1016/j.jhevol.2014.07.005>
- Show, S. B., & Kotok, E. I. (1924). *The Role of Fire in the California Pine Forests*. U.S. Dept. of Agriculture. <https://doi.org/10.5962/bhl.title.107935>
- Sharaftmandrad, M., & Shahraki, M. (2025). Understanding rangeland desertification through pastoralist perspectives using a grounded theory approach. *Scientific Reports*, 15(1). <https://doi.org/10.1038/s41598-025-86573-z>
- Smith, S. (2011). Eastern Red-cedar: Positives, negatives and management. *The Samuel Roberts Noble Foundation*. <https://doi.org/https://www.noble.org/wp-content/uploads/2023/04/nf-wf-11-01.pdf>

- Smith, W., Neale, T., & Weir, J. K. (2021). Persuasion without policies: The work of reviving Indigenous Peoples' fire management in Southern Australia. *Geoforum*, 120, 82–92. <https://doi.org/10.1016/j.geoforum.2021.01.015>
- Soulodre, E. M. J., Dhar, A., & Naeth, M. A. (2022). Plant community development trends on mixed grass prairie well sites 5 years after reclamation. *Ecological Engineering*, 179. <https://doi.org/10.1016/j.ecoleng.2022.106635>
- Stavi, I. (2019). Wildfires in grasslands and shrublands: A review of impacts on vegetation, soil, hydrology, and geomorphology. *Water*, 11(5). <https://doi.org/10.3390/w11051042>
- Thomas, D., Butry, D., Gilbert, S., Webb, D., & Fung, J. (2017). The costs and losses of wildfires: A literature survey. *National Institute of Standards and Technology*, 1–64. <https://doi.org/10.6028/nist.sp.1215>
- Tie, Y. C., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. *SAGE Open Medicine*, 7. <https://doi.org/10.1177/2050312118822927>
- Toledo, D., Kreuter, U. P., Sorice, M. G., & Taylor, C. A. (2014). The role of prescribed burn associations in the application of prescribed fires in rangeland ecosystems. *Journal of Environmental Management*, 132, 323–328. <https://doi.org/10.1016/j.jenvman.2013.11.014>
- Toledo, D., Sorice, M. G., & Kreuter, U. P. (2013). Social and ecological factors influencing attitudes toward the application of high-intensity prescribed burns to restore fire adapted grassland ecosystems. *Ecology and Society*, 18(4), 104–112. <https://doi.org/10.5751/es-05820-180409>
- Toman, E., Shindler, B., & Brunson, M. (2006). Fire and fuel management communication strategies: Citizen evaluations of agency outreach activities. *Society & Natural Resources*, 19(4), 321–336. <https://doi.org/10.1080/08941920500519206>
- Toman, E., Shindler, B., McCaffrey, S., & Bennett, J. (2014). Public Acceptance of Wildland Fire and Fuel Management: Panel Responses in Seven Locations. *Environmental Management*, 54(3), 557–570. <https://doi.org/10.1007/s00267-014-0327->
- Towne, E. G., & Craine, J. M. (2016). A critical examination of timing of burning in the Kansas Flint Hills. *Rangeland Ecology & Management*, 69(1), 28–34. <https://doi.org/10.1016/j.rama.2015.10.008>

- Tracy, S. J. (2010). Qualitative quality: Eight “big-tent” criteria for excellent qualitative research. *Qualitative Inquiry*, 16(10), 837–851.
<https://doi.org/10.1177/1077800410383121>
- Turner, C., & Astin, F. (2021). Grounded theory: What makes a grounded theory study? *European Journal of Cardiovascular Nursing*, 20(3), 285–289.
<https://doi.org/10.1093/eurjcn/zvaa034>
- Twidwell, D., Bielski, C. H., Scholtz, R., & Fuhlendorf, S. D. (2021). Advancing fire ecology in 21st Century rangelands. *Rangeland Ecology & Management*, 78, 201–212.
<https://doi.org/10.1016/j.rama.2020.01.008>
- Twidwell, D., Rogers, W. E., Fuhlendorf, S. D., Wonkka, C. L., Engle, D. M., Weir, J. R., Kreuter, U. P., & Taylor, C. A. (2013). The rising Great Plains fire campaign: Citizens’ response to woody plant encroachment. *Frontiers in Ecology and the Environment*, 11(s1), 64–71. <https://doi.org/10.1890/130015>
- U.S. Department of Agriculture (2023, March 9). President’s 2024 Budget Advances Efforts to Address the Nation’s Wildfire Crisis through Workforce Reform and Other Investments in Wildland Fire Management Programs [Press release].
<https://www.usda.gov/media/press-releases/2023/03/09/presidents-2024-budget-advances-efforts-address-nations-wildfire>
- U.S. Department of the Interior. (2022). *Flint Hills Geology*. National Parks Service.
<https://www.nps.gov/articles/000/flint-hills-geology.htm>
- United States General Accounting Office. (2003). *Forest Service: Information on decisions involving fuels reduction activities*. (Gao-03-689R). <https://www.gao.gov/assets/gao-03-689r.pdf>
- van Wagtenonk, J. W. (2007). The History and Evolution of Wildland Fire Use. *Fire Ecology*, 3(2), 3–17. <https://doi.org/10.4996/fireecology.0302003>
- Vermeire, L. T., & Russell, M. L. (2018). Seasonal timing of fire alters biomass and species composition of northern mixed prairie. *Rangeland Ecology & Management*, 71(6), 714–720. <https://doi.org/10.1016/j.rama.2018.06.005>
- Weir, J. R., Kreuter, U. P., Wonkka, C. L., Twidwell, D., Stroman, D. A., Russell, M., & Taylor, C. A. (2019). Liability and prescribed fire: Perception and reality. *Rangeland Ecology & Management*, 72(3), 533–538. <https://doi.org/10.1016/j.rama.2018.11.010>

- Weir, J. R., Twidwell, D., & Wonkka, C. L. (2015). Prescribed burn association activity, needs, and safety record: a survey of the Great Plains. *Great Plains Fire Science Exchange. GPE Publication*, 6, 19.
- Weir, J. R., Twidwell, D., & Wonkka, C. L. (2016). From grassroots to National Alliance: The emerging trajectory for landowner prescribed burn associations. *Rangelands*, 38(3), 113–119. <https://doi.org/10.1016/j.rala.2016.02.005>
- Wibking, R. K. (1963). (dissertation). *Geography of the cattle industry in the Flint Hills of Kansas*. [Doctoral dissertation, The University of Nebraska]. ProQuest Dissertations Publishing.
- Wilgers, D. J., & Horne, E. A. (2006). Effects of different burn regimes on tallgrass prairie herpetofaunal species diversity and community composition in the Flint Hills, Kansas. *Journal of Herpetology*, 40(1), 73–84. <https://doi.org/10.1670/162-05a.1>
- Wilm, J. (2020). “‘The Indians must yield’: Antebellum Free Land, the Homestead Act, and the Displacement of Native Peoples,.” *Bulletin of the German Historical Institute*, 67, 17–39.
- Wonkka, C. L., Rogers, W. E., & Kreuter, U. P. (2015). Legal barriers to effective ecosystem management: Exploring linkages between liability, regulations, and prescribed fire. *Ecological Applications*, 25(8), 2382–2393. <https://doi.org/10.1890/14-1791.1>
- Zouhar, K. (2021). Fire regimes of plains grassland and prairie ecosystems. *Fire Effects Information System*. https://doi.org/https://www.fs.usda.gov/database/feis/fire_regimes/PlainsGrass_Prairie/all.html

Appendix A - Institutional Review Board Approval Letter Tallgrass

Study



TO: Carolyn Baldwin
Cooperative Extension Admin
Manhattan, KS 66506

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 04/14/2022

RE: Approval of Proposal Entitled, "Defining the Fire Culture of the Flint Hills."

Proposal Number IRB-11165

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for three years from the date of this correspondence.**

APPROVAL DATE: 04/14/2022

EXPIRATION DATE: 04/13/2025

In giving its approval, the Committee has determined that:

No more than minimal risk to subjects

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

Electronically signed by Rick Scheidt on 04/14/2022 3:42 PM ET

Appendix B - Institutional Review Board Approval Letter Mixed- Grass Study



TO: Katie Burke
Communications & Ag Education
Manhattan, KS 66506
Proposal Number IRB-10952

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 12/20/2021

RE: Approval of Proposal Entitled, "An ecosystem-level evaluation of sustainable agricultural practices and the barriers to their adoption."

The Committee on Research Involving Human Subjects has reviewed your proposal and has granted full approval. This proposal is **approved for three years from the date of this correspondence.**

APPROVAL DATE: 12/19/2021

EXPIRATION DATE: 12/18/2024

In giving its approval, the Committee has determined that:

No more than minimal risk to subjects

This approval applies only to the proposal currently on file as written. Any change or modification affecting human subjects must be approved by the IRB prior to implementation. All approved proposals are subject to continuing review, which may include the examination of records connected with the project. Announced post-approval monitoring may be performed during the course of this approval period by URCO staff. Injuries, unanticipated problems or adverse events involving risk to subjects or to others must be reported immediately to the Chair of the IRB and / or the URCO.

Electronically signed by Rick Scheidt on 12/24/2021 11:40 AM ET

203 Fairchild Hall, Manhattan, KS 66502 | (785) 532-3224 | fax: (785) 532-3278

Appendix C - Semi-structured Interview Consent Form

An ecosystem-level evaluation of sustainable agricultural practices and the barriers to their adoption

Thank you for your time and consideration in helping us better understand fire culture in Kansas. Our goal is to use information from these interviews to help us provide educational programming for producers in the region. The interview will take 30-60 minutes.

Your participation is voluntary. The audio for this interview will be recorded, but your personal information, like your name and anyone else's name, will not be shared and will be stored separately from the recording. It is possible that your responses, without your personal information, could be stored and used for future research studies or by future researchers without asking for further consent. As the researcher, I will do everything possible to separate your identity from the results of this research, though in rare cases, one may be able to piece together information and determine who has participated in the interview. There is no direct benefit in participating in this research. If you do not agree to participate, we will not proceed with the interview (refusing to participate will result in no penalty or loss). For additional information regarding human participation in research, contact Lisa Rubin with the Kansas State University Office of Research Compliance at (785) 532-3224, or 203 Fairchild Hall, 1601 Vattier St, Manhattan, KS 66506.

If you have any questions about this research, please feel free to ask them now, after the interview is over, or through email: Adrian Sulivant, Sulivant@ksu.edu, 918-812-7971.

Do you agree to participate in this research interview?

Yes

No

Interviewee signature: _____ Printed name: _____

Project staff member: _____

Appendix D - Semi-Structured Interview Guide Tallgrass

Personal Perceptions towards Prescribed Fire

1. Why do you use prescribed fire?
2. What ecosystem impacts (soils, water, vegetation, wildlife) have you seen from the use or non-use of prescribed fire on land you manage?
3. What are the biggest constraints to achieving the amount of prescribed fire you'd like to use?
4. Is there a historic context for using prescribed fire?
5. How long has prescribed fire been used to manage Flint Hills rangelands? Do you see yourself as part of a tradition of using prescribed fire?
6. Are there acceptable substitutes for prescribed fire?

Community Perceptions towards Prescribed Fire

7. How is prescribed fire regulated in the Flint Hills (include self-regulation if appropriate)? If you self-regulate, what things do you consider?
8. Do most residents of the Flint Hills accept prescribed burning as a normal practice? If not, what kind of complaints do you most often receive?
9. What risks are most important to you in deciding whether or not to burn?
10. Do you view prescribed burning as a generally risky activity?
11. What is most incomprehensible in other people's attitudes towards prescribed fire (local and non-local)?

Economics of Prescribed Fire

12. What would be the economic impact if you lost the ability to use prescribed fire?
13. If you lease land or custom graze cattle, are there stipulations in the contract documents relating to prescribed burning? If so, what would be typical wording?

Experience with Prescribed Fire

14. How much prescribed burning have you conducted in the past 10 years (estimated number of fires, number of acres)?

15. Who has provided you with assistance in planning or applying prescribing fire during the past 10 years?
16. How do you adjust your use of prescribed fire based on climatic factors, prior years' utilization and regrowth, and changes you see occurring on the land you manage?
17. What is your personal step-by-step process when conducting a burn, from planning to mop up?

Information Acquisition

18. How did you learn to conduct prescribed burns?
19. How do you learn about new/modified prescribed burn equipment or methods?
20. How do you share information about prescribed fire?
21. How well informed do you feel you are when making decisions about whether to use prescribed fire (very informed, uninformed, informed, very informed, unsure)
22. What types of prescribed burning factual information would be most useful to you? How would you prefer to receive this information from?

Demographics

23. What is your age group? 20-40, 40-60, 60+
24. What is your gender? (Female, Male)
25. In which area of the Flint Hills do you burn? (North, Central, South)
26. What percentage of your household income is generated from ranching? (0-25%, 26-50%, 51-75%, 76-100%)

Appendix E - Semi-Structured Interview Guide Mixed Grass

An ecosystem-level evaluation of sustainable agricultural practices and the barriers to their adoption - Qualitative Analysis

Semi-structured interview guide

Thank you for meeting with me today. As we discussed via email, I'm interviewing several Kansas producers about land management approach, specifically their fire culture and prescribed burning practices. We have only an hour to visit today so that all producers get the same amount of time to share their thoughts on the questions we are going to discuss. If I notice we are running short of time, I will move us along so you have a chance to weigh in on all the questions. Okay?

For research purposes, I am going to record our discussion. Your name will not be associated with any information reported or further research. It stays with the research team of five at Kansas State. We will assign you a pseudonym, so all of your responses will remain confidential. If there is a question you prefer not to answer, please just say so. You may also stop the interview at any time.

Is it okay if I start recording?

Personal Perceptions towards Prescribed Fire

To get us started, would you please describe your operation?

Prompts:

What region of Kansas do you consider yourself to operate in? What county is most of your operation in?

What is your acreage of rangeland vs cropland?

How much land is owned versus leased?

What are your overall priorities in land management?

What is your outlook on using fire as a management tool?

Tell me more

Can you describe how fire is used on your operation? Why do you use fire for your operation?

What ecosystem impacts (soils, water, vegetation, wildlife) have you seen from the use or non-use of prescribed fire on land you manage?

What are the biggest constraints to achieving the amount of prescribed fire you'd like to use?

Is there a historic context for using prescribed fire?

How long has prescribed fire been used to manage your rangelands?

Do you see yourself as part of a tradition of using prescribed fire?

Are there acceptable substitutes for prescribed fire?

Community Perceptions Towards Prescribed Fire

These next few questions will help me understand how your community affects your decision on whether or not to burn.

Prompts:

How is prescribed fire regulated in your region (or county)?

Can you describe how you also self-regulate?

Do most residents of your region accept prescribed burning as a normal practice? If not, what kind of complaints do you most often receive?

What risks are most important to you in deciding whether or not to burn?

Do you view prescribed burning as a generally risky activity?
What do you think other people's attitudes are towards prescribed fire (local and non-local)?

Economics and Lease agreements: Prescribed Fire

Prompts:

What would be the economic impact if you lost the ability to use prescribed fire?
If you lease land or custom graze cattle, are there stipulations in the contract documents relating to prescribed burning? If so, what would be typical wording?

Experience with Prescribed Fire

Prompts:

How much prescribed burning have you conducted in the past 10 years (estimated number of fires, number of acres)?
Who has provided you with assistance in planning or applying prescribed fire during the past 10 years?
How do you adjust your use of prescribed fire based on climatic factors, prior years' utilization and regrowth, and changes you see occurring on the land you manage?
What is your personal step-by-step process when conducting a burn, from planning to mop up?

Information Acquisition

Prompts:

How did you learn to conduct prescribed burns?
How do you learn about new/modified prescribed burn equipment or methods?
How do you share information about prescribed fire?
How well informed do you feel when making decisions about whether to use prescribed fire (Very informed, informed, uninformed, very uninformed, unsure)
What types of prescribed burning information would be most useful to you? How would you prefer to receive this information?
Besides fire, are there any other land management tools or approaches you want to learn more about?

Demographics

Prompts:

What is your age group? 20-40, 40-60, 60+
What is your gender? (Female, Male)
What percentage of your household income is generated from ranching? (0-25%, 26-50%, 51-75%, 76-100%)

What did you hope to get out of this interview. Is there anything we didn't discuss that you'd like to talk about?

Is there anything else you would like to add?

I'm looking for additional farmers or ranchers in your region who are either actively using fire, or want to use fire as a management tool. Do you know anyone who would be a good fit for this study?

