The perceived barriers among Prescribed Burn Association members to burning on Kansas Grasslands and Conservation Reserve Program Lands

by

Wyatt Charles Cheney

B.S., University of Northern Iowa, Geography, 2019

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Geography and Geospatial Sciences
College of Arts and Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2024

Approved by:

Major Professor
Audrey Joslin, Ph.D.

Copyright

Abstract

Prescribed burning, the intentional application of fire to the landscape is used for meeting land management goals like grassland rejuvenation and nuisance species removal. While this practice is beneficial, studies in Oklahoma and Texas reveal barriers to using prescribed fire among individual land managers. Prescribed burn associations (PBAs) are collectives of landowners pooling knowledge and resources together, promoting safe burn practices and reducing many of the the barriers individual land managers otherwise face. This research examines the barriers to prescribed burning in Kansas and examines how PBA membership perceive barriers to prescribed burning on grasslands, including those enrolled in conservation lands. It advances knowledge on the diversity existing between PBAs in different Kansas ecoregions and communities. This study takes a mixed-methods approach that deploys a Qualtrics survey on Kansas PBA members as well as semi-structured key informant interviews with Kansas PBA leaders. My research also analyzes secondary survey data from landowners across the Southern Great Plains and compares their perceptions of burning on CRP to those held by Kansas PBA members. Overall, this research reveals similarities and differences in the perceptions of barriers faced by PBAs in prescribed burning and identifies drought, social perceptions, and liability as inhibitors of PBA prescribed fire application. Designing policy to better support burning in dry conditions and PBA activity and promoting gross negligence liability may help address these barriers to PBAs and increase the use of prescribed fire across Kansas.

Table of Contents

List of Figures vii
List of Tables viii
Acknowledgements x
Chapter 1 - Introduction and Background 1
1.1 Introduction 1
1.2 Literature Review 3
1.2.1 Historical Roots 4
1.2.2 Current Burning Practices and Motivations 5
1.2.3 Barriers to Prescribed Fire 12
1.2.4 Role of Prescribed Burn Associations in addressing Barriers to Individual Burning 17
1.3 Summary 18
Chapter 2 - Methods 21
2.1 Introduction 21
2.2 Study Area 21
2.2.1 Ecoregions 24
2.3 Framework for Analysis 26
2.3.1 Environmental Barriers 27
2.3.2 Political Barriers 27
2.3.3 Practical Barriers 28
2.3.4. Social Barriers 28
2.4 Data 28
2.4.1 Surveys 29
2.4.2 Kansas Prescribed Burn Association Survey 30
2.4.3 Agricultural Producer Survey 33
2.5 Case Studies 36
2.6 Key Informant Interviews 37
2.7 Study Limitations 40

Chapter 3 - Patterns of Commonalities and Differences between Kansas Prescribed Burn Associations 42
3.1 Introduction 42
3.2 Kansas Prescribed Burning Associations 42
3.3 Commonalities between Kansas PBAs: Motivations, actors, and challenges/opportunities 45
3.3.1 Motivations 45
3.3.2 External Actors in PBA Establishment 48
3.3.3 Challenges and Opportunities 49
3.4 PBA Characteristics and Patterns by Ecoregion 53
3.4.1 Central Great Plains 54
3.4.2 Central Irregular Plains 55
3.4.3 High Plains 56
3.4.4 Southwestern Tablelands 56
3.5 Conclusion 57
Chapter 4 - A Comparative Case Study on the Barriers to Prescribed Fire facing the Gyp Hills and Eastern Kansas Prescribed Burn Associations 59
4.1 Introduction 59
4.2 Data 60
4.3 Case Study Comparison 61
4.3.1 The Eastern Kansas PBA and the Central Irregular Plains 61
4.3.2 The Gyp Hills PBA and the Southwestern Tablelands 63
4.4 Aggregated Responses by Barrier for Each Case Study PBA 65
4.5 Differences Between Survey Responses 69
4.6 Conclusion 74
Chapter 5 - Prescribed Fire as a Management Tool for Conservation Reserve Program Lands 77
5.1 Introduction 77
5.2 Secondary Survey Participant Characteristics 78
5.3 Common Barriers to Prescribed Fire on Kansas CRP 79
5.4 Fire use and CRP Enrollment 79
5.5 Factors Contributing to Prescribed Fire use on CRP 81

5.5.1 Age 82
5.5.2 Prescribed Fire Decreases Wildfire Risk 82
5.5.3 Acres of CRP 83
5.5.4 Acres for Grazing 83
5.5.5 Education 84
5.5.6 Financial Security 84
5.5.7 Liability Insurance 85
5.5.8 Drought Frequency 85
5.5.9 Experienced a Wildfire 85
5.6 Logistic Regression Model 86
5.7 Comparing Landowner Perceptions of burning CRP PBA Membership 88
5.8 Conclusions 90
Chapter 6 - Conclusions 93
6.1 Research Summary 93
6.2 Future Directions 95
Bibliography 97
Appendix A - Institutional Review Board Approval Letter 106
Appendix B - PBA Survey 107
Appendix C - Semi-structured Interview Consent Form 134
Appendix D - Semi-structured Interview Guide 137

List of Figures

Figure 1.1 Photo of a firestick. Obtained from Kansas Historical Society, 2008. 9
Figure 1.2 Ring burn diagram (Baldwin et al. 2022a:155) 10
Figure 2.1 Study participants from 44 articles reviewed in Clark et al. 2022 (Map source: Clark et al. 2022) 22
Figure 2.2 Extent of ecoregions in Kansas with a PBA participating in the study (map by author) 24
Figure 2.3 Kansas PBA locations. Crosshatched PBAs were contacted but did not enroll in the study. Grey PBAs participated in the study. Some PBAs are active in multiple states. (map by author) 32
Figure 3.1 Common barriers in each Kansas ecoregion 54
Figure 4.1 Case study prescribed burn associations and level III ecoregions. The GHPBA is active in both Kansas and Oklahoma. (Map by author) 61

List of Tables

Table 2.1 Summarized barrier definitions 27
Table 2.2 Counts of survey responses from each participating PBA. 31
Table 3.1 Characteristics of the interviewed PBAs including year established, membership count in number of individuals, reported membership and burn trends, and the level III ecoregion each PBA falls within. The ASPBA and WAPBA have been inactive due to drought. The SHPBA is too new to show a trend. 43
Table 3.2 Typical burn characteristics for each PBA. * Denotes values from when active. Burn size for WAPBA based on informant burn practices. 44
Table 3.3 Motivations for conducting prescribed burns for each PBA and relevant interview excerpts. 47
Table 3.4 External actors and their roles with PBAs. 49
Table 3.5 Barriers and Opportunities for Kansas PBAs. 53
Table 3.6 Count for each instance a barrier was discussed in key informant interviews. 53
Table 4.1 Counts of survey responses from each participating PBA. One included response did not indicate their PBA. 60
Table 4.2 Case study ecoregion characteristics. Mean annual precipitation is given in parentheses. 63
Table 4.3 Case study PBA comparison. *Standard deviation 64
Table 4.4 Responses to survey statements from case PBAs by barrier type. Statements with * denote agreement contributes to a barrier while ** indicates that agreement reduces a barrier. 66
Table 4.5 Cochran-Mantel-Haenszel test statistics based on all table scores. 69
Table 4.6 Agreement with “Lack of knowledge and burn experience in my community limit the use of prescribed fire.” A value of 1 indicates strong disagreement while 5 indicates strong agreement. 71
Table 4.7 Agreement with “With 1 being very unsatisfied and 5 being very satisfied, rate your satisfaction with the amount of prescribed fire in your community.” A value of 1 indicates very unsatisfied while 5 indicates very satisfied. 72

Table 4.8 Agreement with “Escaped fires have negatively impacted community perceptions of the benefits of prescribed fire.” A value of 1 indicates strong disagreement while 5 indicates strong agreement. 73
Table 4.9 Agreement with “County level regulations inhibit prescribed burns.” A value of 1 indicates strong disagreement while 5 indicates strong agreement. 74
Table 5.1 Summary of Kansas participant characteristics for landowners enrolled and not enrolled into the CRP. Values for all but Gender and College education are the mean with *standard deviation in parentheses. USDA Ag values are from USDA – NASS 2022 AgCensus[a] or USDA – ERS[b] 79
Table 5.2 Observed and expected counts of responses for enrollment into the Conservation Reserve Program and prescribed fire use. Expected values are in parentheses. 80
Table 5.3 Logistic regression results for using prescribed fire on CRP. 87

Acknowledgements

This thesis may not have been completed without the support of many; here, I attempt to acknowledge those who helped along the way. I would first thank my advisor, Dr. Audrey Joslin, as well as my committee members, Dr. Marcellus Caldas and Dr. Matthew Sanderson for their support, guidance, and insight while working through this endeavor. I am deeply grateful for Dr. Joslin's assistance in helping me develop as a researcher and as a professional. I am thankful for Dr. Caldas's help and guidance on the logistic regression aspects of my thesis and through graduate school in general. I am also thankful for Dr. Sanderson's lessons on rural geography and for instilling the motto "It's a marathon, not a sprint."

My family, friends, fellow grad-students, and cat have been strong pillars of support while undertaking this research. My parents, Calvin and Barb have been a constant source of support and encouragement through my education, weathering long drives and days to meet for a few hours. I would like to thank my friends who have been much needed sources of humor and breaks away from research. I am grateful especially for the comments from those who have read early editions of my drafts and the encouragement to keep writing them.

I would like to extend a thank you for the funding I received at Kansas State University. As a student part of the Department of Geography and Geospatial Sciences, I was awarded the Kale Fellowship, which helped me obtain equipment necessary for undertaking this research. I was also awarded the Timothy R. Donaghue Graduate Scholarship. Finally, I am extremely grateful for the opportunity to work as a research assistant on the NSF Project number 2117533, Influence of wildfire risk perception on agricultural land management decisions. Part of my thesis research incorporates findings from a survey that was part of this project.

Chapter 1 - Introduction and Background

1.1 Introduction

Prescribed burning is the intentional application of fire to the landscape and has been used for meeting a variety of land management goals in grassland areas, including combating the spread of woody encroachment. Prescribed fire has been used for stimulating grass growth in cattle pastures and enhancing livestock production while also managing the removal of undesirable woody species and plants (Baldwin et al. 2022a). Prescribed fire has furthermore been found to significantly reduce aboveground fuel loads, such as tree cover from woody encroachment, constraining the size of wildfire events (Rau et al. 2010; Fernandes, 2015). Conservation goals such as restoring native grasslands, increasing plant diversity, and improving soil health and wildlife habitat can also be managed with prescribed fire (Baldwin et al. 2022b). Despite the benefits, there are many barriers limiting the adoption of prescribed fire. Some of these barriers include: risks of legal liability in the event of an escaped fire; landowners lacking experience, resources, or equipment necessary to conduct a burn; and the perception that prescribed burning is a high-risk action (Kreuter et al., 2008, 2019; Toledo et al. 2012). Prescribed burns have also been identified as an air quality concern since burn windows have been linked with elevated concentrations of fine particulate matter like $PM_{2.5}$, which has been associated with spikes in asthma related hospitalizations (Baker et al. 2019; Haikerwal et al. 2015; Huang et al. 2019).

Much of the literature on the barriers to prescribed burning in grasslands examines the perceptions of individual land managers in Texas and Oklahoma (Clark et al. 2022). Past research also points towards Prescribed Burn Associations (PBAs) as a potential way to lessen these barriers (Clark et al. 2022). PBAs are collectives of landowners pooling knowledge and

resources together, promoting safe burn practices and reducing many of the the barriers individual land managers otherwise face. In addition to few studies examining prescribed burning in Kansas, there are a lack of studies addressing barriers to prescribed burning by PBAs in grasslands. Furthermore, given the conservation benefits of using prescribed fire to manage grasslands, it is important to understand perceptions on barriers to prescribed fire use when managing private conservation lands, such as lands enrolled in the Conservation Reserve Program (CRP). This is one of the major conservation initiatives in the United States and is especially common in Kansas which is among the highest in overall acres enrolled by state (USDA, 2023a). Understanding these perceptions is particularly important in light of recent literature indicating that farmers and ranchers may perceive that CRP contributes to wildfire events in the Southern Great Plains (Bergtold et al. 2024). This research plans to address this gap by investigating **how PBA membership across Kansas perceives the barriers to prescribed burning on grasslands, including those enrolled in the conservation reserver program.**

In particular, I investigate how these characteristics and barriers differ on and off CRP across PBAs. More specifically I have three objectives to address my overall research goal:

1) Examine the diversity across PBAs in Kansas ecoregions in terms of their burn activity and perceived barriers for prescribed fire.

2) Assess how barriers for prescribed fire vary between rural and peri-urban contexts.

3) Examine the dynamics of prescribed burning on Kansas lands enrolled in the Conservation Reserve Program between agricultural producers and PBA members.

I take a mixed-methods approach to research to address each of these objectives. For Objective 1, I assess key-actor interviews with leadership in in 6 different Kansas PBAs in four ecoregions. In Objective 1, I hypothesize that *the motivations for and barriers to prescribed fire*

are likely to differ across ecoregions. I expect to find differences in motivations and barriers in different ecoregions because different vegetation and climatic characteristics can be observed in different ecoregions. For Objective 2, I use a survey of the membership in two case study PBAs, one peri-urban and one rural, to identify how prescribed burning barriers differ between contexts. I also include findings from my key informant interviews to aid in survey interpretation. Because of the differences in contexts, I hypothesize *survey responses on the barriers to prescribed fire in different contexts are more likely to be different than similar*. For Objective 3, I use a secondary survey to examine the dynamics of prescribed burning on Kansas lands enrolled in the CRP between agricultural producers and PBA members. In this chapter I examine the association between prescribed fire use and CRP enrollment and identify factors associated with prescribed burning in CRP. I tie in results from my PBA survey and key informant interviews as well to compare the perceptions of burning on CRP between independent producers and PBA members. Understanding these dynamics is important because prescribed fire is one of the options available for landowners when maintaining CRP, however, burning on these lands may be inhibited out of fear of potential wildfires given the fuel load present on CRP lands.

In the next section, I will present relevant literature that provides important background on the place of prescribed fire in grassland ecosystems through describing its historical roots through modern practices and motivations. Then I explain the barriers to prescribed fire pointed out in previous studies. I end with a discussion on the roles of PBAs before a brief summary and outline of this research.

1.2 Literature Review

Generally, a prescribed burn is the intentional use of fire on a landscape (Diaz et al. 2016). Throughout this work, this practice will also be referred to as prescribed fire. Prescribed

fire is typically applied in the Spring and Fall, with a burn frequency of every 1-3 years (Baldwin, et al. 2022a). Prescribed burns are applied to meet a variety of land management objectives. Limiting the encroachment of woody vegetation across the Great Plains is one of the many objectives cited; however, others will be discussed throughout this thesis. The implementation of prescribed burning is contentious and varies spatially and temporally.

1.2.1 Historical Roots

Fire has a deep history across the Great Plains. Many historical accounts of European colonizers recount indigenous peoples' skilled usage of fire for a variety of reasons. Such accounts have mentioned that grass surrounding their campsites were burnt, depriving food for their horses. Other accounts note how fire was also commonly used for hunting bison and manipulating their migration patterns. For example, an area could be burnt to serve as a new pasture or to drive herds to new pastures by depriving them of grass in some places but not others. The ways fire was used varied temporally and spatially as well, as indigenous tribes moved from place-to-place following bison migration, technology changes, and relocation due to Euro-American expansion (Courtwright, 2011).

Other uses of fire include burning grass to stimulate new growth, hunting and war, communication, celebration, revenge, or pleasure. While fire could be used on a hunt, strategic locations were also burnt to act as a lure for bison, encouraging them to graze in convenient locations. Fire was also used to surround or create horseshoe-like shapes, driving herds towards one path of escape where hunters lay in wait. When using fire as a communication tool, these fires were often placed in areas that would be less than ideal camps, helping differentiate them from campfires. Battle victories and defeats were also communicated, as well as practical messages for arrival were all relayed through smoke (Courtwright, 2011).

Fire also saw use in skirmishes between indigenous tribes to surround Spanish colonizers, similar to how it was used in hunts. It also had defensive purposes, such as setting up backfires in response to an incoming blaze to create a zone of burnt vegetation, inhibiting the incoming fire's spread. Smoke and fire could also confuse an opponent by obscuring movements, the number of men, and their locations while also harassing pursuers (Courtwright, 2011).

All this to say, fire was used extensively across the Great Plains, and this widespread usage had an extreme impact on the evolution of the landscape. Through time, the landscape adapted to frequent fire, supporting various species of grasses that not only tolerated but thrived under fire regimes. But as Euro-Americans pushed westward across the Plains, the frequency of these fires decreased significantly with the establishment of towns and settlements (Hoy, 1989). Early settlers did not see the benefits of these practices and this sentiment continued well into the late nineteenth century. An editorial printed in the Walnut Valley Times from 1875 proclaimed, "*Stop the prairie fires! … stop the prairie fires and you stop drought, hot winds and parched crops. Stop the prairie fires and you will save the country from another visitation of grasshoppers… produce regular rainfalls… fill our springs… cause thousands of young trees to spring up… Stop the prairie fires and Kansas is a garden of Eden…*" (KSHS, 1937). Despite the resistance of anti-burn movements, over time, the benefits of prescribed fire began to be recognized.

1.2.2 Current Burning Practices and Motivations

Today, fire is used for many other reasons. The most common reasons these practices are used is to enhance livestock production, remove woody vegetation and nonnative plants while promoting native plant growth, to enhance prairie wildlife habitat, and mitigate the risk of wildfires (Baldwin et al. 2022b). Plants native to the Great Plains have long become accustomed to burning,

and in fact see rapid growth after a fire event (Baldwin et al. 2022a). This rapid growth is especially valuable to ranchers and their cattle. Cattle, especially younger stock, have been found to gain more weight when grazing recently burnt pastures (Baldwin et al. 2022a). Additionally, since prescribed burning requires some amount of vegetation in order to burn, it discourages ranchers from letting their stock overgraze (Hoy, 1989).

As mentioned earlier, removal of woody vegetation is also a common reason for landowners to conduct a prescribed burn. Woody encroachment is a shift from grassland ecosystems dominance to woody plants. While the editorial was proven wrong about many things, the author was correct in regard to young tree-growth. The literature agrees that this growth is partially due to fire suppression by humans (Londe, et al. 2022; Ratajczak et al. 2016) In addition to the increased fire risk of woody landcover discussed earlier, woody encroachment is presents other issues too.

As prairie systems transition to woody systems, many of the ecosystem services offered by prairie are lost. Baldwin et al. (2022a) discussed how these systems offer water storage and filtration – absorbing fertilizer and inhibiting runoff. Prairie systems also offer value in the form of wildlife habitat and ecotourism (Baldwin et al. 2022a). The population of many grassland bird species living in these ecosystems are declining, or even listed as vulnerable for the case of the lesser prairie chicken (Fuhlendorf et al. 2002; Twidwell et al. 2013). Fuhlendorf et al. (2002) found that decline in lesser prairie chickens was more common in “patchier” landscapes where there has been more woody growth, potentially breaking up grassland areas and isolating species and making them more vulnerable. This vulnerable species’ population and range have declined by over 90% in the last 100 years (Fuhlendorf et al. 2002). Grassland transformation to

woodland has a variety of other implications for biodiversity, stream flow and groundwater recharge, and wildfire suppression (Twidwell et al. 2013).

Loss of biodiversity is especially prevalent in grassland environments and seen most demonstrably in grassland birds (Roberts, et al. 2022). While factors like agriculture and urban development play a part in this, woody encroachment has a role not as directly tied to human development (Roberts et al. 2022). However, after re-introducing fire to a mixed-grass prairie, grassland bird species diversity was found to increase while woodland encroachment decreased. Further, Roberts et al. (2022) found the largest increases in grassland bird species richness were in areas treated with prescribed fire, over areas that were left untreated.

Some research has also been done investigating the effects of woody encroachment on streamflow and groundwater recharge. Generally, the literature's consensus on this point is inconclusive. Some studies have found that increased woody species in grasslands decreases streamflow and groundwater recharge (Twidwell et al. 2013). The complex and extensive root systems forming along with woodland systems has also been found to reduce water storage (Twidwell et al. 2013). Prescribed burning can be used to reduce the woody vegetation, freeing up absorbed water.

As the dominant land cover in areas facing woody encroachment changes, it follows that the way fire spreads on these landscapes will change too. Fire interacts and spreads across woodland ecosystems differently from the way it spreads across grasslands. Fires with higher intensity in woodlands often evolve into crown fires, spreading across the tops of taller trees. Fires such as these spread rapidly as sparks burst out and ignite trees several meters away (DeBano et al. 1998). Furthermore, fires with higher flame length, like those occurring in woodland ecosystems are difficult to extinguish. Fire suppression efforts taken at the head are

ineffective when flames are greater than 11 feet in length (Andrews and Rothermel, 1982). Grassland ecosystems are similar to pastures in that they seem to thrive under fire regimes. Fire behavior is also much more consistent and predictable in grasslands than fire in woodlands (DeBano et al. 1998). The stems and leaves of grassland plants ignite easily, they represent a low fuel loading thus even high intensity fires in grassland can have low impacts on soil heating (DeBano et al. 1998). Low fire intensity in prescribed fire can in fact be a problem when trying to use fire as a management strategy, but this will be discussed later on.

While at its core, prescribed burning is applying fire to a landscape, the way a prescribed burn has been implemented can differ from burn to burn, depending upon resources and people available. Older methods often simply involved riders on horseback dragging a rope wired to a kerosene-soaked rag (Hoy, 1989). Another method involved riders dropping matches (Hoy, 1989). Dragging implements like rakes, burning hay bales, or tires are also older examples of ignition sources (Baldwin et al. 2022).

Modern day practices are more sophisticated and strategic, both with the tools and equipment employed, but also with the planning and preparations involved in a prescribed burn. Today, horses have been replaced with all-terrain vehicles and trucks equipped with ignition devices, sprayers, or back-up water supplies (Baldwin et al. 2022a). Ignition devices have also evolved from matches and tires to drip torches, firesticks (Baldwin et al. 2022a), or welding torches, or even army surplus flame-throwers (Hoy, 1989). Firesticks are essentially steel pipes where one end has been capped and the other plugged. This plugged end has a small hole drilled through and the pipe is filled with gasoline. The dripping end is stuck into a fire that is already set and then drug along the grass (Hoy, 1989).

Figure 1.1 Photo of a firestick. Obtained from Kansas Historical Society, 2008.

Many burns are planned years in advance (Baldwin et al. 2022a). There are many considerations when choosing where to burn including whether an area has been burned in the last year or an areas precipitation or grazing history (Baldwin et al. 2022a). After choosing where and when to burn, neighbors receive notice in case they also want to burn their land or prevent fire from spreading onto their property (Hoy, 1989). A typical burn will have a crew of approximately 6 people (Hoy, 1989), consisting of neighbors, family members, or employees (Baldwin et al. 2022a). Burns can also be conducted by PBAs. These are groups of local landowners or other citizens that come together and conduct burns, combining their resources and experience to make prescribed fire a safer practice (Diaz et al. 2016). With the crew assembled and the equipment gathered a burn can commence.

When conducting a burn, a common pattern a crew uses is called a “ring burn” (Baldwin et al. 2022a). This pattern is popular because it minimizes the chances of a fire escaping by creating a firebreak using backfires (Baldwin et al. 2022a). When starting a ring burn, two ignitors start in the downwind corner or side of a property (Baldwin et al. 2022a). Each ignitor is followed by a crew member with a sprayer to extinguish fires moving into or across a fireguard (landscape feature like road, stream, fence, etc.), while the ignitors follow along the fireguard and meet in the opposite corner (Baldwin et al. 2022a). Once the ignitors meet again, a head fire is lit, burning the rest of the unit (Baldwin et al. 2022a).

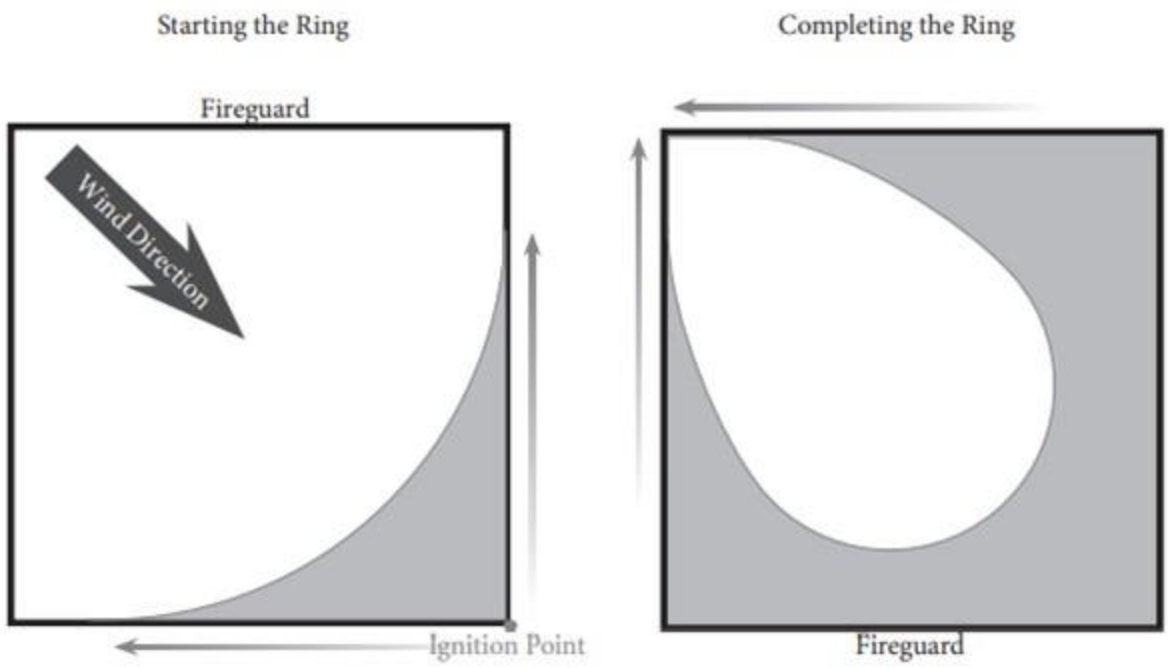

Figure 1.2 Ring burn diagram (Baldwin et al. 2022a:155)

There is a growing body of literature on the effects and uses of prescribed fire. While its application in limiting the spread of woody encroachment in grassland systems is widely studied, the effectiveness of prescribed fire for managing the encroachment is under scrutiny. Part of this comes from the frequency in which fire is applied. Even in the Flint Hills, a region that is generally known for its early adoption of prescribed fire and strong fire culture (Baldwin et al. 2022), is facing a growing rate of woody encroachment, similar to counties in regions that receive less fire as a management strategy (Londe et al. 2022). Rising encroachment was found across counties in the Flint Hills, Rolling Red Hills, and Edwards Plateau regions of the Great Plains (Londe et al. 2022). Tree coverage was calculated and compared between 2000 and 2019. The Flint Hills exhibited the highest percent change, initially starting at 180,770 km² and then expanding to 265,002 km² in 2019 (Londe et al. 2022). The Rolling Red Hills started with 101,763 km² and ended with 141,659 km² (Londe et al. 2022). The Edwards Plateau had the highest initial tree coverage, starting with 2,002,122 km² and ending with 2,375,052 km² (Londe

et al 2022). Despite the awareness of woody encroachment, and the practices in place, it seems prescribed fires current usage is not enough in these areas to limit the rate of spread.

Some studies have investigated the effectiveness of prescribed fire on woody encroachment. Ratajczak et al. (2016) for example, concluded that as much as approximately 56% of the Flint Hills are not burned frequently enough to prevent woodland transitions. A fire interval of 1 to 3 years has been found to be frequent enough to limit encroachment, occurring approximately 43% of the Flint Hills (Ratajczak et al. 2016). The effectiveness of prescribed fire has also been analyzed in areas with infrequent burn regimes. A part of the Konza Prairie had not had a prescribed burn on it since 1975, although there were two instances of wildfire activity in 1991 (Nippert et al. 2021). After burning in April 2017, vegetation surveys were conducted between late May and early August of the same year, identifying 3,020 individual woody species (Nippert et al. 2021). During this short time span, even though many of the species were damaged by the fire, they were still alive and had started resprouting (Nippert et al. 2021). The 2017 vegetation survey found that approximately 53.9% *J. virginiana*, one of the most common woody plants associated with woody encroachment, was successfully burnt in the fire (Nippert et al. 2021). A follow up survey conducted in 2019 found an additional mortality of 23.3%, for a total 77.2% (Nippert et al. 2021). While a significant amount of woody vegetation was burnt, the single fire had minimal impacts on resprouting woody species, indicating the need for other solutions (Nippert et al. 2021).

Fire has deep historical roots in the Great Plains; especially in the Flint Hills ecoregion. In fact, much of the research on prescribed fire comes from the Flint Hills (Baker et al. 2019; Baldwin et al. 2022a; Hoy, 1989; Ratajczak et al. 2016). Prescribed fire is a common practice here. In part, this is driven its early adoption among ranchers migrating to the region in the late

1800s (Hoy, 1989). Another factor in the history of fire within the Flint Hills may be the influence of research institutions like Kansas State University. Researchers apply and study prescribed fire in the nearby Konza Prairie, one of the last in-tact stretches of tall grass prairie in North America. University extension also hosts events educating attendants on how to conduct a prescribed burn, potentially supporting engagement with the practice.

Today, there are a variety of reasons landowners may want to use prescribed burning. Ranchers may find it a favorable practice to stimulate their pastures, benefiting from the increased growth in their livestock grazing on new grass. The stimulated growth is also valuable to biodiversity, being a benefit to vulnerable grassland birds. It has also been found to be effective to varying degrees at combating woody encroachment. Although there are various benefits for prescribed fire, there are many barriers with the implementation of this practice.

1.2.3 Barriers to Prescribed Fire

Prescribed burning is a controversial topic. Perceptions of implementing these practices vary by time and space. For example, prescribed burning is a fairly common practice implemented by landowners and ranchers in the Flint Hills (Hoy, 1989), but is not practiced consistently throughout the Great Plains. More recently, landowners within the Great Plains have been forming Prescribed Burn Associations (PBAs) to promote burning and reduce barriers to individual landowners conducting burns. Landowners in Nebraska, Texas, and Oklahoma were among the first to have formally grouped together to conduct burns as way to limit the encroachment of woody plant species like *Juniperus spp*. (Weir, Twidwell, and Wonkka, 2016). At the time of writing, there are approximately 118 PBAs throughout the United States (GPFSE, 2022). Despite the growing number of PBAs, there are many regions where constraints and barriers limit the implementation of these practices. Other barriers to individual landowners

using prescribed fire include lack of resources or training (Clark et al. 2022). As mentioned earlier, there is a variety of equipment required to safely conduct a prescribed burn.

Some of the most prominent constraints and barriers on prescribed fire include the perceptions of landowners and managers, legal liability, and environmental concerns such as air quality and wildfires (Stroman et al. 2020, Kreuter et al. 2019, Baker et al. 2019). That said, there are other regions where landowners see benefits of prescribed fire, like the Flint Hills. There is a growing body of literature exploring how these perceptions differ, and exploring the perceived risks, benefits and constraints of prescribed fire.

The Edwards Plateau, an eco-region located in Texas, and mentioned earlier, has been the area of interest for a few studies (Kreuter, et al. 2008; Kreuter et al. 2019). In 2008, Kreuter et al. conducted a survey of Texas landowners who were non-members and members of the Edwards Plateau Prescribed Burn Association (EPPBA) (Kreuter et al. 2008). Of the 364 respondents, 38% reported to have implemented prescribed fire on their land (Kreuter et al. 2008). These respondents indicated that insufficient resources, insufficient knowledge, liability concerns, and lack of assistance with burn plans were considered the most prominent reasons for not using fire (Kreuter et al. 2008). Participants who do not use fire also identified various measures for encouraging prescribed burning, indicating reduced liability, burn plan assistance, and cost sharing of resources to be the important factors in this (Kreuter et al. 2008).

In a later study, Kreuter et al. (2019) identified legal liability again as a deterrent to prescribed fire. Specifically, Kreuter found that landowners who perceived high levels of legal liability were less likely to implement prescribed fire on their own lands. This sentiment extends to assisting in the application of fire on the property of other landowners as well (Kreuter et al. 2019). Additionally, 43% of the 680 usable responses indicated that they had been prevented

from burning because of burn bans during hot, dry periods. (Kreuter et al. 2019), finding an additional barrier to prescribed fire.

Landowner perceptions and preferences for woody plants and prescribed fire have also been examined (Stroman et al. 2020). This included asking participants about woody plant coverage on their property (Stroman et al. 2020). Overall, while respondents indicated a preference for less woody plant coverage, these preferences had no effect on landowner use of prescribed fire (Stroman et al. 2020). Differences in woody coverage were found to be associated with differences landowner goals. For example, respondents whose land was used for hunting and recreational purposes were more likely to prefer woody plant coverage, while ranchers wanted more grassland coverage (Stroman et al. 2020). These three studies (Kreuter et al. 2008; 2019; and Stroman et al. 2020) all target individual landowners in the Edwards Plateau (central Texas) and the Rolling Plains (east and northcentral Oklahoma). Comparing PBA member perceptions with nonmembers is a focus in the three papers, thus the literature is limited to regions with an established PBA. Broadly speaking, PBA members tend to be more comfortable with using prescribed fire and more likely to perceive it as beneficial than nonmembers (Kreuter et al. 2008; 2019; and Stroman et al. 2020).

Perceptions and constraints of prescribed fire have also been studied in North Dakota (Bendel et al. 2020). This study analyzed two counties per North Dakota eco-region (Missouri Plateau, Drift Prairie, and Red River Valley). Of the 96 respondents, 38% self-identified ranchers agreed that prescribed fire was useful, while 43% disagreed (Bendel et al. 2020). Only around 9% of the ranchers had ever used fire on their lands. Non-rancher participants held a more positive attitude toward prescribed fire, 55% agreeing that it is a beneficial tool for rangeland restoration (Bendel et al. 2020). Perceived constraints were also investigated. Conflicting with

Kreuter et al. (2008, 2019) and Stroman et al. (2020), Bendel et al. (2020) found knowledge and experience to be weaker constraints. More prominent constraints included time, financial resources, and labor/equipment (Bendel et al. 2020).

One of the more recent potential barriers emerging from the literature is tied to the risk of using prescribed fire on lands enrolled into the Conservation Reserve Program (CRP). This is a major conservation initiative in the United States that is administered by the Farm Service Agency under the U.S. Department of Agriculture. In this program, landowners may agree to enroll land from their agricultural operation into the program in return for payments depending on the amount of acres enrolled and state enrolled in. Enrolled lands are removed from agricultural production and are planted with vegetation that helps restore natural landcover like native grasses to help recover water quality, prevent soil erosion, and promote wildlife habitat (Farm Service Agency, 2024). Enrollment involves carrying out a mid-contract management practice like disking or burning at least once during the 10-15 year enrollment period. While ecologically beneficial, these grasses provide additional fuel load, potentially increasing the risk of a fire escape when burning on these lands (Stritzke, 1996). Furthermore, Bergtold et al. (2024) found that landowners with more land enrolled into the CRP were more likely to perceive an increase in wildfire frequency. These perceptions may be driven by the high fuel loads on these lands due to the abundance of dry, natural grasses promoted by the program (Stritzke, 1996). This research examines the perceived risk on applying prescribed fire to these lands, in light of CRP enrollment's contribution to perceiving increased wildfire frequency and higher fuel loads.

Overall, it seems that perceptions towards prescribed fire and woody encroachment vary from state to state. Landowners perceiving high risks of legal liability are much less likely to participate in or implement prescribed burns. Insufficient knowledge and resources have also

been identified as barriers to prescribed fire. A lack of assistance in creating burn plans and burn bans also contribute to inhibiting the application of prescribed fire to the Great Plains. Landowners may also prefer woody coverage, depending on their goals for land ownership, such as if they are using land as hunting ground or for some other recreational purpose.

While liability, lack of knowledge, labor, and resources have been identified as barriers to prescribed fire, there are also health and environmental concerns with these practices. Air quality during burn seasons is one such area of concern. In the Flint Hills, roughly 800 thousand acres are burnt per year (Baker et al. 2019), burning around 14% of all grasslands within this ecoregion (Baker et al. 2019). This is concerning for air quality because Baker et al. found a relationship between periods of burn activity and higher levels of organic carbon, elemental carbon, and potassium (Baker et al. 2019). Furthermore, ozone, ammonia, sulfur dioxide and oxidized nitrogen gasses were also found to increase with high prescribed fire activity (Baker et al. 2019).

Prescribed burns also have been linked to emitting particulate matter less than 2.5 micrometers in diameter, or $PM_{2.5}$ (Baker et al. 2019, Haikerwal et al., 2015). These particles have can have adverse health impacts, and peaks in their emission during periods of high prescribed fire activity have been associated with heightened asthma related hospitalizations (Huang et al. 2019). While these findings are alarming, doing away with prescribed fire may not be the solution as it helps reduce the impact of wildfires (Rau et al. 2010; Fernandez 2015). Researchers expect wildfire activity to increase in the southern Great Plains (An et al. 2015; Donovon et al. 2017) and other studies indicate that wildfire incidents have higher concentrations of emissions than prescribed burns (Jaffe et al. 2020; Liu et al. 2017).

In addition to having a detrimental effect on air quality, (Jaffe et al. 2020) wildfires and their associated smoke present a variety of hazards to human life. These can include economic

disruptions and loss (Lappe and Vargo, 2022; Wang et al. 2021). Agricultural producers like cattle ranchers have also reported livestock evacuations and pasture loss, as well as livestock losses from pneumonia due to smoke inhalation (O'Hara et al. 2021).

Given the damages and loss associated with wildfire events (Jaffe et al. 2020; Lappe and Vargo, 2022; O'Hara et al. 2021; Wang et al. 2021) and the expected increase of activity in the Southern Great Plains (An et al. 2015; Donovon et al. 2017), there is growing demand for prescribed fire. This management practice has been found reduce the impact of wildfires (Rau et al. 2010; Fernandez 2015) and has many benefits for grassland ecosystems (Baldwin et al. 2022b; Roberts et al. 2022). It has also been found to be more economically feasible than other vegetation management strategies (Kreuter et al. 2008; Toledo et al. 2012). Thus, addressing the barriers and challenges to the expanded use of prescribed fire is of utmost importance.

1.2.4 Role of Prescribed Burn Associations in addressing Barriers to Individual Burning

PBAs have had some success in addressing these challenges. One of the main benefits of establishing a PBA is that the members can pool their labor, equipment, and experience together, providing the practical aspects necessary to conducting a burn (Diaz et al. 2016). Social barriers like perceiving high levels of risk with prescribed fire can also be addressed with PBAs as members gain familiarity with the practice (Toledo et al. 2012). For example, in a survey conducted by Toledo et al. (2012) PBA member and nonmember perceptions toward prescribed fire were compared. The researchers found that 49% of nonmembers with a pro-burning attitude perceived the practice to be high-risk whereas none of the pro-burn PBA members viewed prescribed fire as highly risky (Toledo et al. 2012). Furthermore, perceived level of risk toward prescribed burning was found to lower with years of experience using prescribed fire (Joshi et al.

2019). PBAs also provide a social network that supports prescribed fire and helps build social capital among their members while promoting willingness to engage with prescribed fire (Toledo et al. 2014).

PBAs provide their membership with training and opportunities to burn that are valuable in lowering risks associated with engaging with prescribed fire (Diaz et al. 2016; Toledo et al. 2012; Joshi et al. 2019). Toledo et al. (2012) also posit that PBAs have potential in helping reduce concerns over legal liability when applying prescribed fire by increasing membership burn capacity through training opportunities and other burn resources. These associations also help support expanding prescribed fire use by building social capital and willingness to apply the management practice (Toledo et al. 2014). While building membership confidence and lowering individual perceptions of risk, PBAs also directly address negative perceptions to burning (Diaz et al. 2016; Weir et al. 2016). In one incident, a Texas PBA overcame misplaced accusations of property damage from a fire caused by a welder and were issued an apology in the local newspaper (Weir et al. 2016).

1.3 Summary

In this chapter, I identified my overarching research question and objectives. I furthermore provided background relevant to this study, including an overview of the historical roots, modern practices, and motivations for using prescribed fire; explanation of the barriers to prescribed fire from previous studies; and discussion on the roles of PBAs. Ranchers can benefit from managing their land with controlled burns with enhanced growth in grazing livestock. Prescribed burns also help land managers achieve conservation-oriented goals like restoring native grasslands, increasing plant diversity, improving soil health and enhancing wildlife habitat. This practice has also been found to be the most economically efficient method for

removing species like eastern red cedar, which are part of a growing issue of woody encroachment on grassland ecosystems. Woody encroachment has been linked to wildfire intensification in the Southern Great Plains, decline in grassland bird populations and water uptake. While there are many benefits for prescribed fire, there are many barriers to the practice's wider use.

While previous studies have identified barriers to prescribed fire, this research has primarily been conducted in Texas and Oklahoma. Furthermore, there is a dearth of research conducted on prescribed fire use on private conservation lands such as land that has been enrolled into the Conservation Reserve Program. This study addresses these gaps by focusing on barriers to prescribed fire in Kansas, one of the states with the highest CRP enrollment by acre with an added focus on CRP. This research is also novel because it uses a mixed methods approach rather than utilizing a survey alone. Based on previous studies, I have outlined definitions of common barriers to prescribed fire. I used these to inform Qualtrics survey and semi-structured interview guide. When coding the interview transcripts, I coded for these definitions in my interview transcripts for a qualitative analysis. I additionally use a secondary data source for examining significant factors contributing to prescribed fire use on CRP.

Using this mixed approach, I answer my research question asking how PBA membership across Kansas perceives the barriers to prescribed burning on grasslands, including those enrolled in the Conservation Reserve Program**.** Answering this research question provides an expansion to the research conducted in other states within the Southern Great Plains through its focus on Kansas and private conservation lands. It also offers an analysis of the barriers facing PBAs as a collective while also examining the barriers perceived by people experienced with using prescribed fire when conducting burns both on and off lands enrolled into the CRP.

Finally, it creates an account for PBA characteristics that are valuable in securing additional resources needed to support the efforts of these associations. The next chapter will address methods, followed by chapters addressing each one of my objectives. I end by summarizing major findings from this thesis project.

Chapter 2 - Methods

2.1 Introduction

This chapter outlines and justifies the methods I used in my research. To address my overarching research question, I chose a mixed methods approach. Mixed methods research incorporates aspects of both qualitative and quantitative analysis and applies them to inform and strengthen interpretations of research findings through triangulation (Johnson, Onwuegbuzie, & Turner, 2007; Sieber, 1973). After presenting details on Kansas, my study region, I discuss the details of the two surveys and the interviews used in this study as well as the methods used in their analysis. I explain the limitations of my research at the end of this Chapter.

Mixed methods research leverages strengths from both quantitative and qualitative research approaches. Utilizing both can inform and support interpreting research findings (Johnson et al. 2007; Sieber, 1973). Additionally, triangulation strengthens confidence in results by reaching similar conclusions using multiple approaches (Johnson et al. 2007). Quantitative and qualitative approaches support each other; the generalizability of qualitative findings can be tested quantitatively. Furthermore, quantitative findings may be contextualized, clarified, or validated qualitatively (Johnson et al. 2007; Sieber, 1973). I blend the two approaches by using two surveys and including questions in my interviews that enhance survey interpretation.

2.2 Study Area

Kansas, my study area, is a valuable addition to prescribed fire research, as examination of prescribed burn associations in the Sunflower State differs from states in previous studies. It offers novelty in terms of liability policies and ecosystem characteristics. The state itself has not been thoroughly studied in terms of the barriers to prescribed fire as a majority of this research

has focused on parts of Texas and Oklahoma (see figure 2.1) (Clark et al. 2022). Thus, little is known about the perceived barriers in the various ecoregions and PBAs across the state.

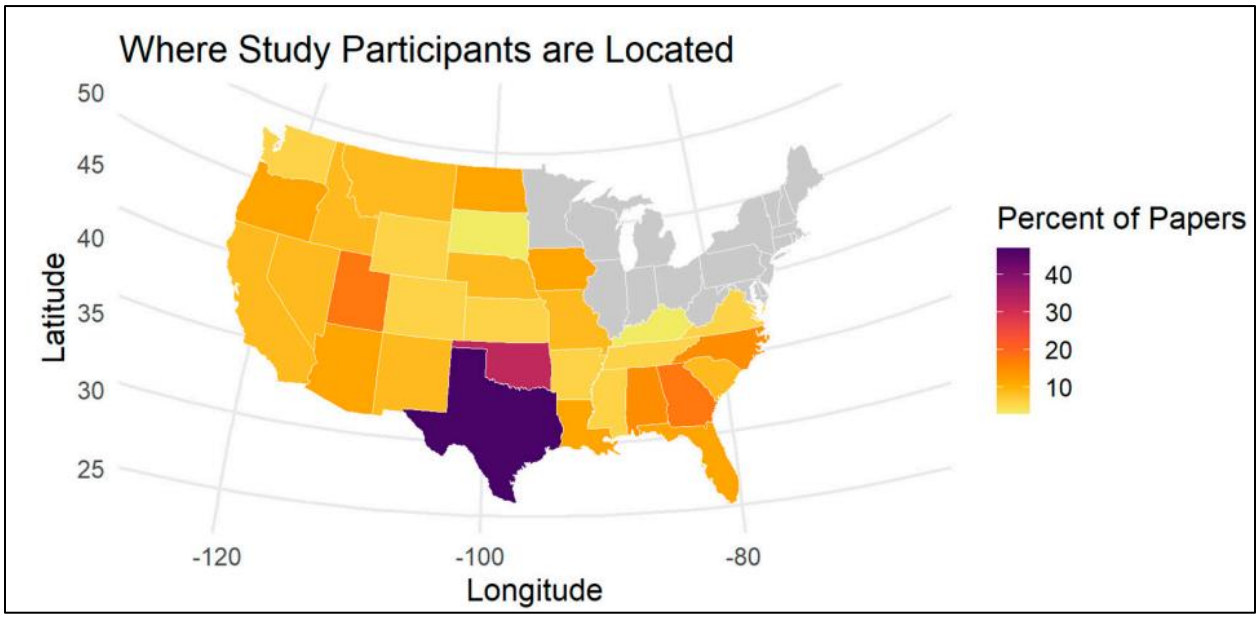

Figure 2.1 Study participants from 44 articles reviewed in Clark et al. 2022 (Map source: Clark et al. 2022)

One slight difference between Kansas and the states in previous studies are liability practices for prescribed fire. These practices can vary from state to state, but typically go into one of three categories: strict liability, simple negligence, and gross negligence (Wonkka, Rogers, & Kreuter, 2015). To clarify, strict liability policies hold the ignitors responsible for the property damages due to an escaped prescribed burn, regardless of actions taken by the burner (Wonkka et al. 2015). On the other hand, gross negligence policies include language specifying that a burner must show recklessness or blatant disregard of care toward others through their actions (Wonkka et al. 2015). Lastly, simple negligence policies necessitate that burners take reasonable care in conducting a prescribed fire, requiring a plaintiff to show the defendant as negligent in order for the defendant to be liable for damages (Wonkka et al. 2015). While Texas and Oklahoma follow simple negligence policies, the liability policy for Kansas is undefined (Wonkka et al. 2015); this means Kansas follows simple, or ordinary negligence.

While Kansas, Oklahoma, and Texas are similar by following simple negligence, Kansas stands out because it is undefined and there is precedence for agricultural producers having a "right to burn." In the legal case *Koger v. Ferrin,* 1996 (Kan. Ct. App. 1996) the Court takes a clearly pro-burn stance, including language like ". . . the utility of pasture burning is so great, and it is so clearly sanctioned by universal use, that strict liability, even on the part of industrial enterprises, is not considered convenient or desirable," and "In Kansas, farmers and ranchers have a right to set controlled fires on their property for agricultural purposes and will not be liable for damages resulting if the fire is set and managed with ordinary care and prudence, depending on the conditions present" (Kan. Ct. App. 1996). This pro-burn stance in Kansas courts adds further value to using the Sunflower State as a study area.

Given its diversity in ecoregions, differences in liability practices from previously studied states like Oklahoma and Texas, and "right to burn" precedence in the Court of Appeals of Kansas, the state offers novelty in its study. There has been little if any research that focuses on the Prescribed Burn Associations (PBAs) located around Kansas. Furthermore, extant research focuses on barriers to individual land managers in prescribed burning (e.g. Clark et al. 2022) whereas this study examines collective organizations that engage in prescribed burning practices. PBAs themselves are identified as a mechanism to reduce barriers to prescribed burning (Clark et al. 2022; Kreuter et al. 2008), but there is little acknowledgement that PBAs themselves may face different challenges based on their context. Therefore, this study includes PBAs across different ecological and land management contexts.

Across Kansas there are 16 of these associations (see Figure 2.2). Part of this research includes a "first look" into the associations in Kansas and what challenges they may be facing, and how these challenges vary across different contexts. This study may therefore provide

valuable information that can inform policy making decisions to better support PBAs. It also provides general knowledge on association characteristics like membership counts, burn motivations, and burn unit size, demonstrating variation among PBA characteristics.

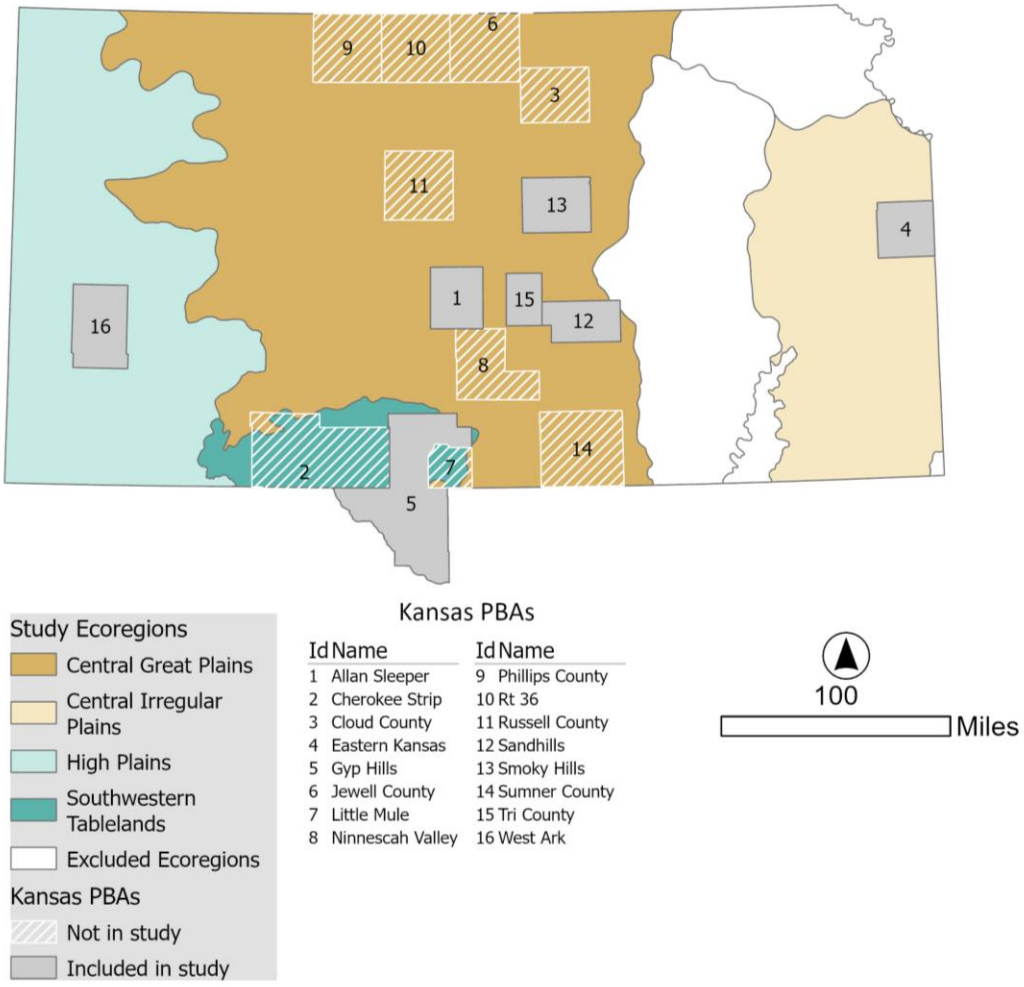

Figure 2.2 Extent of ecoregions in Kansas with a PBA participating in the study (map by author)

2.2.1 Ecoregions

Kansas contains eight Level III ecoregions. Ecoregions are areas of general similarities, identified by a series of environmental characteristics such as land use, land surface form, vegetation, and soil characteristics (Omernik, 1987). Ecoregions have varying levels of detail, but level III ecoregions are widely used (Kreuter et al. 2008; Kreuter et al. 2019; Toledo et al.

2012; Podschwit et al. 2021). Ecoregions are developed on a scale of I to IV, with I being the most generalized and IV the most detailed. I include ecoregions because while many survey efforts focusing on perceptions of prescribed fire state which ecoregions the counties within the study sample frame are part of the uniqueness and context of the ecoregions are often not discussed in depth (Kreuter et al. 2008; Kreuter et al. 2019; Toledo et al. 2012). Furthermore, Podschwit et al. (2021) found statistically significant differences across different level III ecoregions in terms of area burnt using prescribed fire. While level IV ecoregions may offer more detail, I opt to use level III ecoregions to avoid subdividing at the county level as some counties may contain more than one level IV ecoregion.

The Central Great Plains ecoregion spans from central Nebraska to north-central Texas and denote a transition between tallgrass prairie of the eastern to the shortgrass prairie of the west (Wiken, Nava, & Griffith & 2011). This ecoregion consists of mixed-grass prairie with scattered trees and shrubs. Other vegetation includes plants like little bluestem, big bluestem, sideoats grama while the southern reaches include species like honey mesquite, sand sagebrush, and Texas wintergrass. Within the Central Great Plains ecoregion, the dominant land use is irrigated cropland, as well as some pasture and rangeland (Wiken et al. 2011). This ecoregion contains the Allan Sleeper PBA (ASPBA), Sandhills PBA (SAPBA), Smoky Hills PBA (SHPBA), and Tri-County PBA (TCPBA).

Southwest of the Central Great Plains ecoregion lies the Southwestern Tablelands (Wiken et al. 2011). This ecoregion occupies only a small area in southwest Kansas. The Southwestern Tablelands includes shortgrass and midgrass prairie vegetation, scattered sand sagebrush, and some areas of pinyon pine, Rocky Mountain Juniper, and oneseed juniper. Water sources are scarce and the terrain is rugged with canyons and gorges that break up the broad, rolling plains.

Ranching and grazing are the dominant land uses, although smaller patches of hay, alfalfa, corn, and sorghum are cultivated (Wiken et al. 2011). This ecoregion contains the Gyp Hills PBA (GHPBA).

The Central Irregular Plains extends from includes parts of southern Iowa, northwestern Missouri, eastern Kansas, and northeastern Oklahoma (Wiken et al. 2011). This ecoregion is characterized by a mosaic of forested areas and allgrass prairie, and common perennial streams. Greater access to surface water promotes a variety of cropland activity, as well as reliance on the region's forests and grasslands (Wiken et al. 2011). This ecoregion contains the Eastern Kansas PBA (EKPBA).

Moving westward, the High Plains ecoregion extends from southeast Wyoming, west Nebraska, and east Colorado down through western Kansas to the panhandles of Oklahoma and Texas (Wiken et al. 2011). The High Plains has more of a steppe climate, drier than the Great Plains, and is characterized by vegetation like sort and midgrass prairie. The High Plains also has intermittent and ephemeral streams, rather than perennial water sources. The drier climate here promotes grazing and limits crop activity to wheat and sorghum primarily (Wiken et al. 2011). This ecoregion contains the West Ark PBA (WAPBA).

2.3 Framework for Analysis

Clark et al. (2022) identified various "barrier builders" and "barrier busters" in a variety of categories including: social, knowledge, practical, and regulations. The general categories as well as previous studies on the perceptions of prescribed fire were used in my study to develop categories of barriers to PBAs in conducting prescribed burning.

These categories then informed the questions I include in my prescribed burn association survey and semi-structured interview guide. I created the following categories and definitions

for environmental, political, practical, and social barriers for my qualitative analysis. These categories also help with generalizing and comparing the impact of these barriers between Kansas PBAs and ecoregions. The categories are summarized in table 2.1 but are discussed in more detail in the following subsections.

Table 2.1 Summarized barrier definitions

Barrier	Definition
Environmental barriers	Environmental barriers are physical features of the environment that may inhibit the number of prescribed burns.
Political barriers	Political barriers are factors like policies or regulations that limit engagement with prescribed burning.
Practical barriers	Practical barriers to prescribed fire are a general need of a component necessary for conducting a prescribed burn.
Social barriers	Social barriers include the influence of negative perceptions of prescribed fire within familial and communal social circles on engagement with prescribed burning.

2.3.1 Environmental Barriers

Environmental barriers are physical features of the environment that may inhibit the number of prescribed burns. These factors include weather conditions with high wind speeds or variability in wind direction, humidity, temperature, recent precipitation, soil moisture, and drought conditions (Baldwin et al. 2022a; Weir et al. 2015). Temperature, moisture, and wind are especially important when burning, as they greatly influence fire behavior (Waldrop and Goodrick, 2012).

2.3.2 Political Barriers

Political barriers are factors like policies or regulations that limit engagement with prescribed burning. Studies have identified air quality regulations and environmental laws to

limit prescribed burns (Elmore et al. 2010; Quinn-Davidson and Varner, 2011). Fear of legal liability for the damages of an escaped burn event also limits engagement with controlled burning (Morton et al. 2010; Toledo et al. 2012; Kreuter et al. 2008). These regulations may differ from county to county, some implementing more restrictive regulations to limit the impact of burn smoke on air quality (Baldwin et al. 2022).

2.3.3 Practical Barriers

Practical barriers to prescribed fire are a general need of a component necessary for conducting a prescribed burn. Needs commonly identified in literature include knowledge, resources, experience and equipment used in the burn itself (Polo et al. 2020; Taylor, 2005; Toledo et al. 2012). A lack of adequate labor in terms of the number of people needed to conduct a burn is also included within this category.

2.3.4. Social Barriers

Lastly, social barriers include the influence of negative perceptions of prescribed fire within familial and communal social circles on engagement with prescribed burning. Public perceptions have been commonly identified as a barrier to the expansion of prescribed fire (Quinn-Davidson and Varner, 2011; Schohr et al. 2019). This is because community members may be more likely to perceive prescribed fire's negative impacts over the positive benefits (Hamilton and Salerno, 2020; Harr et al. 2014). This barrier may also be attributed to risk aversion, fire escape concerns, and unawareness of the practice's benefits among community members (McCaffrey, 2005; Schultz et al. 2019).

2.4 Data

My overall thesis research utilizes three data sources; two surveys and a set of transcripts derived from semi-structured interviews with PBA leaders. A Qualtrics survey distributed to

Kansas PBA members and the transcripts are primary data and approved by the Kansas State Institutional Review Board under Proposal Number IRB-11737. In addition, I analyzed a secondary data source in form of a mail survey sent to agricultural producers in the Southern Great Plains approved under Proposal Number IRB-10721, NSF award number #2117533. My third chapter analyzes the interview transcripts while chapters four and five focus on the PBA member surveys, and producer surveys, respectively. The survey instrument and interview guide I use for my primary data sources can be found in the appendix (see Appendix B). In the following sections, I describe the sources in greater detail.

2.4.1 Surveys

Surveys are a very common technique for geographic research (McLafferty, 2010) and have been widely applied studying the perceptions of prescribed fire in previous studies (e.g. Clark et al. 2022; Kreuter et al. 2008; Kreuter et al. 2019; Toledo et al. 2013). In a literature review of barriers to prescribed burning, Clark et al. (2022) found that 28/44 (64%) reviewed journal articles on barriers to prescribed fire were quantitative works relying data collected thorough postal and web surveys. Surveys can provide useful information when no other sources exists and can help researchers understand complex behaviors and social interactions (McLafferty, 2010). Web surveys are also growing in popularity, offering an advantage through ease of deployment with low costs (McLafferty, 2010). Surveys deployed online using services like Qualtrics have also been used to analyze risk perceptions while working with PBAs, as seen in Joshi et al. (2019). I use surveys to address my second and third research objectives. In the following sections, I describe the survey I deployed for my case study on two Kansas PBAs in distinct communities in Chapter 4. I also discuss the secondary agricultural producer survey on wildfire risk, focusing on CRP and prescribed fire in Chapter 5.

2.4.2 Kansas Prescribed Burn Association Survey

For part of my research, I developed a survey to primarily address my second research objective: assess how barriers for prescribed fire vary between rural and peri-urban contexts. For more information on PBAs, see Chapter 1; Chapter 2 contains more information on the PBAs participation in this research. Toward meeting this objective, I used an online Qualtrics survey to gather information from members of Kansas PBAs. The survey began with an informed consent page detailing the survey's contents and importance, along with a confidentiality statement and participant rights. The survey also included questions over participants' history with their PBA, perceptions on barriers to prescribed fire, usage of prescribed burning on lands enrolled in the Conservation Reserve Program, farm or ranch characteristics, and demographic information. Each question about barriers corresponded with a category from the framework of prescribed burning barriers described earlier in this chapter. The survey was developed with feedback from two key informants in PBA leadership roles. I sent lists of the survey questions and responses to pre-testers and received their feedback via phone-call and email. With their feedback, some questions were adjusted or removed. Pretesting can help improve the survey instrument by identifying areas that may be expanded or removed to maximize survey results without overtaxing participants (Sieber, 1973).

I obtained contact information from 16 Kansas PBAs from the Kansas Grazing Land Coalition (KGLC, 2023) and the Prescribed Fire Council. Each of these resources provided contact information for PBA leaders on their websites. I sent an initial email out to the available leadership email addresses, giving a brief description of the study's focus. The initial email also asked if the leaders would share other members' email addresses or be willing to distribute the survey on my behalf. A follow-up email was sent out to non-respondents after two weeks, giving

time for contacts to respond. When applicable, non-respondents were also contacted via phone one week after the follow-up email. Failing this, no further contact was attempted and were assumed to be not interested in participating.

After PBA leaders expressed an interest in the study, I solicited them for a future interview over the survey responses before sending out the survey link. I deployed the survey in the middle of August 2023, and it remained active until early September of 2023. This gave respondents a three-week window to complete the survey. Overall, contact was made with seven of the PBAs and seven opted to participate in the study (See figure 2.1). One of the PBA members took the survey, despite not having heard from its leadership. The survey yielded a total of 28 responses, 25 of which were fully complete. The other three were incomplete or declined participation, however, one incomplete response was also used as only the demographic questions were left unanswered. Table 2.2 shows the overall count of survey participants from each PBA while figure 2.3 shows the PBA locations. One included response did not indicate which association they are part of.

Table 2.2 Counts of survey responses from each participating PBA.

PBA	**ASPBA**	**EKPBA**	**GHPBA**	**SAPBA**	**SHPBA**	**TCPBA**	**WAPBA**	**Unknown**
Count	1 (4%)	9 (36%)	7 (28%)	1 (4%)	2 (8%)	3 (12%)	1 (4%)	1 (4%)

N = 25

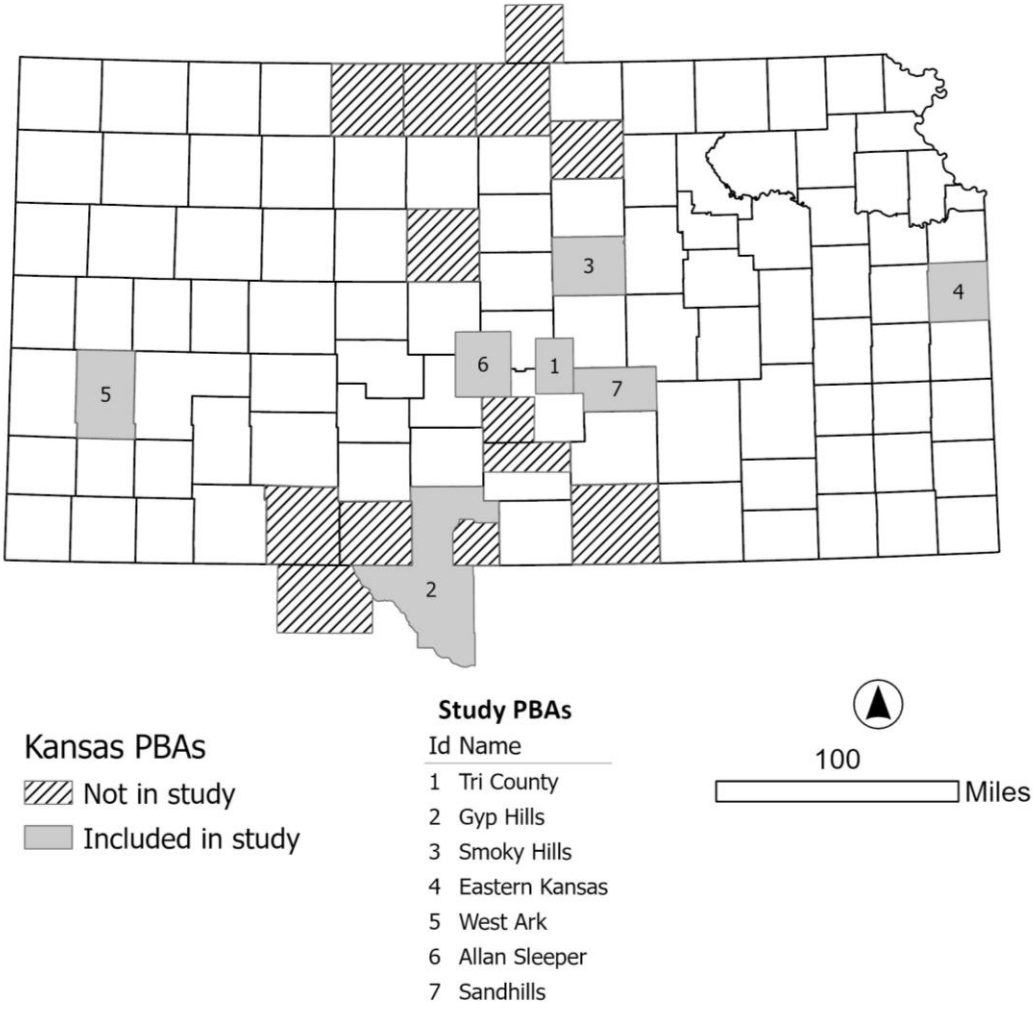

Figure 2.3 Kansas PBA locations. Crosshatched PBAs were contacted but did not enroll in the study. Grey PBAs participated in the study. Some PBAs are active in multiple states. (map by author)

When analyzing the PBA survey, descriptive statistics were calculated of the respondent demographics. Mean and standard deviation were also calculated for Likert scale responses. Additionally, write-in responses were coded using the barrier definitions in the framework. The Cochran-Mantel-Haenszel (CMH) test was used for comparing responses between the two case study PBAs using the PROC/FREQ procedure in SAS.

CMH analysis has been used in public health and epidemiology (e.g. Eirey et al. 2008; Hall et al. 2000; Kuritz et al. 1988) but is also common for analyzing survey data (e.g. Peltonen-

Sainio et al. 2022a; Peltonen-Sainio et al. 2022b; Tseng et al. 2024). The CMH test is especially useful in both applications as it is designed to test for association between two categorical variables while controlling for a third variable (Hall et al. 2000). This test has three versions, each having their own applications and uses. One version calculates the "Nonzero Correlation" which is typically used when analyzing linear associations between a pair of ordinal variables. Another version, more applicable to my research, calculates the "Row Mean Scores Differ"; this is used for analyzing one ordinal variable by one nominal variable (Peltonen-Sainio et al. 2022a). The third version calculates the "General Association Statistics, which analyses the association between nominal variables (Peltonen-Sainio et al. 2022a).

In my research, I use the Row Mean Scores Differ to analyze the ordinal, Likert scale responses collected in my PBA survey by the case study PBA functions as the nominal variable controlled by the survey question. When paired with the PROC/FREQ functions in SAS, CMH tested for associations by first creating a 2 X 5 (two PBAs and Likert scale values from 1 to 5) contingency table for each question and then analyzing it using the exact distribution of responses. The test can also use the Row Mean Scores Differ as a measure of overall mean difference across multiple contingency tables. Here, columns are Likert scale levels of agreement/disagreement with statements representing potential barriers to prescribed fire while rows are the count of responses selecting any given level. The CMH test can use I x J x K tables to calculate the general association statistic, row mean scores differ statistic, and the nonzero correlation.

2.4.3 Agricultural Producer Survey

In my fifth chapter I address my third objective of examining the dynamics of prescribed burning on Kansas lands enrolled in the Conservation Reserve Program between agricultural

producers and PBA members. For this objective, I analyze secondary data from a survey focused on agricultural producers' wildfire experiences, risk perceptions, and adaptations taken in response to recent drought and wildfire events (NSF Award #2117533). The survey consisted of sections on general perceptions of drought and wildfire impact, insurance practices and wildfire mitigation strategies. The survey also gathered data on farm characteristics and involvement with the Conservation Reserve Program and prescribed burning. Finally, the survey asks producers about various conservation practices used on the farm and gathered respondents' demographic characteristics.

Deployment of the survey followed the methods discussed in Dillman et al. (2014). An initial wave of mail surveys were sent out in the first week of June, followed up with a postcard reminder after one week. A second mailing was sent to nonrespondents in the 2nd week of July. Overall, 4,000 postal surveys were sent out to farmers, ranchers, and landowners in eastern Colorado, Kansas, eastern New Mexico, Oklahoma, and Texas. Seventeen surveys were also completed at a county fair and were gathered through convenience sampling in Ford County, Kansas. The total sample size for the survey effort was 4017, however only 466 usable surveys were returned. Fifty-five surveys were sent back incomplete due to bad mailing addresses (8); being deceased (25); no longer farming or ranching (20); or being fully retired (2). The overall response rate from these two initial survey waves was 11.8%.

When analyzing the survey data, descriptive statistics were calculated of the respondent demographics. I conducted a Chi-square test of independence to test for an association between landowners that use prescribed fire and whether or not they have lands enrolled into the CRP. The Chi-Square test is a common test when analyzing contingency tables. These are useful when comparing two groups on a binary (yes/no) response (Agresti, 2007). This test evaluates if the

counts within a cell of a contingency table are independent or dependent of each other. The null hypothesis of this test claims the responses from the two groups are independent, meaning they are unrelated (Mendenhall et al. 2003). This hypothesis is tested by comparing the observed and expected counts of each cell in the contingency table (Agresti, 2007). Smaller differences between observed and expected values support the null hypothesis while larger differences suggest the null hypothesis can be rejected, and the responses from groups dependent. Said differently, if the null hypothesis can be rejected then there is evidence that a given group and response have a statistically significant association (Agresti, 2007). The statistic assumes the cell the data are independent, and that all expected cell counts equal or exceed five (Mendenhall et al. 2003).

Additionally, logistic regression was used for analyzing the significant factors associated with using prescribed fire on CRP. Logistic regression is useful for determining significant factors influencing a binary outcome, where the outcomes for each response are either "success" or "failure" (Agresti, 2007). These models are flexible and have been used in other studies related to barriers on prescribed fire. Kreuter et al. (2019) use logistic regression to analyze a survey deployed to identify factors that contribute to the willingness of landowners to apply prescribed fire on their land and on another landowner's property. Logistic regression was also used to examine factors influencing county commissioner's decisions when enacting a burn ban (McDaniel et al. 2021). I use multi-variate logistic regression to analyze factors contributing to whether or not a landowner with land enrolled into the CRP uses prescribed fire to maintain their CRP as the dependent, binary variable. Chapter 5 contains more information on my regression model, including explanatory variables, accuracy metrics, and results.

Logistic regression models can have multiple explanatory variables which can be categorical or quantitative. When using multiple variables, the model for the log odds of the dependent (*Y*) variable occurring holds the other explanatory variables constant (Agresti, 2007). Logistic regression not only evaluates each explanatory variable in the model, while controlling for the influence of the other variables but also identifies how each variable increases or decreases the likelihood of *Y*. Furthermore, logistic regression evaluates the statistical significance of each variable (Agresti, 2007). Logistic regression assumes no multicollinearity when using multiple variables, meaning they cannot be correlated with each other (Rogerson, 2006). This can be checked by calculating the variance inflation factor (VIF). Generally, a VIF value of 5 or more indicates potential multicollinearity issues (Rogerson, 2006).

I evaluate the accuracy, or model fit using the Pearson's Chi-square goodness of fit test in addition to the Hosmer–Lemeshow Test (Hosmer et a. 2013). Generally for both, significance levels greater than 0.05 indicate good model fit. Results of the VIF calculation and measures of model fit are reported in Chapter 5, along with more information on the variables is in Chapter 5. All calculations were performed in R.

2.5 Case Studies

The second objective of my research (Chapter 4) uses a comparative case study approach to explore the barriers perceived by two PBAs in separate contexts, hypothesizing that differences in the environment lead to differences in perceived barriers. Specifically, I compare PBAs situated in peri-urban context with a rural, ranching context. I include the EKPBA and GHPBA in my case study given the high response counts from these associations (see table 2.2). These associations are also in different Kansas ecoregions (Central Irregular Plains and Southwestern Tablelands, respectively) thus I suspect they have different perceptions on the

prescribed fire barriers. The associations are situated in different contexts; the EKPBA is spatially closer to Kansas City, a major regional hub whereas the GHPBA is situated in a more rural context, contextualized by low population and engaged with ranching.

Detailed information about a small population can be obtained through conducting case studies. While they may not necessarily offer a substantial sampling size to use statistical methods and identify generalizable findings, the detailed information gathered in case studies may reveal general interactions that inform models and hypotheses (Rice, 2010; Harvey, 1969). Comparative case studies assess how generalizations apply to an individual "bounded system" or case. Case studies of communities are especially common in geographic research. Comparative case studies integrate detailed, spatially bound case studies with comparative traditions (Knight, 2001). Comparing between cases can both reveal commonalities, delineate relationships, and clarify ambiguity in singular cases (Knight, 2001).

2.6 Key Informant Interviews

Surveys are valuable approaches to understanding perceptions of prescribed fire. However Clark et al. (2022) point out there is a dearth of studies incorporating qualitative analysis within research focusing on the barriers to prescribed fire. Thus, I use qualitative analysis to address my first objective: examining the diversity across PBAs in Kansas ecoregions (Chapter 3). I do this in terms of PBA characteristics like burn activity and through examining the variability of discussed barriers within differing contexts. Although surveys can provide insights into the attitudes and perceptions held by participants, interviews can explore these in more depth at the cost of fewer participants. Interviews can also include open-ended questions, allowing for participants to express their opinions in their own words (Dunn, 2000). What comes out may be factors not considered by the researcher or in previous studies. Interviews also make

space for feedback on the researcher's questions and provide an opportunity to validate potential conclusions and clarify misconceptions (Dunn 2000). While interviews can be formatted using varying degrees of structure, semi-structured interviews offer flexibility, and can range from a list of keywords or themes to carefully worded questions (Dunn, 2000).

I opted to use a list of open- and close-ended questions when designing the semi-structured interview guide. In addition to keeping the interviews consistent and within the allotted time, the semi-structured interview format also allows the interviews to have a conversational nature, giving the participant a chance to discuss issues or concepts they believe are relevant and important (Longhurst, 2010). Another advantage of interviews is even when going through preconceived questions, the interviewer can ask for clarifications and expansion (Dunn, 2000).

Finally interviewing is advantageous because with permission, the conversation can be recorded for transcription. Transcripts can then be analyzed both qualitatively and quantitatively; they create vast datasets, rich with detail provided by the participants opinions (Cope, 2010). Information that may be otherwise unknown or difficult to obtain through other means can be provided by transcripts (Cope, 2010). Coding is one way transcripts can be qualitatively analyzed to obtain meaning from the text by creating categories and subcategories that allow researchers to make connections between themes (Cope, 2010).

Respondents in leadership roles of participating PBAs were solicited for key informant interviews to follow-up on survey results. I contacted PBA leaders when soliciting participants with my PBA survey, obtaining their contact information from the Kansas Grazing Lands Coalition and Prescribed Fire Council. More information on this outreach process is discussed in the PBA survey section of this chapter. Rather than interviewing individual members, I chose to

conduct key informant interviews with PBA leaders. Those leading the associations may have a more thorough understanding of the barriers the association faces as a collective than individual members. Given their roles, leaders may also be more aware of overall trends in their association, both in terms of burn and membership activity. These interviews followed a semi-structured format with a a series of questions focusing on the participants' role within their PBA as well as information regarding the amount of members PBA itself including years active, burn activity and membership trends, and how the association formed. The interview guide also included sections on the practice of conducting a burn on lands both unenrolled and enrolled with the Conservation Reserve Program. Lastly, the guide included questions to expand and clarify findings from the survey regarding the barriers to prescribed fire in Kansas.

To maximize the overall participation of key informants, the interviews took place in a variety of formats, including in-person, over-the-phone, and on Zoom. Two interviews were in-person and conducted at nearby public libraries. Three interviews were conducted over the phone and one interview was over Zoom. At the start of each interview, I explained the study and informed consent document, then gave participants time for questions before proceeding. While going over the informed consent document, I asked for permission to record the interview, receiving approval consent from each participant. During the interviews I took written notes on hard copies of the interview guides; these were supplemented with recordings of the interview with participant consent.

Overall, the interviews took between half an hour to one hour. Additionally, I accepted an offer to visit an informant's ranch to see part of the area affected by the Anderson Creek Wildfire of 2016. After conducting the interviews, I used TurboScribe, to generate the transcripts before coding for major themes using Taguette. I developed codes from the categories defined in my

framework on barriers to prescribed fire to analyze the transcripts produced from my semi-structured interviews. After an initial round of deductive coding the transcripts for barriers and other emerging themes, I grouped similar themes and created distinct sub-categories. After reviewing the codes, I prepared summaries of the text for overlapping themes. I also scanned my physical notes and input short answers into a spreadsheet for comparing across PBAs. See the interview guide (Appendix D), survey questions (Appendix B), and associated informed consent documents (Appendix C). in the Appendix, as well as Institutional Review Board (IRB) approval document (Appendix A).

2.7 Study Limitations

While this study offers key insights into PBAs in Kansas, it is not without limitations. The largest being its limited sample size. Only seven of the 16 PBAs in Kansas participated with the Qualtrics survey, and six in interviews. Of the seven PBAs participating in the survey, only 25 usable responses were gathered. Other studies relying on survey data related to perceptions of prescribed fire have had greater success with postal surveys. Additionally, the Qualtrics survey was deployed in the late summer and early fall, a notoriously busy time for agricultural producers. Last, while key informants were sought for feedback on the survey, participation may have been bolstered through more engagement with Kansas PBAs through attending meetings, trainings, and prescribed burns before attempting to cold contact their leadership.

My research is also limited by a lack of data. The variables I use in my logistic regression model were gathered from a survey which is secondary data; while potentially useful, the survey was not designed specifically for my research. There may be variables that better predict whether or not a landowner uses prescribed fire on CRP that were excluded from the

survey since this was not the goal when the questionnaire was designed. Furthermore, this survey had few participants involved with PBAs, thus PBA membership was not included as a factor in my analysis. This is not surprising considering the vast spatial extent of the survey in comparison to the smaller area covered by PBAs.

Chapter 3 - Patterns of Commonalities and Differences between Kansas Prescribed Burn Associations

3.1 Introduction

In this chapter, I introduce the Kansas prescribed burn associations (PBAs) and present my qualitative analyses of the key informant interviews with PBA leaders. Relying on the six key informant interviews I conducted with PBA leadership, I address my first objective: examining the diversity across PBAs in Kansas ecoregions in terms of their burn activity and perceived barriers for prescribed fire. Understanding the characteristics among Kansas PBAs is important because it provides insight on the barriers PBAs face as a collective. In addition, I present Kansas PBAs burn activity and variability of characteristics and barriers within different contexts. This provides contextualized knowledge on how different barriers may be limiting prescribed fire activity across the state. In particular, I describe the similarities and differences in the challenges PBAs face based on their context. I start by describing the participating Kansas PBAs before discussing the general motivations for burning and identify the actors helpful in establishing PBAs. I then discuss the common challenges or opportunities PBAs experience. Last, I tie the patterns and trends emerging from the qualitative analysis to the ecoregions the PBAs are located in.

3.2 Kansas Prescribed Burning Associations

While conducting key informant interviews with the leadership in the Kansas PBAs, I asked questions about general PBA characteristics like year of establishment, typical membership size, and burn activity. In this section, I summarize these findings. I begin by discussing burn activity. I specifically asked participating PBAs about their fire frequency, size,

and season as well as important considerations when burning. I use these characteristics to describe Kansas PBAs.

Based on the interviews, these associations are a more recent phenomenon, with the most established association being the Gyp Hills PBA (GHPBA) in Barber County which formed in 2007. From the interviews, participating Kansas PBAs formed between 2007 and 2021. These associations do not have large memberships, as the average size of participating PBAs was approximately an average of 17 members. See table 3.1 for PBA specific information I gathered from the interviews.

Table 3.1 Characteristics of the interviewed PBAs including year established, membership count in number of individuals, reported membership and burn trends, and the level III ecoregion each PBA falls within. The ASPBA and WAPBA have been inactive due to drought. The SHPBA is too new to show a trend.

PBA	Establishment (Year)	Member count (*n*)	Reported membership trends	Reported burn activity trends	Ecoregion
ASPBA	2013	8	Slowly shrinking	Inactive	Central Great Plains
SHPBA	2021	40	Too soon to establish	Too soon to establish	Central Great Plains
TCPBA	2016	20	Shrinking	Shrinking	Central Great Plains
EKPBA	2017	14	Slowly growing	Slowly growing	Central Irregular Plains
WAPBA	2018	5	Inactive	Inactive	High Plains
GHPBA	2007	20	Growing	Growing	Southwestern Tablelands

Burn frequency, size, and seasonality tended to vary across associations. Kansas PBAs typically conduct approximately four prescribed burns each year. Based on conservative estimates of burn sizes, the average area burnt is 140 acres. For carrying out a burn, the average crew size needed, or number of individuals, is approximately eight members. Burning is typically conducted during the spring; however, it is growing more common to burn in the late summer for some PBAs. See table 3.2 for burn characteristics across PBAs. This is largely due to more favorable weather conditions for achieving burn goals that may call for drier, warmer weather.

Table 3.2 Typical burn characteristics for each PBA. * Denotes values from when active. Burn size for WAPBA based on informant burn practices.

PBA	Annual burns	Burn size (acres)	Burn crew (individuals)	Burn season
ASPBA*	5 to 10	80 to 640	6	Spring
EKPBA	3 to 5	5 to 80	6 to 12	Spring, summer, fall
GHPBA	10 to 15	600 to 1200	14 to 25	Spring, summer
SHPBA	3	30 to 160	10 to 12	Spring, summer
TCPBA	1 to 6	120 to 640	10 to 15	Spring, summer
WAPBA*	N/A	5 to >1000	2 to 6	Spring

Weather is one of many considerations when conducting a prescribed burn. Other burn considerations include neighboring landcover and fuel load. For example, roads and right-of-ways may help with burn containment. When fuel loads on a burn unit, or the sections of land intended to be burnt, are high they may emit more sparks. This may potentially cause ignitions on neighboring property (GHPBA Interview, October 2023). Fuel load also influences desirable conditions for burning. For example, burn units with more cedar have little grass growing beneath the trees and will require lower humidity, while units with grass can be burnt in higher humidity (SHPBA Interview, October 2023).

Burn preparation is stressed in each of the PBAs interviewed ($n = 6$). Often, this preparation involves designing a burn plan ($n = 5$); these are detailed documents outlining the

goal for an individual burn. These documents also contain protocol describing how exactly a burn will be conducted and include details on how many crew will need to be present, what sort of equipment is required, and what weather conditions would be needed for burning. Ideal weather conditions can be based on neighboring land cover, the burn area land cover, and potential hazards present in the burn unit. These documents may also contain contact information for local emergency services (SHPBA Interview, October 2023). While important for providing protocol and safety information, these plans may also help in the case of an escape in regard to liability, as they help illustrate care taken when conducting a burn, rather than recklessness. Establishing a burn plan is not the only component of burn preparation. Perimeters around a burn unit are typically mowed to help reduce the chance of a burn escaping onto neighboring property (n = 5). Finally, neighboring landowners and local authorities are alerted or contacted for permission to burn.

3.3 Commonalities between Kansas PBAs: Motivations, actors, and challenges/opportunities

In the following sub-sections, I discuss patterns of commonalities across Kansas PBAs that surfaced in the interviews regarding their burn motivations, involved external actors, challenges and opportunities for burning. In all of the interviews, there was significant overlap in motivations regarding reasons to conduct prescribed burns. Another commonality I found was that external actors, or agents outside of PBAs were critical when establishing an association.

3.3.1 Motivations

In my literature review, I discuss several reasons why landowners engage with prescribed fire. Many of those motivations, like promoting grass growth for grazers, combatting woody encroachment, and removing fuels for wildfires were echoed in my interviews (Baldwin et al.

2022b). Prescribed fire's role as a beneficial conservation practice for local wildlife like quail also emerged, albeit less frequently (n = 2). Based on my semi-structured interviews, I identified the most common motivation for PBAs to conduct a prescribed burn was some form of vegetation control and management. Species associated with woody encroachment like Eastern red cedar (*juniperus virginiana)* were by far the most common form of vegetation being controlled; five of the six interviewed PBAs including the Allan Sleeper (ASPBA), Eastern Kansas (EKPBA), Gyp Hills (GHPBA), Smoky Hills (SHPBA), and Tri County (TCPBA) included combatting cedar encroachment as a primary motivation for burning. While cedar was the most common vegetation being controlled, the West Ark PBA (WAPBA) utilize prescribed fire for managing species like the Russian thistle (*Salsola tragus*) and the sand hill plum (*prunus angustifolia*) while being less concerned than other associations with cedar. Grassland management was another common motivation, especially for improving grazing in pastures by stimulating grass growth. This motivation was emphasized when interviewing with the ASPBA, GHPBA, and SHPBA. Managing invasive species like thistles and cedar, or other species like the sandhill plum (ASPBA, GHPBA, SHPBA, and WAPBA); freeing up water resources (ASPBA, GHPBA, and SHPBA), and reducing wildfire opportunities (GHPBA and SHPBA) were other common motivations for conducting prescribed burns. Table 3.3 gives more information on the burn motivations for each participating PBA.

Table 3.3 Motivations for conducting prescribed burns for each PBA and relevant interview excerpts.

PBA	Motivations	Interview examples
ASPBA	1) Vegetation control 2) Grassland management	1) "To control invasive species. Plum thickets and red cedar trees is the primary two issues we deal with." 2) "Trying to promote better grass and cleaner rangeland to run. Better utilize the grass is the primary reason, because it's expensive to have everything machine cut."
EKPBA	1) Vegetation control 2) Grassland management 3) Wildlife	1-3) ". . . We have people who want to do all kinds of things with their land. We have one that keeps it for their bees, other people that just have grass that needs to be burned every once in a while to keep the cedars out. And some people want it for wildflowers and wildlife."
GHPBA	1) Vegetation control	1) "The main goal is to eliminate this Eastern Cedars. And obviously, and it's just not Eastern Cedars. There's other brush that it knocks back. It knocks back the sagebrush."
GHPBA	2) Grassland management	2) "And then the second thing is that it improves your grassland. It's amazing how that improves your grassland."
SHPBA	1) Vegetation control 2) Grassland management	1-2) "Cedar encroachment. That is by far the biggest purpose. Beyond that is for rangeland improvement. Removing the grass thatch and encouraging new grass growth. That new grass growth has got the highest protein available at any time of its growth stage, and you get the best gains on cattle after a burn. And then the third reason is invasive plants. There's a plant that's invading the natural prairie, and it's called old world bluestem."
TCPBA	1) Vegetation control	"Brush control or Eastern red cedar. I would say zero is for grazing quality. That's a Flint Hills thing."
WAPBA	1) Vegetation control	"Our sole purpose was to control annual weeds, whether it was annual brome or Russian thistles, which is probably the big one."
$N = 6$		

3.3.2 External Actors in PBA Establishment

While prescribed fire can help achieve vegetation management goals, PBAs are not forming organically. In fact, they tend to follow a pattern in which their formation is reliant on intervention and resources from external actors. Each of the interviewed PBAs indicated external actors having a role in PBA activities, and five of the six mentioned these actors being involved with establishing their association ($n = 5$). External actors like the Natural Resources Conservation Service (NRCS), county conservation districts, Kansas State Forest Service (KFS), and Kansas State University (KSU) Extension offices were the most common. Meetings hosted by the NRCS on the topics of woody encroachment, cedar removal, and prescribed burning helped with forming the ASPBA and SHPBA; many of these meetings' attendees went on to form their respective PBAs (ASPBA Interview, November 2023; SHPBA Interview, October 2023). The NRCS was also involved with establishing the GHPBA (GHPBA Interview, October 2023).

As for the EKPBA, both county conservation district and KFS have been involved. A county board member was interested in gauging local interest in forming a PBA, so a meeting was held with the KFS. After a secondary meeting, its attendees decided to form a PBA and were assisted by the KFS. The KFS also has attended the PBA's annual meetings and provides training opportunities (EKPBA Interview, October 2023). University Extension hosted a training on prescribed fire, sparking the formation of the TCPBA. Some of the attendees of this training were neighbors with each other and went on to form the board of this association. Five of the six members attending that training continue to serve on that board today (TCPBA Interview, October 2023). The Department of Wildlife and Parks (KDWP) was loosely involved with the WAPBA, but not with the association's establishment, however, it was assumed the Department

could aid in burning by helping provide equipment (WAPBA Interview, October 2023). More information on external actor interactions with the PBAs is in table 3.4.

Table 3.4 External actors and their roles with PBAs.

PBA	External Actor	Role
ASPBA	NRCS	PBA formed from attendants of meeting on woody encroachment.
EKPBA	County conservation; KFS; KSU	Held meeting with county conservation district and KFS on prescribed fire. KFS supports with forms and training opportunities. Collaborates with KSU research.
GHPBA	NRCS; KSU	NRCS employee and community members formed the association in response to woody encroachment. Collaborates with KSU research.
SHPBA	NRCS; KSU	PBA formed from attendants of meeting on woody encroachment. Collaborates with KSU research.
TCPBA	KSU	PBA formed from attendants of extension meeting on prescribed fire.
WAPBA	KDWP	Intended to work with KDWP for equipment.
$N = 6$		

3.3.3 Challenges and Opportunities

Just as the PBAs had similar motivations and external actors to support their formation, the Kansas associations also shared several overlapping challenges and opportunities in their operations. In general, examples of the environmental, political, practical, and social barriers I identify (see Chapter 2) were present in most of the interviews. Here, I introduce the common barriers; the final section of this chapter includes a more detailed discussion connecting the barriers to ecoregions.

By count, key informants discussed environmental barriers most frequently ($n = 6$). Weather conditions like drought and wind were by far the most common of these barriers. The informant from the GHPBA explained "…*you are totally dependent on environmental factors on whether you can or can't. Drought wipes out most opportunities that we have to burn*".

Social barriers were the next most common (n = 6). While present in all interviews, social barriers did not seem as influential as environmental barriers. Of the themes within the social barriers, the most prominent were lacks of understanding and public risk perceptions. The key informants perceived nonmembers of associations are more likely to view burning as a high-risk activity (Toledo et al. 2012). This sentiment was echoed in another interview: "*But it is a concern because fire is scary and people, you know, 'Gosh, if I light this up, what's it going to do?' And they don't really understand that your whole idea is to control that fire to do what you want it to do.*" While social barriers were common, there has been progress toward promoting prescribed fire, linked in part to wildfire and the work of external actors. An informant from the Central Great Plains ecoregion explained "*People were just scared, scared of fire. Since we've had some wildfires, all of a sudden now we've got fire departments and lots of agencies, extension, NRCS, all of these people all talking about how useful prescribed fire is in managing wildfire risk. I think the broader community is really starting to catch on. And that support has really gained. So I would say now it is rare to run into a hostile neighbor. Every once in a while we still get a skeptical one.*"

Burn bans and liability were the most common political barriers; bans are typically issued during conditions of drought or high wind by county fire departments or county commissions to reduce wildfire risk. I was surprised to see that despite the case of *Koger v Ferrin,* 1996 liability was a major concern when implementing prescribed fire. Liability is still a major concern, especially for a Central Great Plains informant explaining: "*That's kind of my main soapbox issue because that's what I hear over and over from landowners worried about fire is liability. . . We make sure when we conduct burns, the actual landowner always strikes the match. Even if it's a 90-year-old man being wheeled out there in his wheelchair to have a ceremonial lighting*

because we all know that if something bad happens and we're all in court someday, the judge is going to ask who started the fire."

Practical barriers were the least frequently occurring barrier. This is unsurprising given the role of PBAs in addressing barriers like lacks of equipment, labor, and knowledge (Diaz et al. 2016). While few, the practical barriers discussed in interviews were typically related to scarce labor or equipment. One informant explains "*I'm by myself. You know how hard it is to find twelve people to help you burn 320 acres? It's pretty damn tough. When your association only has ten people in it, it's pretty hard. And you want the right people there*." Overall, establishing PBAs has been beneficial since this category is so infrequent.

When coding the interview transcripts, a few other barriers emerged in marketing the PBA to the public to attract new members. The ASPBA and SHPBA both indicated difficulties in building public interest. Building public interest is important for the longevity of these organizations as they require an active membership to continue functioning. While building interest is important, it can be difficult to reach the broader community (ASPBA Interview, November 2023; SHPBA Interview, October 2023). Busy schedules affiliated with agricultural production can also compete with burning as spring planting can overlap windows for burn activity.

Fire departments also came up regularly; in counties with burn permits, landowners are required to contact fire departments for permission before conducting a burn. While it is more common for prescribed fire to be prohibited during periods of dry or windy weather, rural fire departments may also limit burn activity due to their limited capacity to fight multiple fires in the event of a fire escape. These departments can be limited in terms of crew size and equipment.

Rural fire departments can also find it difficult to extinguish fires in rural counties due to limited road access, reducing their ability to deploy equipment to burning areas.

Although departments may limit fire activity, collaboration can be beneficial to both parties. The ASPBA and WAPBA both had interactions with neighboring departments by providing opportunities to test fire department equipment and for firefighters to interact with grassland fires they do not have to extinguish. While coding, I identified additional opportunities for expanding prescribed fire. Increasing awareness has boosted engagement with prescribed fire as more people become aware of the benefits and methods of burning. This awareness has not only been driven by successful burns, but also by wildfires. The GHPBA and TCPBA have both experienced wildfires and partially attributed growing communal support of prescribed fire to these events. Table 3.5 summarizes the barriers and opportunities for each PBA while table 3.6 displays the count that each barrier was discussed in the interview. Barriers discussed in more depth or frequency may be more intensely perceived by the key informant.

Table 3.5 Barriers and Opportunities for Kansas PBAs.

PBA	ASPBA	EKPBA	GHPBA	SHPBA	TCPBA	WAPBA
Environmental Barrier	Drought, wind	Wind, rain	Drought, wind	Drought, wind	Drought	Drought, wind
Political Barrier	Regulations, liability	Burn permits	Liability, regulations	Liability	Burn bans, liability, regulate-ons	Burn bans
Practical Barrier	Labor	—	—	—	—	Equipme-nt
Social Barrier	Lack of understanding, Public fear	Public fear	Lack of understanding Public fear	Lack of understa-nding	Public fear	Lack of understa-nding
Opportunities	Local fire department	Increased awareness	Wildfire, Increased awareness	Research collabor-ation	Wildfire, increase-d awarene-ss	Local fire depart-ment
$N = 6$						

Table 3.6 Count for each instance a barrier was discussed in key informant interviews.

PBA	ASPBA	EKPBA	GHPBA	SHPBA	TCPBA	WAPBA
Environmental Barrier	17	7	14	8	6	13
Political Barrier	7	1	4	1	13	5
Practical Barrier	5	—	—	1	—	6
Social Barrier	11	2	5	4	8	4

3.4 PBA Characteristics and Patterns by Ecoregion

In the first section of this chapter, I described overarching motivations, external actors that have helped I establish PBAs, and discussed the common challenges and opportunities for Kansas PBAs. This section expands on the first by tying common themes to ecoregions and describing other emerging patterns I found in my interviews with these associations. See figure

3.1 for a map showing barriers by ecoregion. I divide by ecoregions because each has distinct vegetation, landform, climactic, and land use characteristics. Given the impact of weather on burn opportunities and vegetation on fuel load, I hypothesize there is variation in barriers across ecoregions.

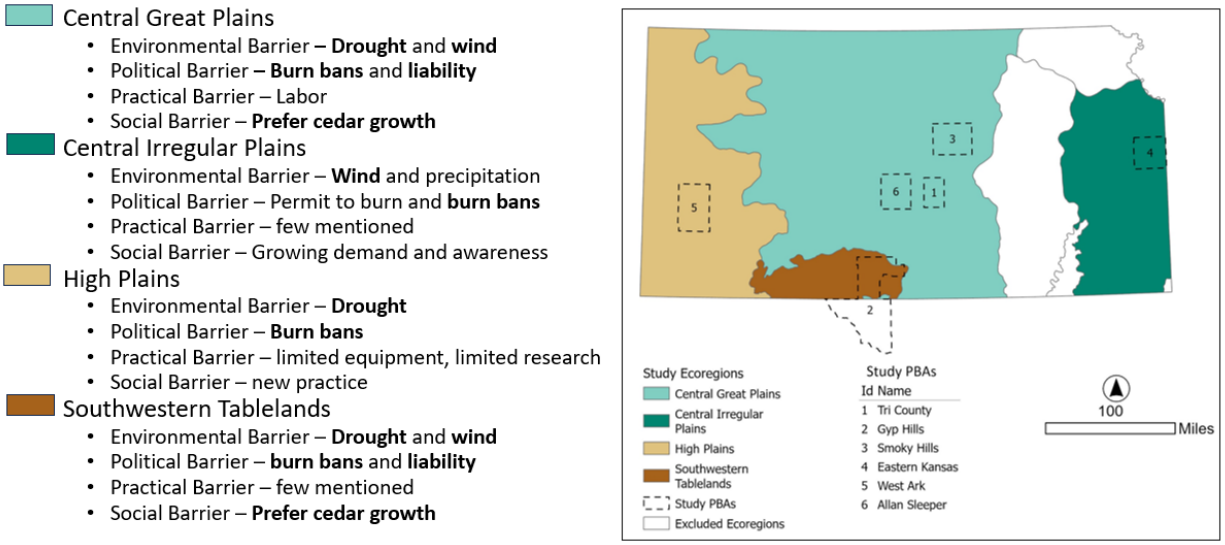

Figure 3.1 Common barriers in each Kansas ecoregion

3.4.1 Central Great Plains

The Central Great Plains ecoregion had the the highest number of PBAs (ASPBA, SHPBA, and TCPBA). Within the Central Great Plains, combatting woody encroachment was the main motivation for burning. This was expected given the expansion of woody encroachment across ecoregions within the Southern Great Plains (Londe et al. 2022). Grassland management, specifically grassland improvement for ranching were other motivations for the ASPBA and SHPBA while the TCPBA burnt for brush removal. Drought was the most common environmental barrier within this ecoregion; dry conditions have prevented the ASPBA from burning since 2019. The SHPBA was also limited, as they planned 15 burns in 2023 but only conducted three. Burn bans and liability were also described as political barriers limiting burn activity. Practical barriers, specifically difficulties in finding labor for conducting a burn also

arose, especially when burning in the spring due to burn windows competing with spring planting season (ASPBA Interview, November 2023). Landowners with goals more oriented towards recreation like hunting were a common theme within this ecoregion as well. These landowners prefer cedar growth, perceiving the trees as beneficial for local wildlife and thus improving hunting activities while ultimately promoting woody encroachment (ASPBA Interview, November 2023; SHPBA Interview, October 2023). This was also seen in the Southwestern Tablelands (GHPBA Interview, October 2023). Farm operation sizes in these two ecoregions are much larger than in the Central Irregular Plains based on my PBA survey responses; the average size for the Central Great Plains and Southwestern Tablelands were 1,400 and 17,600 acres, respectively. Parcel size, distance to major cities, and lower populations in these ecoregions may make them more appealing for establishing outfits than ecoregions like the Central Irregular Plains.

3.4.2 Central Irregular Plains

The EKPBA is currently the only PBA within the Central Irregular Plains. This association had a variety of burn motivations. While the EKPBA is concerned with woody encroachment, its members also burn for grassland management, wildlife habitat, and wildflowers. The primary environmental barriers include wind and rain rather than drought. This matches the description of the Central Irregular Plains because of the higher average precipitation when compared with the other Kansas ecoregions (Wiken, Nava, & Griffith & 2011). The higher precipitation, easier access to surface water, and rich soils in the ecoregion support land use diversity, and this is reflected in the diversity in burn motivations. The variety of burn motivations may also be linked to the PBA's proximity to major regional hubs like Kansas City. Proximity to the city contributes to a higher population thus more potential

motivators to burn. Although there is some uncertainty about fire use, this association indicated growing interest in prescribed burning. Since the EKPBA is situated in Miami county, they face the political barrier of being required to obtain permission from local fire chiefs before burning; permits are typically denied in windy conditions (EKPBA Interview, October 2023). Overall, this PBA reported having the capacity to conduct the burns as needed by their members and indicated few practical barriers.

3.4.3 High Plains

Situated in western Kansas, the WAPBA is the only association in the High Plains. Rather than burning for woody encroachment, burns in western Kansas are typically conducted for burning overgrown grasses and weeds or burning thistles (WAPBA Interview, October 2023). This makes sense considering the High Plains are characterized by their arid steppe climate and typically receive little rainfall necessary in supporting tree growth (Wiken et al. 2011). Drought is a major environmental barrier for this association; dry conditions dominated soon after the WAPBA formed and no burns were conducted by the association (WAPBA Interview, October 2023). This ecoregion's description also indicates having less precipitation on average when compared to other Kansas ecoregions (Wiken et al. 2011). Due to drought, political barriers like burn bans arose. Even with proper conditions, the WAPBA reported limited access to burn equipment in the west and that prescribed fire is a novel practice in that part of the state. The informant also expressed concern over limited research on the effectiveness of prescribed fire in ecosystems local to the High Plains with such limited rainfall.

3.4.4 Southwestern Tablelands

The GHPBA falls within the Southwestern Tablelands and shares similar motivations with the Central Great Plains associations including removing red cedar, improving rangelands

for grazing, and releasing water stored in cedars. The association faces similar environmental barriers too, specifically drought and wind. While political barriers like regulations and liability arose, practical barriers were less of a concern (GHPBA Interview, October 2023). This could potentially be explained by Barber County having an additional PBA. Barber County was among the counties affected by the Anderson Creek Fire in 2016. This led to some initial concerns about prescribed fire, but was also framed as a motivator for conducting burns, as it demonstrated some of the positive benefits of the practice like stimulating growth, eliminating cedar, and releasing water back into seeps and springs that landowners were unaware of (GHPBA Interview, October 2023). Another emerging similarity between the Central Great Plains and Southwestern Tablelands was the influence of landowners keeping cedar growth, perceiving them beneficial to wildlife hunted for recreation.

3.5 Conclusion

In this chapter, I draw on my semi-structured, key informant interviews conducted with Kansas PBA leadership to address my first research objective - examining the diversity across PBAs in Kansas ecoregions in terms of their burn activity and perceived barriers for prescribed fire. I found that most participating Kansas PBA formed within the last 10 years, making them fairly novel. Most formed from attendees of meetings held by external actors like the NRCS or KFS and burn for controlling woody encroachment or promoting grass growth. Kansas associations typically have fewer than 20 members and conduct an average of four burns each year. Burns can be limited by weather conditions, especially drought and wind. Drought specifically has caused the ASPBA and WAPBA to become inactive in recent years. I also describe the barriers to prescribed fire by Kansas ecoregions. PBAs in the Central Great Plains and the Southwestern Tablelands shared similar barriers due to drought, wind, and burn bans.

Liability was also discussed as a barrier while interviewing associations from these ecoregions. While drought was common in western and central Kansas, precipitation and wind were common environmental barriers in the Central Irregular Plains. While burning in dry, warmer conditions is associated with higher risk (see Toledo et al. 2013) drought was extremely common across Kansas PBAs.

Chapter 4 - A Comparative Case Study on the Barriers to Prescribed Fire facing the Gyp Hills and Eastern Kansas Prescribed Burn Associations

4.1 Introduction

In this chapter, I address my second objective of assessing how barriers for prescribed fire vary between rural and peri-urban contexts. Toward this, I analyze the responses to my Prescribed Burn Association (PBA) survey. I take a comparative case study approach, focusing on two PBAs located in distinct Kansas contexts. I specifically use responses from the Eastern Kansas (EKPBA) and Gyp Hills PBAs (GHPBA); these PBAs are in two different ecoregions. Ecoregions are regions with distinct vegetation, climatic, and land use characteristics (Omernik, 1987; Wiken, Nava, & Griffith & 2011). A study in Washington state found trends in prescribed fire to differ significantly across ecoregions (Podschwit et al. 2021).

The case study PBAs are also located in distinct human landscapes. The EKPBA is located within a peri-urban landscape, otherwise known as a transitional zone between urbanized and rural contexts. Meanwhile, the GHPBA is located within a rural, ranching and agriculturally focused community. My hypothesis is that the types of barriers are likely to differ across different contexts. This provides information on the barriers of prescribed fire in relation to differing contexts in terms of land use from the perspectives of individual PBA members. First I compare responses to questions aggregated the barrier they relate to in my framework on barriers to prescribed fire. The framework itself is discussed in Chapter 2. I also test my hypothesis using the Cochran-Mantel-Haenszel (CMH) statistic to evaluate the overall and individual differences in responses from my Qualtrics survey of Kansas PBA members from case study PBAs. I start

this chapter by introducing the context of my case study PBAs before discussing the aggregated results. Then I present the overall results of the Cochran-Mantel-Haenszel statistic and identify questions where the across PBAs responses were different.

4.2 Data

This chapter utilizes both of my primary data sources: a Qualtrics survey sent out to Kansas PBA members and semi-structured key informant interviews with the participating PBA leaders. I designed this survey to include questions that relate to each of the four barriers defined in my framework. I primarily analyze the responses to Likert scale questions on perceived barriers in this section; however, I also I ask participants about their agricultural operations and demographic information for describing participant characteristics. A full list of my survey questions is in the Appendix B and more information on deploying the survey is given in Chapter 2. The Likert questions were formatted as statements where participants indicated their level of agreement. I set the levels as "strongly disagree", "disagree", "neither agree nor disagree", "agree" and "strongly agree." I recoded the levels for this analysis by changing the levels to be values from 1 to 5 with higher values indicating agreement. The survey had 25 usable responses with a majority coming from the EKPBA and GHPBA members. Table 4.1 shows the overall responses. Although the responses came primarily from these associations, the case study PBAs are in distinct contexts adding value to their comparison.

Table 4.1 Counts of survey responses from each participating PBA. One included response did not indicate their PBA.

PBA	ASPBA	EKPBA	GHPBA	SAPBA	SHPBA	TCPBA	WAPBA	Unknown
Count	1 (4%)	9 (36%)	7 (28%)	1 (4%)	2 (8%)	3 (12%)	1 (4%)	1 (4%)

$N = 25$

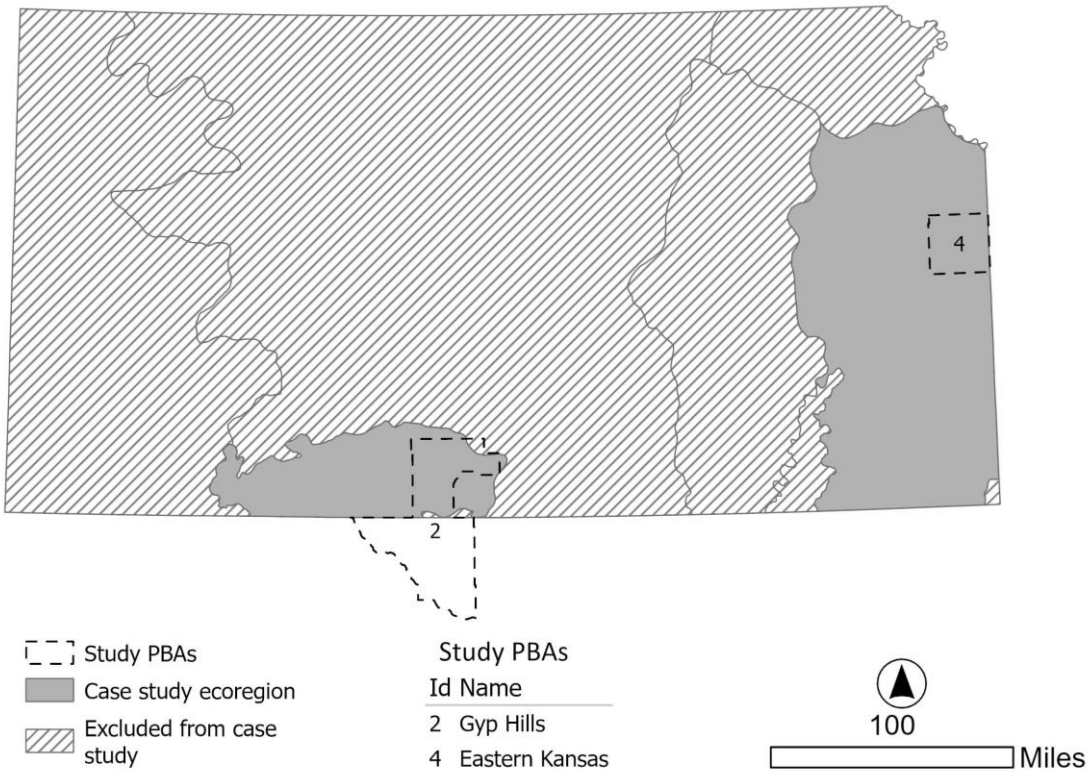

Figure 4.1 Case study prescribed burn associations and level III ecoregions. The GHPBA is active in both Kansas and Oklahoma. (Map by author)

4.3 Case Study Comparison

In this section, I introduce the case study PBAs and their environmental contexts. Figure 4.1 shows the location of the PBAs in comparison with the extents of the ecoregions they are part of. After describing the PBAs, I delve into the differences in responses.

4.3.1 The Eastern Kansas PBA and the Central Irregular Plains

Located in Miami County, Kansas, the EKPBA falls within the Central Irregular Plains ecoregion (see Figure 4.1). This ecoregion is characterized by hot summers and mild to cold winters (Wiken et al. 2011). In terms of precipitation, the ecoregion receives approximately an average of 983 mm (38 inches) and ranges between 865 to 1145 mm (34 to 45 inches). A mosaic of land uses are present within the Central Irregular Plains; forests and grasslands are intermixed with croplands consisting of corn, soybeans, wheat, alfalfa, hay, or sorghum. Landscape features

like perennial streams, rolling and irregular plains are also common to the ecoregion (Wiken et al. 2011). Table 4.2 compares the case study ecoregions.

The EKPBA matches the diversity of the Central Irregular Plains. While farming is the most common agricultural practice among responses (n = 6), three participants indicated neither farming nor ranching. As suggested by the ecoregion description, the most common grown crops among participants are wheat, soybeans, and hay. The informant from this PBA explained some of the non-farming members *". . . we have people [who] want to do all kinds of things with their land… We have one that keeps it for their bees, other people that just have grass that needs to be burned every once while [to] keep the cedars out. And some people want it for wildflowers and wildlife*." One influence contributing to this variety of land uses among EKPBA members is the association's proximity to a major regional hub, Kansas City. This proximity and rising population contribute to smaller parcel sizes, thus smaller farm operation sizes. This also situates the EKPBA within a peri-urban landscape, a transitional zone between urban and rural interfaces, where the mixing of houses and wildland vegetation makes communities potentially more vulnerable to wildfire (USFA, 2022). Part of this proximity is a generally higher population when compared to the western half of Kansas. Table 4.3 compares the two case study associations.

Table 4.2 Case study ecoregion characteristics. Mean annual precipitation is given in parentheses.

Ecoregion	Central Irregular Plains	Southwestern Tablelands
Climate	Humid continental/subtropical	Dry, mid-latitude steppe
Precipitation	34 – 45 inches (38 inches)	10 – 27 inches (17 inches)
Vegetation	Grassland and forest	Shortgrass and midgrass prairie
Terrain	Rolling hills and irregular plains	Broad, flat plains and tablelands
Land use	Cropland, woodland, and grassland	Rangeland, agriculture, hunting reserves

4.3.2 The Gyp Hills PBA and the Southwestern Tablelands

While the EKPBA is in Miami County, the GHPBA falls within Barber County, Kansas and is located in the Southwestern Tablelands ecoregion. The GHPBA is also active in Woods County, Oklahoma (see figure 4.1). In the Southwestern Tablelands, summers and winters are hot and cold; however, the Tablelands have a dry, mid-latitude steppe climate (Wiken et al. 2011). The mean annual precipitation is lower here than the Central Irregular Plains, as the Tablelands receive 448 mm (17 inches) and ranges between 255 to 710 mm (10 to 27 inches). While the Central Irregular Plains have a wide variety of cropland, most of the Tablelands are semiarid rangelands, with a higher concentration of ranching and livestock grazing. The rugged terrain, dotted with canyons and gorges make the landscape less favorable to crop farming. Nonetheless, small areas are cultivated with hay, alfalfa, corn, sorghum, or wheat. The Tablelands have fewer surface water resources, as streams are mostly ephemeral and intermittent (Wiken et al. 2011).

Table 4.3 Case study PBA comparison. *Standard deviation

PBA	EKPBA	GHPBA
Ecoregion	Central Irregular Plains	Southwestern Tablelands
Survey Participants (n)	9	7
Mode age range (years)	65-69 (3); 70-74 (3)	45-49 (2); 70-74 (2)
College degree (Associates or higher)	8 (88%)	6 (86%)
Establishment (year)	2017	2007
Reported Members (n)	14	20
Average years as member	4 (1.92)*	12 (4)*
Annual burns (n)	3 to 5	10 to 15
Burn size (acres)	5 to 80	600 to 1200
Average farm operation size (acres)	112 (139)	17,616 (19,307)
Average annual burn participation (n)	3 (1)	6 (3)

Similar to the description of the ecoregion, ranching was the most common agricultural practice among its members (n = 5), however, all but one of the GHPBA respondents are agricultural producers. One of these members indicated both ranching and farming, cultivating wheat and milo. Other ranchers also indicated growing sorghum, hay, wheat, and alfalfa. Farm operation sizes are considerably larger among the GHPBA. This association is more established when compared to the EKPBA considering the Gyp Hills association formed in 2007. Unlike the EKPBA, this association is much further from neighboring regional hubs. The closest major city, Wichita, is smaller both spatially and population-wise when compared to the Kansas City metropolitan area. This distance from hubs makes for larger land parcel sizes when compared to Miami County, seen by the farm operation sizes listed in Table 4.3.

4.4 Aggregated Responses by Barrier for Each Case Study PBA

In this section I present results from aggregating my PBA survey questions using my framework. Survey questions were assigned a category based on my framework definitions. Then, I grouped responses into either barrier contributors or reducers. For example, responses agreeing to the statement “My community supports prescribed fire use” were categorized as a reducer for social barriers. Factors that may inhibit prescribed fire, like unsuitable weather are categorized as barrier contributors; on the other hand, factors that may expand the practice like having adequate PBA resources are reducers. While ignoring neutral responses, I tallied the amount of contributors or reducers for each barrier. Tables 4.4 shows the results.

Table 4.4 Responses to survey statements from case PBAs by barrier type. Statements with * denote agreement contributes to a barrier while ** indicates that agreement reduces a barrier.

	EKPBA (*n* = 9)		GHPBA (*n* = 7)	
	Agreement	Disagreement	Agreement	Disagreement
Environmental barriers				
Prescribed fire contributes significantly to air quality issues.*	1	4	2	2
Prescribed fire supports healthy ecosystems.**	9	0	7	0
Prescribed fire is beneficial to soil quality.**	9	0	6	0
Prescribed fire enhances wildlife habitat.**	9	0	7	0
The lack of natural fire breaks on my land inhibits the use of prescribed fire.*	0	7	2	2
Unsuitable weather during the burn season inhibits the use of prescribed fire.*	6	1	5	1
	Contributors	7	Contributors	9
	Reducers	39	Reducers	25
	EKPBA (*n* = 9)		GHPBA (*n* = 7)	
	Agreement	Disagreement	Agreement	Disagreement
Political barriers				
County level regulations inhibit prescribed burns.*	0	5	4	1
Concern over liability for potential damages inhibit prescribed burns.*	5	2	5	0
Concern over fees associated with potential local emergency management callouts (like local fire departments) inhibit prescribed burns.*	3	8	2	2
Community leaders understand the benefits of prescribed fire.**	5	1	3	2
	Contributors	9	Contributors	14
	Reducers	17	Reducers	6

	EKPBA (*n* = 9)		GHPBA (*n* = 7)	
	Agreement	Disagreement	Agreement	Disagreement
Practical barriers				
Lack of knowledge and burn experience in my community limit the use of prescribed fire.*	4	0	5	0
An adequate amount of help is available in my PBA to successfully complete all burns.**	9	0	4	2
The PBA has adequate resources and equipment to conduct prescribed burns.**	8	0	5	1
Burn season windows are adequate for meeting prescribed burn goals.**	8	1	2	3
	Contributors	5	Contributors	11
	Reducers	25	Reducers	11
	EKPBA (*n* = 9)		GHPBA (*n* = 7)	
	Agreement	Disagreement	Agreement	Disagreement
Social barriers				
My neighbors support the use of prescribed fire.**	5	1	6	1
It is important to have the approval of neighboring land owners to conduct a prescribed burn.*	8	1	4	2
My community supports the use of prescribed fire.**	5	0	5	1
My family supports the use of prescribed fire.**	7	1	7	0
Community members outside the PBA understand the benefits of prescribed fire.**	1	1	1	4
Escaped fires have negatively impacted community perceptions of the benefits of prescribed fire.*	2	0	6	0
	Contributors	12	Contributors	16
	Reducers	19	Reducers	21

When aggregated by barrier, the responses are very similar, even considering the higher response count from the EKPBA. Across the barriers, statements relating to reducing barriers tended to outnumber those contributing to barriers. An exception to this is the GHPBA responses to Political barriers where more potential barrier contributors are present than barrier reducers. In the key informant interview with the leader of the GHPBA, they described a history of lawsuits within Barber County due to escaped burns. The informant also perceived strict county regulations, matching the agreement seen among GHPBA members (n = 4, 57%). Regulations in Barber County may be in response to the history of escaped burns pointed out by the GHPBA informant. Responses to environmental barriers were similar, which may be explained by similar weather conditions being needed to conduct a burn despite location.

Contributors and reducers were equal for the GHPBA regarding practical barriers; a minority of members disagreeing the association had adequate help (n = 2, 28%) or resources and equipment (n = 1, 13%) available to conduct burns. It was more common for GHPBA members to disagree that burn windows are adequate for meeting prescribed burn goals (n = 3, 43%) while EKPBA consistently agreed (n = 8, 88%). This may be explained by the dry conditions characterizing the Southwestern Tablelands. The lower precipitation in comparison to the Central Irregular Plains may cause drought-related burn bans, thus limiting burn windows. Responses among both were similar regarding social barriers as well, with exception to the GHPBA where members tended to disagree that community members outside the PBA understand the benefits of prescribed fire (n = 4, 57%) meanwhile EKPBA members tended toward neutral answers (n = 7, 77%). While interviewing the GHPBA informant, they explained landowners may prefer woody landcover provided by red cedar. These landowners hunt wildlife recreationally on encroached lands, perceiving the cedars as beneficial to wildlife despite the

wildfire risk posed by the trees. These landowners may contribute to the disagreement expressed by GHPBA members.

4.5 Differences Between Survey Responses

I start this section by describing the results of the Cochran-Mantel-Haenszel (CMH) test used to examine the overall differences in survey responses from the case study PBAs. Next, I report individual questions where the case study PBAs had significantly different answers. The CMH test examines the relationship between row and column variables while controlling for a third variable; see Chapter 2 for more information on CMH tests. CMH tests were conducted in SAS. With a size of 480 responses across all Likert questions (16 participants, 30 questions) the CMH test's row mean scores differ value was 0.1997 with a probability of 0.6549, indicating the PBAs responses not to be statistically significantly different. See table 4.4 for the general statistic scores. The row mean scores differ value of 0.1997 indicates little differences in row mean scores when comparing the two PBAs. Additionally, the p-value of 0.6549 indicates no strong evidence of differences in the row mean scores across the PBAs.

Table 4.5 Cochran-Mantel-Haenszel test statistics based on all table scores.

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)				
Statistic	**Alternative Hypothesis**	**DF**	**Value**	**Prob**
1	**Nonzero Correlation**	1	0.1997	0.6549
2	**Row Mean Scores Differ**	1	0.1997	0.6549
3	**General Association**	4	10.6826	0.0304

While the two PBAs had similar results across all Likert questions, some significant differences emerged when applying the CMH to individual statements. Given the small sample size, I use

the Fisher's Exact Test to analyze the differences by statement. The Fisher's Exact Test is especially useful in cases with small sample sizes (Agresti, 2007).

One statement with significantly different responses was the agreement that "Lack of knowledge and burn experience in my community limit the use of prescribed fire." This explores the practical barriers category I define in Chapter 2. Table 4.5 shows the levels of agreement, frequency each level was selected, percent, row percent, and column percent. Note that 1 indicates strong disagreement while 5 indicates strong agreement. Table Probability (P) and Pr <=P for this statement are 0.0184 and 0.0337, respectively; these values indicate a statistically significant difference in responses as the GHPBA tended to agree with the statement while the EKPBA neither agreed or disagreed. The GHPBA's agreement may be tied to the presence of landowners within the community preferring cedar, perceiving woody encroachment as beneficial to recreation activities like hunting. This preference emerged through my interview with the GHPBA informant and was echoed among Central Great Plains PBAs (n = 2). The GHPBA is located in a more rural part of Kansas while the EKPBA is located in closer proximity to the Kansas City metropolitan area, a major regional hub. Being located further from major cities, the community local to the GHPBA has larger parcel sizes demonstrated by the farm operation size. While ranchers typically use these larger parcels for rangelands, hunters may also prefer them for their size.

In a question that was not significantly different, respondents from the two PBAs indicated their level of concern over woody encroachment. Similar to the other Likert questions, 1 indicates low levels of concern while 5 indicates high concern. The means from the GHPBA and EKPBA were 4.86 and 3.89, respectively (t = 2.1682, p-value = 0.0559). This potentially indicates a slightly higher concern over woody encroachment among GHPBA members than

EKPBA members. This higher concern may be related to cedar-preferring land uses discussed above.

Table 4.6 Agreement with "Lack of knowledge and burn experience in my community limit the use of prescribed fire." A value of 1 indicates strong disagreement while 5 indicates strong agreement.

PBA	1	2	3	4	5	Total
EKPBA						
Frequency	0	0	5	4	0	9
Percent	0	0	31.25	25.00	0	56.25
Row pct	0	0	55.56	44.44	0	
Col Pct	0	0	100	40.00	0	
GHPBA						
Frequency	0	0	0	6	1	7
Percent	0	0	0	37.50	6.25	43.75
Row pct	0	0	0	85.71	14.29	
Col Pct	0	0	0	60.00	100.00	
Total			5	10	1	16
			31.25	62.50	6.25	100.00

Statistically significant differences between PBAs were also observed when comparing the level of satisfaction with the amount of prescribed fire in the community. Rather than measuring levels of agreement/disagreement, this variable measures levels of satisfaction. When examining this variable, more GHPBA members indicate dissatisfaction with current prescribed fire amounts. The Fisher's Exact test revealed Table Probability (P) and Pr <= P values of 0.0147 and 0.0234, indicating the responses differ significantly. Table 4.6 compares the responses for this variable. Low satisfaction with current levels of prescribed fire potentially indicates the presence of barriers to implementing the practice. When conducting the follow up interviews with PBA leaders, low satisfaction was attributed to burning to a lack of burning rather than an abundance of it. This lack of burning could be linked to few opportunities to burn because of the dry climate associated with the Southwestern Tablelands ecoregion (Wiken et al. 2011). In my interviews, I also found that drought has a major impact on prescribed fire. An informant

explains "*Drought wipes out most opportunities that we have to burn. You don't have the fuel, number one, to make it successful. And people are very concerned [if] something gets away*" (GHPBA Interview, October 2023).

Table 4.7 Agreement with "With 1 being very unsatisfied and 5 being very satisfied, rate your satisfaction with the amount of prescribed fire in your community." A value of 1 indicates very unsatisfied while 5 indicates very satisfied.

PBA	1	2	3	4	5	Total
EKPBA						
Frequency	0	2	7	0	0	9
Percent	0	12.50	43.75	0	0	56.25
Row pct	0	22.22	77.78	0	0	
Col Pct	0	28.57	87.50	0	0	
GHPBA						
Frequency	1	5	1	0	0	7
Percent	6.25	31.25	6.25	0	0	43.75
Row pct	14.29	71.43	14.29	0	0	
Col Pct	100	71.43	12.50	0	0	
Total	1	7	8			16
	6.25	43.75	50.00			100.00

While PBAs can have a beneficial influence on individual perceptions of prescribed fire and successful burns can normalize its use, I was interested in the role of escaped prescribed burns in shaping communal perceptions towards the practice. To examine this, I included a variable that asks about respondent agreement that escaped fires negatively impacting community perceptions of prescribed fire benefits. This question explores potential social barriers to prescribed fire. The Fisher exact test showed responses had statistically significant differences when comparing responses between the GHPBA and EKPBA (Table Probability = 0.0084; Pr <= P = 0.0203). Table 4.7 shows the responses to this variable from case study PBAs. The GHPBA responses tend to agree escaped burns are negatively impacting communal perceptions of prescribed fire. This could potentially be another social barrier as the benefits of prescribed fire may be overlooked by damages from escaped burn incidents within the

community. It also may indicate additional education is needed on the benefits of burning and burn practices outside the PBA.

Table 4.8 Agreement with "Escaped fires have negatively impacted community perceptions of the benefits of prescribed fire." A value of 1 indicates strong disagreement while 5 indicates strong agreement.

PBA	1	2	3	4	5	Total
EKPBA						
Frequency	0	0	7	1	1	9
Percent	0	0	43.75	6.25	6.25	56.25
Row pct	0	0	77.78	11.11	11.11	
Col Pct	0	0	87.50	16.67	50.00	
GHPBA						
Frequency	0	0	1	5	1	7
Percent	0	0	6.25	31.25	6.25	43.75
Row pct	0	0	14.29	71.43	14.29	
Col Pct	0	0	12.50	83.33	50.00	
Total	0	0	8	6	2	16
	0	0	50.00	37.50	12.50	100.00

Responses differed, albeit not statistically significantly when the case PBAs were asked about their agreement that county level regulations inhibit prescribed fire (Table Probability = 0.0066; Pr <= P = 0.0577). Table 4.8 displays differences in responses to this variable. A majority of GHPBA responses indicated agreement while most EKPBA participants disagreed. This may be evidence of political barriers in Barber County, but not in Miami County. While interviewing, the GHPBA explained feeling strict regulations in Barber County. The informant explained: "*We have . . . I would say a fairly strict requirement as far as prescribed burning is concerned. But our county commissioners understand the need for burning. And two of them are ranchers. And so they definitely understand the need for it. But they also get the pressure from the public*."

The interview also revealed that Barber County has had a history of lawsuits. Furthermore, when prompted in my survey to write in the "top two" barriers to prescribed fire,

five of the seven GHPBA participants wrote in liability. Although the Fisher's Exact Test values for this variable are not quite significant, there is a noticeable pattern when paired with the interview and write-in responses that indicates political barriers interfering with prescribed fire engagement.

Table 4.9 Agreement with "County level regulations inhibit prescribed burns." A value of 1 indicates strong disagreement while 5 indicates strong agreement.

PBA	1	2	3	4	5	Total
EKPBA						
Frequency	1	4	4	0	0	9
Percent	6.25	25.00	25.00	0.00	0	56.25
Row pct	11.11	44.44	44.44	0.00	0	
Col Pct	100.00	80.00	66.67	0.00	0	
GHPBA						
Frequency	0	1	2	4	0	7
Percent	0	6.25	12.50	25.00	0	43.75
Row pct	0	14.29	28.57	57.14	0	
Col Pct	0	20.00	33.33	100.00	0	
Total	1	5	6	4		16
	6.25	31.25	37.50	25.00		100.00

4.6 Conclusion

This analysis shows that while PBAs can be located in different contexts, the associations are more similar than they are different in terms of the perceived barriers to prescribed fire. When grouping the responses into their barriers, responses tended to indicate both PBAs experience more factors reducing barriers than contributing to them. This is not to say members do not perceive a barrier, but rather suggest they have the capacity to burn despite the barrier. An exception to the trend is the GHPBA membership response to political barriers, where there are more barrier contributors than reducers. This shows the PBAs members are perceiving political barriers, specifically with county regulations and liability. Addressing these may to help expand prescribed fire, especially regarding liability and county level regulations.

Some significant differences emerge when examining the results of individual statements. When examining individual statements, the GHPBA indicated experiencing more barriers than

the EKPBA. This could be explained by ongoing dry conditions being less common in the Central Irregular Plains. Additionally, the EKPBA is situated closer to a major regional hub, thus a higher population with a higher diversity in land use goals. Another potential explanation may lie in the size of fires conducted. Burning larger areas, like with the GHPBA may be more difficult than burning smaller areas.

Overall, the GHPBA responses had a lower satisfaction with the amount of prescribed fire, potentially indicating barriers to prescribed fire within the community limiting engagement with the practice. The GHPBA tended to agree that county regulations inhibit prescribed fire, potentially indicating political barriers. Responses from the GHPBA also indicated social and practical barriers in the forms of the community not perceiving prescribed fire's benefits due to escaped burns and lacks of knowledge and experience inhibiting prescribed fire use, respectively.

The low overall satisfaction regarding the amount of prescribed fire expressed by the GHPBA may be linked to narrow burn windows driven by dry conditions that characterize the context of the PBA (Wiken et al. 2011). The amount may also be limited by county regulations potentially established in response to incidents of escaped burns. The social and practical barriers of not perceiving prescribed fire's benefits may also be linked to the context of the PBA. One of the benefits of using prescribed fire is cedar removal, which may not be desirable to landowners that use their lands for hunting and recreation. Given the large parcel size within the Southwestern Tablelands and Great Plains ecoregions, hunters may be more likely prefer to establishing hunting reserves within this region than in the Central Irregular Plains.

Based on the analyses in this chapter, both ecoregion characteristics and proximity to urban areas contribute to prescribed burn barriers. For example, characteristics like precipitation rates can influence both burn windows (i.e. fewer burn opportunities due to drought related burn-

bans) and burn desirability as ranchers may prefer to not use prescribed fire on their rangelands if the vegetation receives too little precipitation to regrow. The rugged topography, thin soils, and limited surface water that characterize the Southwestern Tablelands play a part in dictating land use. The soil may not support crops as well as grazing lands and cattle. Cattle operations need sufficiently large parcels of land to support cattle populations, potentially explaining the difference in operation size between the GHPBA and EKPBA members.

Another reason for this difference may include proximity to urban areas. Typically, parcels closer to urban areas are smaller than those located further away like the GHPA. Since the parcels are larger and are further from urban areas, they may be more desirable for landowners to establish hunting preserves. Such landowners may not want prescribed fire, seeing it as a negative for tree growth and in opposition to their goals. This may partially explain why GHPBBA members perceive their local community as unaware of the benefits of prescribed fire. Increasing outreach on the benefits of prescribed fire, especially regarding wildlife habitat may motivate landowners prioritizing recreation to use prescribed fire, potentially helping in reducing woody encroachment and wildfire hazards. This comparative case study suggests that the drier, more rural ranching community of the GHPBA experiences more barriers when conducting burns than the peri-urban community of the EKPBA. Future research can further examine the impacts of these barriers and potentially work toward policy changes that better support PBA and prescribed fire activity across different contexts.

Chapter 5 - Prescribed Fire as a Management Tool for Conservation Reserve Program Lands

5.1 Introduction

In this chapter, I investigate the barriers to using prescribed fire in Kansas private conservation lands, specifically those enrolled into the Conservation Reserve Program (CRP). Leveraging a secondary data source, a survey sent to agricultural producers in the Southern Great Plains (see Chapter 2), I address my third research objective: examine the dynamics of prescribed burning on Kansas lands enrolled in the Conservation Reserve Program between agricultural producers and PBA members. Toward this, I investigate the associations between prescribed fire use and CRP enrollment; I hypothesize that there is a relationship between having land enrolled into the CRP and not using prescribed fire. Recent literature (Bergtold et al. 2024) has suggested a perception among Southern Great Plains landowners that lands enrolled into the CRP intensify wildfire risk. This may cause landowners to be reluctant to use prescribed fire to maintain their CRP and instead opt to apply a different management practice. Analyzing secondary data from a study on wildfire and conservation lands (NSF Award# 2117533). I also apply a logistic regression analysis to identify factors that are related to prescribed fire use on CRP lands. Finally, I discuss how perspectives of risk associated with conducting a prescribed fire on lands enrolled into CRP among prescribed burn association (PBAs) members may differ from those of independent landowners by tying in results from my two primary data sources: a Qualtrics survey of PBA members and and semi-structured key informant interviews with PBA leaders (see Chapter 2).

5.2 Secondary Survey Participant Characteristics

The secondary survey data used in this analysis focused on the Southern Plains region and included 5 states. Of the 466 surveys from the secondary source, I analyzed data from the Kansas participants for my chi-square analysis (n = 211). For my logistic regression model, I specifically use Kansas responses that indicate having land enrolled into the CRP (n = 85). Chapter 2 has more details on this survey. Here, I describe the responses from Kansans with land enrolled into the CRP although I provide a summary table that compares the two groups.

Survey respondents reported an average age of 67 (SD = 11), which is higher than the average age given in the 2022 Agricultural U.S. Census from the U.S. Department of Agriculture that reported an age of 58. A majority of the participants (91%) indicated they were male and have a college education (65%). These are both higher than the values from the Agricultural survey by comparison (64% male and 28% having a college degree, respectively). The survey participants are experienced farmers and ranchers, having managed their operations for an average of 34 (SD = 16) years after turning 18. This is also higher than the years of farming experience reported in the Agricultural Census where producers reported an average of 25 years. These operations are an average of 2633 (SD = 3656) acres in size, which is larger than the operation size when compared with the Agricultural Census, reporting an average of 804 acres in Kansas. Respondent characteristics are summarized in table 5.1.

Table 5.1 Summary of Kansas participant characteristics for landowners enrolled and not enrolled into the CRP. Values for all but Gender and College education are the mean with *standard deviation in parentheses. USDA Ag values are from USDA – NASS 2022 AgCensus[a] or USDA – ERS[b]

Characteristic	Enrolled in CRP (*n* = 85)	KS Responses (*n* = 211)	USDA Ag Census[a]
Average age (years)	67 (11*)	66 (13*)	58
Gender (Proportion M/F)	91%	90%	64%
College education (Proportion Y/N)	56%	59%	28%[b]
Average years managing farm as adult	34 (16*)	37 (17*)	25
Operation size (acres)	2633 (3656*)	2189 (2876*)	804

5.3 Common Barriers to Prescribed Fire on Kansas CRP

In the secondary data source, a survey of Southern Great Plains landowners, participants indicated why they do not use prescribed fire to maintain lands enrolled into the CRP. Of the 85 Kansas responses indicating having land enrolled into the CRP, 38 (45%) of the landowners with CRP did not indicate using prescribed fire for managing CRP. Thes participants who do not use prescribed fire on CRP, indicate fear of escaped fire (*n* = 24, 28%), lack of knowledge (*n* = 10, 11%), and lack of equipment (*n* = 9, 10%) as the primary reasons for not burning.

5.4 Fire use and CRP Enrollment

In this section, I use Chi-Square test of independence to examine the association between prescribed fire use and CRP enrollment. I hypothesize a negative association between CRP enrollment and abstaining from prescribed fire. This hypothesis is informed by the literature perceiving CRP to intensify wildfires in the Southern Great Plains (Bergtold et al. 2024). The heightened fuel load from native grasses and fear of fire escape among participating landowners

support this. If landowners abstain from using prescribed fire on CRP there will be an association between CRP enrollment and not using prescribed fire.

When testing my hypothesis I found a significant relationship between CRP enrollment and prescribed fire use X^2 (1, N = 211) = 4.9236, p < .05. While these variables have a statistically significant relationship, more observations than expected used prescribed fire and had land enrolled in CRP than observations that have CRP and do not engage with burning. See table 5.2 for observed and expected counts.

Table 5.2 Observed and expected counts of responses for enrollment into the Conservation Reserve Program and prescribed fire use. Expected values are in parentheses.

	No CRP	**CRP Enrollment**	**Totals**
No prescribed fire	91 (83)	48 (55)	139
Uses prescribed fire	35 (42)	37 (29)	72
Totals	126	85	*N* = 211

This analysis reveals a positive, statistically significant relationship between prescribed fire use and CRP enrollment. This positive relationship may be explained by the management required as part of enrolling into CRP. Enrolled landowners are required to conduct mid-contract management which may include prescribed fire, mowing, or spraying. Literature suggests landowners perceive prescribed fire as an economically efficient form of land management (Kreuter et al. 2008; Van Liew et al. 2012), potentially making it a preferable option in comparison to other management practices. Communications with the Farm Service Agency underneath the U.S. Department of Agriculture, who established the CRP may also provide landowners with information on prescribed fire, thus encouraging the practice. While the amount of landowners with land enrolled in CRP and uses prescribed fire is higher than expected if there

is no relationship, the observed count (37) is still lower than enrolled landowners abstaining from burning (48). This suggests that although prescribed fire use is higher than expected, other management practices may be more common.

5.5 Factors Contributing to Prescribed Fire use on CRP

Fear of escaped fire and lacks of equipment and knowledge are common barriers to prescribed fire (Clark et al. 2022). While these are prominent barriers, PBAs can help mitigate them. PBAs and other institutions may further help increase prescribed fire use by targeting landowners with land enrolled into the CRP given the association with enrollment and prescribed fire use on their operations. The following section examines the factors contributing to a landowners' decision to use prescribed fire on CRP land using logistic regression. Logistic regression is especially useful in analyzing factors that contribute to the occurrence of a dependent binary (yes/no) variable. Both categorical and continuous variables can be included in a logistic regression model; these can identify how each variable increases (or decreases) the probability of the dependent variable, as well as the statistical significance of the interaction. I include a more detailed discussion on logistic regression and details on the survey itself in Chapter 2. Here, I introduce the variables obtained from the wildfire survey before describing the final results and interpreting significant variables.

In the survey, participants selected which mid-contract management actions they have taken on CRP. While prescribed burning is the variable of interest, other options included grazing, disking, interseeding, and herbicide treatment. Of the 85 respondents who indicated enrolling part of their operation into the CRP, 47 (55%) of them indicate using prescribed fire to manage their CRP, different from the 72 who reported generally using it on their operation. I use the prescribed fire use on CRP as the dependent variable in my model. For independent

variables, I use age, agreement that prescribed fire reduces wildfire risk, amount of acres enrolled in CRP, amount of acres used for grazing, education, financial security, status as having liability insurance for prescribed fire, perceived drought frequency, and wildfire experience as predictors. Before presenting my model results, I describe the rationale for each predicting variable.

5.5.1 Age

In the wildfire survey, participants could indicate their age. Mentioned earlier in the landowner characteristics, participants had an average age of 67 (SD = 11). Most participants in the PBA survey were between 65 and 74 (n = 12). While a majority of respondents fell within this range, due to the labor involved with prescribed fire, I expect higher ages to decrease the likelihood of a landowner using prescribed fire to maintain their CRP. Lower ages have also been found to increase the likelihood of supporting and participating in conservation practices (Adhikari et al. 2023; Golden et al. 2013. Gordon et al. 2020). Older landowners were also found to be less likely to use prescribed fire in Stromon et al. (2020).

5.5.2 Prescribed Fire Decreases Wildfire Risk

Using a Likert scale from one to five, with one indicating strong disagreement and five indicating strong agreement, respondents could indicate their levels of agreement with a variety with statements on regarding wildfire and drought perceptions. One of these statements asked agreement that “Prescribed burning helps to significantly reduce wildfire risk.” I recoded blanks and responses of three or less (strong disagreement, disagreement, and neither agree or disagree) to 0; responses indicating four or five (agreement or strong agreement) as 1. After recoding, 68% (n = 58) of Kansas landowners with CRP agreed prescribed fire decreases wildfire risk. Knowledge of prescribed fire, including its benefits has been found to increase the likelihood of

supporting controlled burns in forests (Piatek and McGill, 2010; Toman et al. 2014). It has also been found increase the likelihood of supporting conservation practices in forests (Gordon et al. 2020). Since knowledge of conservation practices has been found to increase the likelihood of supporting their use, I predict that agreeing prescribed fire decreases wildfire risk increases the likelihood of using prescribed fire to manage CRP.

5.5.3 Acres of CRP

Respondents also gave information about their farm operation, like total acres, cropland acres, grazing acres, and acres of CRP among others. Respondents simply wrote-in their acreage. The average amount of CRP acres among when filtering out not enrolled landowners was approximately 151 acres (SD = 221). Due to low response counts, I assumed empty values meant 0 acres of CRP. Since one of the perks of using prescribed fire is economic efficiency as a management tool when compared with other options like mechanical or chemical treatments (Liew et al. 2012), it could be expected that prescribed fire use probability increases with the quantity of acres enrolled in CRP. On the other hand, when comparing CRP and non – CRP burn sizes in my interviews, CRP burns tended to be smaller except for the EKPBA. With this in mind, I expect to see higher probabilities of burning CRP to have an association with fewer acres of CRP.

5.5.4 Acres for Grazing

Mentioned above, the survey asked participants about the amount of acres dedicated to grazing on their operation. Respondents wrote in their acreage, indicating an average 226 acres with a standard deviation of 678. Again, I assume empty values indicated having 0 acres for grazing. Given the value of stimulating grass for cattle growth (Baldwin et al. 2022a; Hoy, 1989), prescribed fire is especially useful for ranchers. Based on my interviews, ranchers use

prescribed fire not only for enhancing cattle gains, but also for clearing out brush and cedars to maximize the amount of grass for grazers. One informant explained: “That new grass growth has got the highest protein available at any time of its growth stage, and you get the best gains on cattle after a burn.” I expect, that because of the usefulness of prescribed fire for grazers, higher probabilities of burning on CRP to have an association with higher amounts of acres.

5.5.5 Education

In addition to farm characteristics, the survey also collects demographic information like education. Participants could indicate whether or not they have received a college degree. I recoded these values so 1 indicates a participant had a college degree and 0 indicates having no degree. When filtering out participants with no CRP, 55% (n = 47) of landowners enrolled in CRP indicated having a college degree. Education is a common variable and is typically expected to support prescribed fire or other conservation-oriented practices (Gordon et al. 2020; Joshi et al. 2017; Schindler and Reed, 1996). Thus, I expect education will increase the likelihood of using prescribed fire on CRP.

5.5.6 Financial Security

The survey includes a brief section on questions that evaluate a participants comfort in accepting or taking risks while making decisions for in managing their operation. Participants gave their responses using a Likert scale ranging from 1 to 5, where a response of 1 meant strong disagreement while 5 indicates strong agreement with a statement. I use agreement with “I am more concerned about large losses on my agricultural operation than about missing a substantial gain” in my model. I recoded values of 3 or lower (strong disagreement, disagreement, and neither agree or disagree) to 0 and values 4 and 5 (agreement and strong agreement) to 1. Of the filtered results, 45% (n = 37) indicated agreed with the statement. Given the risk perceptions

associated with prescribed fire, I expect agreeing with concern about large losses would decrease the likelihood of using prescribed fire on CRP.

5.5.7 Liability Insurance

Participants were asked a variety of questions regarding their insurance, including if they had liability insurance for prescribed burning; respondents simply indicated 'yes' or 'no.' Of the responses with land enrolled into the CRP, 24% (n = 20) indicated having this form of insurance. I recoded this variable so 1 indicated a response had liability insurance for prescribed fire and 0 meant they did not have this insurance. Given the negative impact of liability in my interviews on prescribed fire, I expect that having liability insurance increases the likelihood of using prescribed fire on CRP.

5.5.8 Drought Frequency

Drought and wildfire were major focus areas in the survey. Perceptions of the intensity and frequency of both phenomena were collected using Likert scale levels of agreement. I use agreement with "Compared to 15 years ago, severe drought conditions occur more often in my local area" in my model. Similar to the other Likert variables, I recode values of disagreement or neither agreement or disagreement to 0 and agreement or strong agreement to 1. Since drought was a major barrier to using prescribed fire in my interviews, I expect agreeing with this will decrease the likelihood of using prescribed fire to manage CRP. After recoding the values 48% (n = 40) of responses with CRP enrollment indicated agreement.

5.5.9 Experienced a Wildfire

Mentioned previously, landowner perceptions and experiences of wildfire were collected. Another variable I use is whether or not a participant experienced wildfires on properties they rent or own. Respondents could indicate 'yes' or 'no.' These were recoded as 1 or 0,

respectively. Of the filtered responses, 34% (n = 27) of landowners with CRP enrollment had experienced a wildfire. Since some of the interviews with PBA leaders (n = 3) framed wildfires as a motivator for using prescribed fire, I expect it to increase the likelihood of use on CRP

5.6 Logistic Regression Model

Logistic regression is useful for determining significant factors influencing a binary outcome, where the outcomes for each response are either "success" or "failure." Logistic regression models can have multiple explanatory variables which can be categorical or quantitative (Agresti, 2007). This flexibility makes logistic regression common method for analyzing factors contributing to a binary dependent variable (Bergtold et al. 2024; Kreuter et al. 2019; McDaniel et al. 2021). In logistic regression, the variance inflation factor (VIF) is used to check for multicollinearity; regression assumes the variables are not correlated with each other (Rogerson, 2006). Model fit, or accuracy can be evaluated using a variety of approaches like the Pearson's Chi-Squared test of goodness of fit or the Hosmer-Lemeshow goodness of fit Hosmer et al. 2013). Results for both are reported below.

I use whether or not a landowner with land enrolled into the CRP uses prescribed fire to maintain their CRP as the dependent, binary variable, explained by the previously mentioned independent variables. When testing model fit the Pearson's chi-squared test yielded a test value of $X^2 = 71$ with 70 degrees of freedom and a p-value of 0.4442. Since this is greater than the 0.05 significance level the null hypothesis can be rejected, meaning there is no statistically significant difference between observed and predicted frequencies and suggests the model fits the data. The Hosmer-Lemeshow goodness of fit test yielded an X^2 value of 7.0627 and p-value of 0.5299. Since the value is greater than 0.05, this indicates good model fit (Hosmer et al. 2013). To ensure none of the model variables are overtly influencing the results, I test multicollinearity using the

(VIF) among the independent variables. Values ranged from 1 to 1.24. Since all VIF values are below the threshold of 5, this indicates there are no multicollinearity problems across the model variables (Rogerson, 2006). Null or empty values were removed, leaving 71 complete responses. Table 5.3 shows the results of the logistic regression. The model's null and residual differences were 98.3 on 70 degrees of freedom and 55.1 on 61 degrees of freedom, respectively. This indicates the model with the predicting variables fits better than the intercept-only model, meaning the variables enhance predicting if prescribed fire is used on CRP.

Table 5.3 Logistic regression results for using prescribed fire on CRP.

Dependent Variable: Uses prescribed fire on CRP (1/0) N: 71				
Variable	**Estimate**	**Std. Error**	**Odds Ratio**	**P-value**
Intercept	1.403e+00	2.797e+00	4.067	0.6160
Education	1.260e+00	7.223e-01	3.524	<0.1
Age	-1.079e-02	3.013e-02	9.892648e-01	0.7202
Liability insurance	2.054e+01	2.262e+03	8.345638e+08	0.9928
CRP acres	-2.874e-03	2.723e-03	9.971306e-01	0.2914
Grazing acres	6.853e-04	8.978e-04	1.001	0.4453
Experienced wildfire	6.233e-01	6.854e-01	1.865	0.3632
Prescribed fire reduces wildfire	1.160e+00	7.750e-01	3.19	0.1345
Drought frequency	-8.448e-02	7.257e-01	9.189883e-01	0.9073
Financial security	-8.452e-01	4.579e-01	4.294892e-01	<0.1

Surprisingly, none of the variables are statistically significant at the p-value < .05 level. However, variables for education and financial security are significant at the < 0.1 level. A log odds ratio of 3.524 indicates that landowners with a college degree are more likely to use

prescribed fire on CRP than landowners with no college degree. In terms of percent change, this means the odds for using prescribed fire to manage CRP are 252.4% higher for landowners with a college degree than landowners without a college degree. This is not surprising given the tendency of education toward conservation practices I discuss when introducing the variables. Additionally, economics literature suggests a willingness to take risks among individuals with higher levels of education (Outreville, 2015). Educated landowners may feel more confident in managing burn escapes or are more motivated to burn by being more aware of the benefits of using prescribed fire.

Financial security was also a statistically significant factor (p-value < .1). An odds ratio of 0.429 indicates that landowners who agree with being more concerned about large financial losses than gains were **less** likely to use prescribed fire to maintain their CRP. I think this can also be tied to liability concerns in that if a landowner is concerned about financial losses, the costs associated with liability damages may deter them from using prescribed fire. Concern for financial losses may also indicate limited funds for buying equipment needed to safely conduct a burn.

5.7 Comparing Landowner Perceptions of burning CRP PBA Membership

When surveying general landowners across Kansas, fear of escaped fire, lacks of knowledge, and lacks of equipment were indicated as the most common reasons for not burning. Despite these reasons, I found an association between prescribed fire and CRP. However, among landowners with CRP, many indicate not using prescribed fire to manage their enrolled lands. Additionally, landowners more concerned about financial losses are less likely to use prescribed fire on CRP. Between the literature (Clark et al. 2022), my interviews with key informants, and my PBA survey results, it seems reasonable to tie this concern to being held liable for damages

in the event of a burn escape. One informant explained: "*I would say that the first thing came up as people as an excuse to not burn is "I don't want to take the risk of burning down my neighbors." And the reason for that? Lawsuits*." Liability was a common theme (*n* = 3, 50%) in my key informant interviews with PBA leaders and as a write in response asking participants for their top two perceived barriers to prescribed fire in my PBA survey. (*n* = 8, 32%).

Although the fear of escaped fires was a common motivation for not burning CRP and having more concerns on financial losses decreased the likelihood of burning, a different picture emerges when examining findings from my PBA interviews and survey. In my survey, I asked respondents if grasses on CRP increase the risk of fire escape when conducting a prescribed burn. Not surprisingly given the higher fuel load associated with native grasses, over half (*n* = 14, 56%) agreed. However, when asked if burns conducted on lands enrolled into the CRP involve more considerations only six participants agreed. Furthermore, participants consistently disagreed (*n* = 17, 68%) that burns on CRP land are riskier than burns on not enrolled land.

I explore this further in my interviews by asking informants about the risk involved in burning CRP. Consistently, informants explain that burning CRP involves similar levels of risk as burning lands not enrolled in CRP. Additionally, following best practices like creating a burn plan and preparing the land for a burn by mowing can help reduce the risk of fire escape (*n* = 4, 66%). Surprisingly, some respondents felt burning on CRP is less risky than non-enrolled lands (*n* = 2, 33%). These key informants explained CRP typically has fewer trees which can continue to emit sparks after a burn and that CRP. Further, CRP land also tends to be on flat, isolated terrain with few neighboring structures. The perceptions of these key informants may be more representative of a norm for CRP in the High Plains and Central Great Plains. Overall, while there may be more risk of fire escape due to the fuel load, PBA members disagree CRP is riskier

than not enrolled lands. Informants support this sentiment by echoing enrolled and not enrolled lands have similar or lower amounts of risk, which can be mitigated through burn preparation practiced among PBAs. These burn preparation steps along with the above described characteristics of CRP may contribute to the confidence PBAs express in burning CRP lands, despite the higher fuel loads.

5.8 Conclusions

Among the participating Kansas landowners from the secondary survey, 38 of the 85 respondents that indicated having land enrolled into the CRP do not use prescribed fire when maintaining their CRP. These landowners indicate fear of escaped fire (n = 24, 28%), lack of knowledge (n = 10, 11%), and lack of equipment (n = 9, 10%) as the most common reasons for not using the practice. Despite these motivations for not using prescribed fire, there is a statistically significant association between having CRP and conducting prescribed burns as seen by my chi-square analysis. This may be tied the enrollment requirement of conducting mid-contract management practices. Landowners may prefer to use prescribed fire given its economic efficiency when compared to to other options. It may also be related to communications received from the Farm Service Agency regarding that promote this relationship. External actors who spark PBA establishment may find more support for prescribed fire among landowners seeking to maintain their CRP; PBAs may also bolster their membership by contacting such landowners.

The logistic regression model analyzing factors related to burning on CRP found that none of the variables were significant at the p-value <.05. However, having a college degree and being more concerned with significant financial losses than gains were significant (p-value < 0.1). The odds for using prescribed fire on CRP among landowners with a college degree are 252.4% higher than landowners without one. One the other hand, landowners more concerned

with financial loss were less likely to use prescribed burns on CRP. Educated individuals tend to be more willing to take risks, or be more aware of the variety of benefits associated with conducting a burn, potentially explaining why landowners with a college degree were more likely to burn than landowners with no degree.

Given the functions of PBAs, I argue joining an association would help mitigate most of the motivations given for not using fire on CRP. PBAs help reduce perceived risks associated with fire use as Joshi et al. (2019) found that more experience burning held lower risk perceptions regarding property damage and injury than those with less experience. Training opportunities and pooled equipment in an association directly address the other common reasons given for not using fire on CRP, like lacks of knowledge (36%) and equipment (25%).

I found mixed responses while interviewing the PBAs towards risks associated specifically with burning on CRP. Only the Gyp Hills PBA (GHPBA) and Eastern Kansas PBA (EKPBA) burn on CRP with any frequency, although the Smoky Hills PBA (SHPBA) indicated potentially burning CRP in the future. While the PBAs tended to agree that private conservation lands have a higher fuel load, there were mixed opinions regarding the level of risk associated with these burns. Overall, by having a plan and proper preparations, the common perception among key informants is that burning CRP is no riskier than burning non-enrolled lands ($n = 6$). With these preparations in place, landowners can feel comfortable with conducting a burn on areas with a high fuel load. Further outreach and education from external actors may increase prescribed fire use on CRP lands. Changing liability policies to gross liability may also encourage prescribed fire, making it a less financially risky action by increasing legal protection when burning with proper precautions. Promoting prescribed fire liability insurance may also

help in this regard. In addition, joining or establishing PBAs may empower landowners with CRP to maintain their lands with prescribed burns.

Chapter 6 - Conclusions

6.1 Research Summary

Prescribed fire is the intentional application of fire to a landscape and helps landowners achieve a variety of goals like grassland rejuvenation and combating the spread of woody encroachment while supporting livestock production (Baldwin et al. 2022a). In addition, this management practice significantly reduces aboveground fuel loads, helping constrain the size of wildfire events (Rau et al. 2010; Fernandes, 2015). Despite these benefits, prescribed fire is limited in its use by a variety of barriers (Clark et al. 2022). Prescribed burn associations (PBAs) help address practical barriers, such as not having the knowledge, experience, equipment, or labor to conduct a burn by pooling individual resources together and promoting burn capacity (Diaz et al. 2016).

While the literature focuses on the benefits, barriers, and risks of prescribed fire, it tends to focus on individuals. These studies also frequently indicate PBAs help address these barriers (Clark et al. 2022). However, little work has examined the barriers to prescribed fire use among PBAs as themselves. Kansas itself is understudied in regard to the barriers to prescribed burning, as is the practices use on lands enrolled into the Conservation Reserve Program (CRP). Thus, my primary research question for this research asks **how PBA membership across Kansas perceives the barriers to prescribed burning on grasslands, including those enrolled in the Conservation Reserve Program.**

To answer my primary research question, I developed three objectives:

1) *Examine the diversity across PBAs in Kansas ecoregions in terms of burn activity and barriers.*
2) *Assess how barriers for prescribed fire vary between rural and peri-urban contexts*.

3) *Examine the dynamics of prescribed burning on Kansas lands enrolled in the Conservation Reserve Program between agricultural producers and PBA members*.

In my first objective, 1) I hypothesize the motivations for and barriers to prescribed fire are likely to differ across ecoregions. Similarly, 2) I hypothesize survey responses on the barriers to prescribed fire in different contexts are more likely to be different than similar when addressing my second objective. For my third objective 3), I use a secondary data source – a survey of landowners within the Southern Great Plains to examine the dynamics of prescribed burning on Kansas lands enrolled in the CRP between agricultural producers and PBA members.

My results indicate that while PBA characteristics may vary, the associations share many commonalities among burn motivations. Although these associations have similar motivations, they are not forming organically; key informants explained that external actors, like the Natural Resources Conservation Service were involved in hosting meetings that ultimately lead to the formation of an association. Additionally, PBAs as a collective share common barriers to prescribed fire. Drought severely effected burn activity in many of the PBAs. Burning in drought-prone areas is perceived as risky due to limited precipitation hindering grass regrowth. Additionally, burns in dry conditions may be limited by the enactment of burn bans. Social barriers like lack of awareness of benefits or need for prescribed burns on grasslands are also common barriers when examining PBAs as a collective.

When comparing the perceptions of individual members in two distinct Kansas PBAs in my second chapter, the responses to statements on potential barriers was similar overall, but differences emerged regarding the satisfaction in local prescribed fire frequency, practical

barriers, and social barriers. This reveals that while PBAs may be located in different contexts, in terms of perceived barriers the associations may be more similar than they are different. However, the case PBA in a dry, more rural Kansas context with a history of wildfire and lawsuits felt less satisifed with local prescribed burn frequency than the case PBA in a peri-urban context with higher land use diversity and rainfall.

Finally, when investigating factors that contribute to using prescribed fire on CRP among Kansas landowners, those with a college degree were more likely to manage their CRP with fire than landowners without a college degree. On the other hand, landowners more concerned with financial losses than gains were significantly less likely to use prescribed fire on CRP. The most common motivations selected for not using prescribed fire on CRP were fear of escaped fire, lack of knowledge, and lack of equipment. If part of this fear of escaped fires linked to liability, PBAs may help address these common motivations by helping landowners gain experience, training, and equipment necessary to safely conduct prescribed burns. While PBA members acknowledge potentilaly higher risk with burning CRP due to higher fuel loads, the preperation required among these associations builds their capacity and confidence when burning these lands. The associations tend to view burning CRP similar to burning unenrolled lands, meaning they likely share the same barriers like drought, burn bans, and lack of awareness regarding the benefits and need for prescribed fire among broader communities.

6.2 Future Directions

Given the frequency of environmental barriers like drought, future research can investigate ways to reduce the barriers to burning in dry conditions. Other directions may involve studying materials used among external actors like the Natural Resources

Conservation Service that contributed to establishing PBAs because so many were formed from attendees of meetings these actors host. Actors like these clearly have a critical role in helping promt the establishment of PBAs and should continue outreach efforts to expand and support these associations. Finally, future studies aiming to increase prescribed fire in Kansas may focus on other contexts across the state, or try to build capacity for those situated in rural contexts. These may face additional challenges due a preference for woody encroachment among landowners with recreation oriented goals. Designing policy that better supports burning in dry conditions, PBA activity, and promotes gross negligence liability may help address these barriers to PBAs and increase the use of prescribed fire across Kansas.

Bibliography

Adhikari, S., Hurst, K. F., & Joshi, O. (2023). Understanding the Barriers to Adoption of Mixed-Species Herbivory in the Southern Great Plains of the United States. *Rangeland Ecology & Management*, *90*, 157–164. https://doi.org/10.1016/j.rama.2023.07.001

Agresti, A., (2007). An Introduction to Categorical Data Analysis (2nd Edition). John Wiley & Sons, Inc.

An, H., Gan, J., & Cho, S. (2015). Assessing Climate Change Impacts on Wildfire Risk in the United States. *Forests*, *6*(12), 3197–3211. https://doi.org/10.3390/f6093197

Andrews, P. L. & Rothermel, R. C. (1982). Charts for interpreting wildland fire behavior characteristics. Ogden, UT: U.S. Dept. of Agriculture. Available at: Charts for interpreting wildland fire behavior characteristics (usda.gov)

Anon. n.d.-a. "Bypaths of Kansas History - August 1937 - Kansas Historical Society." Retrieved December 13, 2022 (https://www.kshs.org/p/kansas-historical-quarterly-bypaths-of-kansas-history-august-1937/12718).

Anon. n.d.-a. "Flint Hills Firestick – Kansas Historical Society." Retrieved April 25, 2024 from https://www.kshs.org/kansapedia/flint-hills-firestick/10360

Baker, K. R., Koplitz, S. N., Foley, K. M., Avey, L., & Hawkins, A. (2019). Characterizing grassland fire activity in the Flint Hills region and air quality using satellite and routine surface monitor data. *Science of The Total Environment*, *659*, 1555–1566. https://doi.org/10.1016/j.scitotenv.2018.12.427

Baldwin, C., Davidson, J., & Coleman, L. (2022a). Pyric legacy: Prescribed burning in the Flint Hills region, USA. In Weir, J. R. & Scasta, J. D. (Eds.), Global Application of Prescribed Fire. (pp. 144-161). CSIRO Publishing. https://doi.org/10.1071/9781486312498

Baldwin, C., Weir, J., Treadwell, M., Bauman, P., Scasta, D., Cram, D., Bammerlin, L., & Twidwell, D. (2022b). *Benefits of rangeland burning* [GPE Publication]. Benefits of Rangeland Prescribed Burning; Great Plains Fire Science Exchange. https://www.ksfire.org/prescribed-burning/documents/3.%20Benefits_of_rangeland_prescribed_burning.pdf

Bendel, C., Toledo, D., Hovick, T., & McGranahan, D. (2020). Using behavioral change models to understand private landowner perceptions of prescribed fire in North Dakota. *Rangeland Ecology & Management*, *73*(1), 194–200. https://doi.org/10.1016/j.rama.2019.08.014

Bergtold, J. S., Caldas, M. M., Joslin, A., & Gharib, M. (2024). Wildfire across agricultural landscapes: Farmer and rancher experiences and perceptions in the southern great plains. *Environmental Hazards*, 1–26. https://doi.org/10.1080/17477891.2024.2304201

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 I: Systematic Review of Socio-Ecological Research. *Land*, *11*(9), 1521. https://doi.org/10.3390/land11091521

Cope, M. (2010). Coding Transcripts and Diaries. In N. Clifford, S. French, & G. Valentine (2nd ed.), *Key Methods in Geography* (pp. 440-452). Sage Publishing.

Courtwright, J. (2011), *Prairie Fire: A Great Plains History*. University Press of Kansas

DeBano, L. F., Neary, D. G., & Ffolliott, P. F. (1998). *Fire's Effects on Ecosystems*. New York, NY: John Wiley & Sons, Inc.

Diaz, J., Fawcett, J. E., & Weir, J. R. (2016). The Value of Forming a Prescribed Burn Association. Southern Fire Exchange Fact Sheet. Available at: https://southernfireexchange.org/wp-content/uploads/2016-2.pdf

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method. Hoboken, NJ: Wiley.

Donovan, V. M., Wonkka, C. L., & Twidwell, D. (2017). Surging wildfire activity in a grassland biome. *Geophysical Research Letters*, *44*(12), 5986–5993. https://doi.org/10.1002/2017GL072901

Donovan, V. M., Wonkka, C. L., Wedin, D. A., & Twidwell, D. (2020). Land-Use Type as a Driver of Large Wildfire Occurrence in the U.S. Great Plains. *Remote Sensing*, *12*(11), 1869. https://doi.org/10.3390/rs12111869

Dunn, K. (2000). Interviewing. In I. Hay, *Qualitative Research Methods in Human Geography*. Oxford University Press.

Eirey, S. M., San-Roman-Montero, J., Gil De Miguel, A., Rojo, R., & López Sánchez, A. F. (2022). Effect of the 2008 economic crisis on oral health in Spain: Analysis of serial cross-sectional, population-based health surveys. *BMJ Open*, *12*(12), e061947. https://doi.org/10.1136/bmjopen-2022-061947

Elmore, R. D., Bidwell, T. G., & Weir, J.R. (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. Available at: https://talltimbers.org/wp-content/uploads/2014/03/Elmoreetal2010_op.pdf

Farm Service Agency (2024). *Conservation Reserve Program*. https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index

Farm Service Agency (n.d.). *CP-1 Establishment of Permanent Introduced Grasses and Legumes.* https://www.fsa.usda.gov/Internet/FSA_File/crp_su43_jobsheets.pdf

Fernandes, P. M. (2015). Empirical Support for the Use of Prescribed Burning as a Fuel Treatment. *Current Forestry Reports*, *1*(2), 118–127. https://doi.org/10.1007/s40725-015-0010-z

Fuhlendorf, S. D., Woodward, A. J., Leslie, D. M., & Shackford, J. S. (2002). Multi-scale effects of habitat loss and fragmentation on lesser prairie-chicken populations of the US Southern Great Plains. *Landscape Ecol* **17**, 617–628 (2002). https://doi.org/10.1023/A:1021592817039

Golden, K. E., Peterson, M. N., DePerno, C. S., Bardon, R. E., & Moorman, C. E. (2013). Factors shaping private landowner engagement in wildlife management. *Wildlife Society Bulletin*, *37*(1), 94–100. https://doi.org/10.1002/wsb.235

Gordon, J. S., Willis, J. L., & Grala, R. K. (2020). Public and forest landowner attitudes towards longleaf pine ecosystem restoration using prescribed fire. *Canadian Journal of Forest Research*, *50*(9), 917–924. https://doi.org/10.1139/cjfr-2019-0415

GPFSE. (2022). "Prescribed Burn Associations | Great Plains Fire Science Exchange." Retrieved December 13, 2022 (https://gpfirescience.org/prescribed-burn-associations/).

Haikerwal, A., Reisen, F., Sim, M. R., Abramson, M. J., Meyer, C. P., Johnston, F. H., & Dennekamp, M. (2015). Impact of smoke from prescribed burning: Is it a public health concern? Journal of the Air & Waste Management Association 65(5), 592-598. https://doi.org/10.1080/10962247.2015.1032445

Hall, D. B., Woolson, R. F., Clarke, W. R., & Jones, M. F., (2000). Cochran–Mantel–Haenszel Techniques: Applications Involving Epidemiologic Survey Data. In Sen, P. K. & Rao, R. (Eds.), Handbook of Statistics, Vol. 18. (pp. 483-500) Elsevier Science.

Hamilton, M., & Salerno, J. (2020). Cognitive Maps Reveal Diverse Perceptions of How Prescribed Fire Affects Forests and Communities. *Frontiers in Forests and Global Change*, *3*, 75. https://doi.org/10.3389/ffgc.2020.00075

Harr, R. N., Wright Morton, L., 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), art41. https://doi.org/10.5751/ES-06404-190241

Harvey, D. (1969). Explanation in Geography. London: Edward Arnold

Hosmer, D. W. J., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression*. John Wiley & Sons, Incorporated.

Hoy, J., "Controlled Pasture Burning in the Folklife of the Kansas Flint Hills" (1989). Great Plains Quarterly. 386. https://digitalcommons.unl.edu/greatplainsquarterly/386

Huang, R., Hu, Y., Russel, A. G., Mulholland, J. A., and Odman, M. T. (2019). The Impacts of Prescribed Fire on PM2.5 Air Quality and Human Health: Application to Asthma-Related

Emergency Room Visits in Georgia, USA. International Journal of Environmental Research and Public Health 16 (2312). https://doi.org/10.3390/ijerph16132312

Jaffe, D. A., O'Neill, S. M., Larkin, N. K., Holder, A. L., Peterson, D. L., Halofsky, J. E., & Rappold, A. G. (2020). Wildfire and prescribed burning impacts on air quality in the United States. *Journal of the Air & Waste Management Association*, *70*(6), 583–615. https://doi.org/10.1080/10962247.2020.1749731

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, *1*(2), 112–133. https://doi.org/10.1177/1558689806298224

Joshi, O., Becerra, T. A., Engle, D. M., Fuhlendorf, S. D., & Elmore, R. D. (2017). Factors Affecting Public Preferences for Grassland Landscape Heterogeneity in the Great Plains. *Environmental Management*, *60*(5), 922–930. https://doi.org/10.1007/s00267-017-0921-5

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 Prescribed Burning Associations. (n.d.). Kansas Grazing Lands Coalition. https://www.kglc.org/kansas-prescribed-burning-associations.cfm

Knight, C. G. (2001). Human–environment relationship: Comparative case studies. In N. J. Smelser & P. B. Baltes (Eds.), International Encyclopedia of the Social & Behavioral Sciences (pp. 7039–7045). Pergamon. https://doi.org/10.1016/B0-08-043076-7/04195-4

Koger v. Ferrin, No. 680-681, 1996 Court of Appeals of Kansas (Nov. 15, 1996). Available at: https://casetext.com/case/koger-v-ferrin

Kreuter, U. P., Stroman, D. A., Wonkka, C. L., Weir, J., Abney, A. A., & Hoffman, J. K. (2019). Landowner Perceptions of Legal Liability for Using Prescribed Fire in the Southern Plains, United States. *Rangeland Ecology & Management*, *72*(6), 959–967. https://doi.org/10.1016/j.rama.2019.08.004

Kreuter, U. P., Stroman, D. A., Wonkka, C. L., Weir, J., Abney, A. A., & Hoffman, J. K. (2019). Landowner Perceptions of Legal Liability for Using Prescribed Fire in the Southern Plains, United States. *Rangeland Ecology & Management*, *72*(6), 959–967. https://doi.org/10.1016/j.rama.2019.08.004

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

Kuritz, S. J., Landis, J. R., & Koch, G. G. (1988). A general overview of Mantel-Haenszel methods: applications and recent developments. *Annual review of public health*, *9*, 123–160. https://doi.org/10.1146/annurev.pu.09.050188.001011

Lappe, B., and Vargo, J. (2022). "Disruptions from Wildfire Smoke: Vulnerabilities in Local Economies and Disadvantaged Communities in the U.S." *Federal Reserve Bank of San Francisco Community Development Research Brief* 2022-06. doi: 10.24148/cdrb2022-06.

Liu, X., Huey, L. G., Yokelson, R. J., Selimovic, V., Simpson, I. J., Müller, M., Jimenez, J. L., Campuzano-Jost, P., Beyersdorf, A. J., Blake, D. R., Butterfield, Z., Choi, Y., Crounse, J. D., Day, D. A., Diskin, G. S., Dubey, M. K., Fortner, E., Hanisco, T. F., Hu, W., … Wolfe, G. M. (2017). Airborne measurements of western U.S. wildfire emissions: Comparison with prescribed burning and air quality implications. *Journal of Geophysical Research: Atmospheres*, *122*(11), 6108–6129. https://doi.org/10.1002/2016JD026315

Londe, D. W., Cady, S. M., Elmore, R. D., & Fuhlendorf, S. D. (2022). Woody plant encroachment pervasive across three socially and ecologically diverse ecoregions. *Ecology and Society*, *27*(3), art11. https://doi.org/10.5751/ES-13348-270311

Longhurst, R. (2010). Semi-structured Interviews and Focus Groups. In N. Clifford, S. French, & G. Valentine (2nd ed.), *Key Methods in Geography* (pp. 440-452). Sage Publishing.

McCaffrey, S. (2005). Prescribed fire: What influences public approval?. Fire in Eastern Oak Forests: Delivering Science to Land Managers. (pp. 192-198). Available at: https://www.nrs.fs.usda.gov/pubs/gtr/gtr_nrs-p1/mccaffrey_p1_192.pdf

McDaniel, T. W., Wonkka, C. L., Treadwell, M. L., & Kreuter, U. P. (2021). Factors Influencing County Commissioners' Decisions about Burn Bans in the Southern Plains, USA. *Land*, *10*(7), 686. https://doi.org/10.3390/land10070686

McLafferty, S. L. (2010). Conducting Questionnaire Surveys. In N. Clifford, S. French, & G. Valentine (2nd ed.), *Key Methods in Geography* (pp. 75-88). Sage Publishing.

Mendenhall, W., Beaver, R. J., & Beaver, B., M. (2003). Introduction to Probability and Statistics. (11th Edition). Duxbury Press.

Morton, L. W., Regen, E., Engle, D. M., Miller, J. R., & Harr, R. N. (2010). Perceptions of Landowners Concerning Conservation, Grazing, Fire, and Eastern Redcedar Management in Tallgrass Prairie. *Rangeland Ecology & Management*, *63*(6), 645–654. https://doi.org/10.2111/REM-D-09-00041.1

Nippert, J. B., Telleria, L., Blackmore, P., Taylor, J. H., & O'Connor, R. C. (2021). Is a Prescribed Fire Sufficient to Slow the Spread of Woody Plants in an Infrequently Burned Grassland? A Case Study in Tallgrass Prairie. *Rangeland Ecology & Management*, *78*, 79–89. https://doi.org/10.1016/j.rama.2021.05.007

O'Hara, K. C., Ranches, J., Roche, L. M., Schohr, T. K., Busch, R. C., & Maier, G. U. (2021). Impacts from wildfires on livestock health and production: Producer perspectives. *Animals*, *11*(11), 3230. https://doi.org/10.3390/ani11113230

Omernik, J.M, 1987, Ecoregions of the conterminous United States (map supplement): Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125, scale 1:7,500,000

Outreville, J. F. (2015). The relationship between relative risk aversion and the level of education: a survey and implications for the demand for life insurance. *Journal of Economic Surveys* 29(1), 97–111). https://doi.org/10.1111/joes.12050

Peltonen-Sainio, P., Jauhiainen, L., Känkänen, H., Joona, J., Hydén, T., & Mattila, T. J. (2022a). Farmers' Experiences of How Under-Sown Clovers, Ryegrasses, and Timothy Perform in Northern European Crop Production Systems. *Agronomy*, *12*(6), 1401. https://doi.org/10.3390/agronomy12061401

Peltonen-Sainio, P., Jauhiainen, L., Mattila, T. J., Joona, J., Hydén, T., & Känkänen, H. (2022b). Pioneering Farmers Value Agronomic Performance of Cover Crops and Their Impacts on Soil and Environment. *Sustainability*, *14*(13), 8067. https://doi.org/10.3390/su14138067

Piatek, K. B., & McGill, D. W. (2010). Perceptions of Private Forest Owners in West Virginia on the Use of Prescribed Fire in Forestry. *Small-Scale Forestry*, *9*(2), 227–241. https://doi.org/10.1007/s11842-010-9112-4

Podschwit, H., Miller, C., & Alvarado, E. (2021). Spatiotemporal Prescribed Fire Patterns in Washington State, USA. *Fire*, *4*(2), 19. https://doi.org/10.3390/fire4020019

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

Quinn-Davidson, L. N., & Varner, J. M. (2012). Impediments to prescribed fire across agency, landscape and manager: An example from northern California. *International Journal of Wildland Fire*, *21*(3), 210. https://doi.org/10.1071/WF11017

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

Rau, B. M., Tausch, R., Reiner, A., Johnson, D. W., Chambers, J. C., Blank, R. R., & Lucchesi, A. (2010). Influence of Prescribed Fire on Ecosystem Biomass, Carbon, and Nitrogen in a Pinyon Juniper Woodland. *Rangeland Ecology & Management*, *63*(2), 197–202. https://doi.org/10.2111/REM-D-09-00088.1

Rice, S. (2010). Sampling in Geography. In N. Clifford, S. French, & G. Valentine (2nd ed.), *Key Methods in Geography* (pp. 230-252) Sage Publishing.

Roberts, C. P., Scholtz, R., Fogarty, D. T., Twidwell, D., & Walker, T. L. (2022). Large-scale fire management restores grassland bird richness for a private lands ecoregion. *Ecological Solutions and Evidence*, *3*(1), e12119. https://doi.org/10.1002/2688-8319.12119

Rogerson, P. A., (2006). Statistical Methods For Geography A Student's Guide (2nd Edition). Sage Publications

Schohr, T. K., Gornish, E. S., Woodmansee, G., Shaw, J., Tate, K. W., & Roche, L. M. (2020). Practitioner insights into weed management on California's rangelands and natural areas. Environmental Management, 65(2), 212–219. https://doi.org/10.1007/s00267-019-01238-8

Schultz, C. A., McCaffrey, S. M., & Huber-Stearns, H. R. (2019). Policy barriers and opportunities for prescribed fire application in the western United States. International Journal of Wildland Fire, 28(11), 874. https://doi.org/10.1071/WF19040

Shindler, B., Reed, M. (1996). Forest management in the Blue Mountains: public perspectives on prescribed fire and mechanical thinning. Corvallis, OR: Oregon State University, Department of Forest Resources. 58 p + appendix. https://www.fs.usda.gov/pnw/pubs/journals/pnw_1996_Shindler001.pdf

Sieber, S. D. (1973). The integration of fieldwork and survey methods. American Journal of Sociology. 73, 1334-1359.

Stritzke, R., (1996). "NF96-268 Conducting a Prescribed Burn on Warm-season Grass CRP Sites" Historical Materials from University of Nebraska-Lincoln Extension. 1098. https://digitalcommons.unl.edu/extensionhist/1098

Stroman, D. A., Kreuter, U. P., & Wonkka, C. L. (2020). Landowner perceptions of woody plants and prescribed fire in the Southern Plains, USA. *PLOS ONE*, *15*(9), e0238688. https://doi.org/10.1371/journal.pone.0238688

Taylor, C. A. (2005). Prescribed Burning Cooperatives: Empowering and Equipping Ranchers to Manage Rangelands. Rangelands 2005, 27, 18–23. https://doi.org/10.2111/1551-501X(2005)27%3C18:PBCEAE%3E2.0.CO;2

Toledo, D., Kreuter, U. P., Sorice, M. G., & Taylor, C. A. (2012). To Burn or Not to Burn: Ecological Restoration, Liability Concerns, and the Role of Prescribed Burning Associations. *Rangelands*, *34*(2), 18–23. https://doi.org/10.2111/RANGELANDS-D-11-00037.1

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), art9. https://doi.org/10.5751/ES-05820-180409

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/s00267-014-0327-6

Tseng, M., Walton, E., Egleston, B. L., & Fang, C. Y. (2024). Pandemic effects on social capital in residents and non-residents of Chinese immigrant enclaves in Philadelphia. *Wellbeing, Space and Society*, *6*, 100185. https://doi.org/10.1016/j.wss.2024.100185

Twidwell, D., Fuhlendorf, S. D., Taylor, C. A., & Rogers, W. E. (2013). Refining thresholds in coupled fire–vegetation models to improve management of encroaching woody plants in grasslands. *Journal of Applied Ecology*, *50*(3), 603–613. https://doi.org/10.1111/1365-2664.12063

U.S. Department of Agriculture, Economic Research Service (USDA-ERS). (2019). Characteristics of principal farm operator households, by experience of operators, 2016. Farm Household Income and Characteristics. https://www.ers.usda.gov/data- products/farm-household-income-and-characteristics/.

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA-NASS). (2022). Census of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_US_State_Level/

U.S. Fire Administration, Federal Emergency Management Agency (USFA-FEMA). (2022). What is the WUI. https://www.usfa.fema.gov/wui/what-is-the-wui.html

Van Liew, D. (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

Waldrop, T. A., & Goodrick, S. L. (2012.) (Slightly revised 2018). Introduction to prescribed fires in Southern ecosystems. Science Update SRS-054. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 80 p. Available at: https://www.srs.fs.usda.gov/pubs/su/su_srs054.pdf

Wang, D., Guan, D., Zhu, S. *et al.* Economic footprint of California wildfires in 2018. *Nat Sustain* 4, 252–260 (2021). https://doi.org/10.1038/s41893-020-00646-7

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

Weir, J., Twidwell, D., & Wonkka, C. L. (2015). Prescribed Burn Association Activity, Needs, and Safety Record: a survey of the Great Plains. [GPE Publication] 2015-6. Available at: https://gpfirescience.org/wp-content/uploads/2022/05/PrescribedBurnAssocSurvey-1.pdf

Wiken, E., Nava, F. J., &, and Griffith, G. (2011). North American Terrestrial Ecoregions—Level III. Commission for Environmental Cooperation, Montreal, Canada. https://gaftp.epa.gov/EPADataCommons/ORD/Ecoregions/pubs/NA_TerrestrialEcoregionsLevel3_Final-2june11_CEC.pdf

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

Appendix A - Institutional Review Board Approval Letter

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Audrey Joslin
Geography & Geo Sciences
Manhattan, KS 66506

Proposal Number IRB-11737

FROM: Lisa Rubin, Chair
Committee on Research Involving Human Subjects

DATE: 08/01/2023

RE: Approval of Proposal Entitled, "Patterns and Perceptions of Wildfire risk and Prescribed Burning on Private Conservation lands in Kansas: A Masters Thesis."

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: 08/01/2023

EXPIRATION DATE: 07/31/2026

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 Lisa Rubin on 08/01/2023 6:10 PM ET

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

Appendix B - PBA Survey

PBA Survey

Start of Block: Consent

Q1 Dear Prescribed Burn Association member,

Please participate in a survey regarding the perceived barriers to expanding prescribed fire use in Kansas, and particularly on lands enrolled into the Conservation Reserve Program. This survey is part of a research study conducted by Wyatt Cheney, a graduate student with the Kansas State University Department of Geography and Geospatial sciences under the supervision of Dr. Audrey Joslin for the student's Master's thesis. Please complete the survey even if you do not personally own or manage land enrolled in the Conservation Reserve Program.

The survey will ask you a series of questions regarding your background, prescribed burn association membership, controlled burn practices, and perceptions on barriers to implementing prescribed fire. Participation in this survey is entirely voluntary and you may withdraw your participation from the research at any time for any reason. The survey should take approximately 10 to 15 minutes to complete. While you will not receive direct benefits from your participation in this research, the results may inform future outreach, policy, and land management practices.

The data collected will be kept strictly confidential. None of the information you provide will be made individually identifiable. Instead, a project-specific identifier will be associated with your survey responses, which is not linked back to your personal information. Identifiers will be removed from identifiable private information. After removal, the deidentified information could be used for future research studies or distributed to another investigator for future research studies without additional informed consent. All data processing will be conducted using the project-specific identifiers to maintain anonymity. Only the graduate student and their supervisory committee will have access to the responses, and only summaries and general

findings from the data will be published or presented to the public.

Your input is extremely valuable, and we hope you will participate in this research project. Following the conclusion of this project, the findings will be published in a thesis that will be accessible through the Kansas State Research Exchange (krex.k-state.edu).

For any questions or feedback on the survey, please contact Wyatt Cheney (wccheney@ksu.edu) or Audrey Joslin (ajoslin@ksu.edu) at 1002 Seaton Hall, Department of Geography and Geospatial Sciences, Kansas State University, Manhattan KS, 66502. Any concerns or questions regarding your rights as a participant may be addressed by contacting the IRB Chair Lisa Rubin in the University Research Compliance Office phone at 785-532-3224; fax at 785-532-3278; or email at comply@k-state.edu.

- ○ I volunteer to enroll understanding that my participation is optional and I may withdraw at any time. (1)
- ○ I decline to participate. (2)

Skip To: End of Survey If Dear Prescribed Burn Association member, Please participate in a survey regarding the perceived b... = I decline to participate.

End of Block: Consent

Start of Block: Section 1: PBA Membership

Q2 Are you a PBA member?

- ○ Yes (1)
- ○ No (2)

Q3 Which PBA are you a member of?

▼ Gyp Hills PBA (1) ... West Ark PBA (14)

Q4 How many years have you been a member?

○ Please enter a number. (1) _____

Q5 What led to your involvement with your PBA? (Select all that apply)

- [ ] Concerns over wildfire (1)
- [ ] Concerns over woody encroachment (2)
- [ ] Tradition (3)
- [ ] Gain access to burn equipment (4)
- [ ] Gain prescribed burn experience or knowledge (5)
- [ ] Promote the expansion of prescribed burning (6)
- [ ] Promote ecological wellbeing (7)
- [ ] Need for additional help to conduct burns safely (8)
- [ ] Other (Fill in the blank) (9)

_____

Q6 About how many prescribed burns do you annually participate in with the PBA?

○ Please enter a number. (1) _____

Q7 Do you manage your own land with prescribed fire?

- ○ Yes (1)
- ○ No (0)
- ○ I don't own land (3)

End of Block: Section 1: PBA Membership

Start of Block: Perceptions and Barriers

Q8 Please indicate your agreement with the following statements:

	Strong Disagreement (1)	Disagreement (2)	Neither agree or disagree (3)	Agreement (4)	Strong Agreement (5)
My neighbors support the use of prescribed fire. (1)	○	○	○	○	○
It is important to have the approval of neighboring land owners to conduct a prescribed burn. (2)	○	○	○	○	○
My community supports the use of prescribed fire. (3)	○	○	○	○	○

My family supports the use of prescribed fire. (4)	○	○	○	○	○
Prescribed fire contributes significantly to air quality issues. (5)	○	○	○	○	○
Community members outside the PBA understand the benefits of prescribed fire. (6)	○	○	○	○	○
County level regulations inhibit prescribed burns. (8)	○	○	○	○	○

Concern over liability for potential damages inhibit prescribed burns. (10)	○	○	○	○	○
Concern over fees associated with potential local emergency management callouts (like local fire departments) inhibit prescribed burns. (11)	○	○	○	○	○
Community leaders understand the benefits of prescribed fire. (12)	○	○	○	○	○

Prescribed fire supports healthy ecosystems. (13)	○	○	○	○	○
Prescribed fire is beneficial to soil quality. (14)	○	○	○	○	○
Prescribed fire enhances wildlife habitat. (15)	○	○	○	○	○
Lack of knowledge and burn experience in my community limit the use of prescribed fire. (16)	○	○	○	○	○

An adequate amount of help is available in my PBA to successfully complete all burns. (17)	○	○	○	○	○
The PBA has adequate resources and equipment to conduct prescribed burns. (18)	○	○	○	○	○
Burn season windows are adequate for meeting prescribed burn goals. (19)	○	○	○	○	○

The lack of natural fire breaks on my land inhibits the use of prescribed fire. (20)	○	○	○	○	○
Unsuitable weather during the burn season inhibits the use of prescribed fire. (21)	○	○	○	○	○

Q9 What are the top two factors limiting prescribed fire?

_____

End of Block: Perceptions and Barriers

Start of Block: Communal perceptions

Q10 With 1 being very unconcerned and 5 being very concerned, rate your level of concern over woody encroachment in your region.

1 2 3 4 5

1 ()	

Q11 With 1 being very unsatisfied and 5 being very satisfied, rate your satisfaction with the amount of prescribed fire in your community.

1 2 3 4 5

1 ()	

Q12 Indicate your agreement. Prescribed fire is becoming increasingly common in my community.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q13 In your opinion, instances of fire escapes in NON PBA burns in your community have:

- ○ Increased (1)
- ○ Remained constant (2)
- ○ Decreased (3)
- ○ Not applicable (4)
- ○ Not sure (5)

Skip To: Q15 If In your opinion, instances of fire escapes in NON PBA burns in your community have: = Not applicable

Q14 Instances of fire escapes in NON PBA burns in your community are caused by (Select multiple):

- [ ] Lack of burn help (1)
- [ ] Lack of knowledge or experience (2)
- [ ] Lack of resources (3)
- [ ] Unpredictable weather (4)
- [ ] Woody Encroachment (5)
- [ ] Other (6) _____
- [ ] None have occurred (7)
- [ ] Not sure (8)

Q15 Escaped fires have negatively impacted community perceptions of the benefits of prescribed fire.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q16 Escaped fires have increased my community's concerns over prescribed fire use.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

End of Block: Communal perceptions

Start of Block: Prescribed fire and CRP

Q17 How many prescribed burns on CRP have you particpated in with the PBA?

○ Please enter a number. (1) _____

Q18 What factors are most important to consider when burning on CRP?

_____

Q19 Please indicate your agreement with the following.

	Strongly Disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly Agree (5)	Not sure (6)
The fuel load from grasses on CRP increases risk of fire escape when conducting a prescribed burn (1)	○	○	○	○	○	○
The fuel load from woody species on CRP increases risk of fire escape when conducting a prescribed burn (2)	○	○	○	○	○	○

Concern over risk of fire escape on CRP inhibits the use of prescribed fire, more than other types of land. (3)	○	○	○	○	○	○
Prescribed burns on CRP lands involve more considerations than prescribed burns on non CRP lands. (4)	○	○	○	○	○	○
Prescribed burns on CRP lands are riskier than prescribed burns on non CRP lands (5)	○	○	○	○	○	○

End of Block: Prescribed fire and CRP

Start of Block: Farm Information

Q20 Do you have a farm or ranch?

- Farm (1)
- Ranch (2)
- Both (3)
- Neither (4)

Skip To: Q30 If Do you have a farm or ranch? = Neither

Q21 How many years have you managed your operation?

- Please enter a number. (1) _____

Q22 What is the size of your operation in acres?

- Please enter a number. (1) _____

Q23 How many acres of your farm operation are dedicated to cropland?

- Please enter a number. (1) _____

Q24 How many acres of your farm operation are dedicated to ranching/pasture?

○ Please enter a number. (1) _____

Q25 How many acres of your farm operation are rented to you?

○ Please enter a number. (1) _____

Display This Question:

If If How many acres of your farm operation are dedicated to cropland? Text Response Is Greater Than or Equal to .001

Q26 What are your primary crops? Pick two at most.

- ☐ Corn (1)
- ☐ Wheat (2)
- ☐ Soybean (3)
- ☐ Sorghum (4)
- ☐ Cotton (5)
- ☐ Hay (6)
- ☐ Silage (7)
- ☐ Other (Write in) (8) _____
- ☐ Not applicable (9)

Q27 How many acres of your farm operation is enrolled in the Conservation Reserve Program?

- ○ Please enter a number. (1) _____

Display This Question:

If If How many acres of your farm operation is enrolled in the Conservation Reserve Program? Text Response Is Greater Than or Equal to 0.001

Q28 What enrollment practice does the majority of your CRP fall into?

- ○ Rare and Declining Habitat (CP - 25) (1)
- ○ Grass already established (CP - 10) (2)
- ○ Permanent wildlife habitat (CP - 4D) (3)
- ○ Habitat buffers for upland birds (CP - 33) (4)
- ○ State acres for wildlife enhancement (CP - 38) (5)
- ○ Other (Write in) (6) _____
- ○ Not applicable (7)

Page Break

Q29 Which category best represents your average net farm income?

- Net loss (1)
- Less than 25,000 (2)
- 25,000 to 34,999 (3)
- 35,000 to 49,000 (4)
- 50,000 to 74,999 (5)
- 75,000 to 99,999 (6)
- 100,000 to 149,000 (7)
- 150,000 to 199,000 (8)
- Greater than 200,000 (9)
- Prefer not to say (10)

Q30 Do you have family that ranches or farms?

- Yes (1)
- No (0)

End of Block: Farm Information

Start of Block: Demographics

Q31 Which category best represents your age?

▼ Under 20 (1) ... Prefer not to say (16)

Q32 What is your gender?

- Male (1)
- Female (2)
- Other (3) _____

Q33 What is your highest level of education obtained?

- High school diploma (1)
- Associates degree (2)
- Bachelor's degree (3)
- Graduate or professional degree (4)
- Prefer not to say (6)

Q34 Which race or ethnicity best describes you?

- ○ Black or African American (1)
- ○ American Indian and Alaska Native (2)
- ○ Asian or Pacific Islander (3)
- ○ White or Caucasian (4)
- ○ Multiple ethnicities/Other (5) _____
- ○ Prefer not to say (6)

End of Block: Demographics

Start of Block: Outreach

Q35 Would you be interested in future contact to hear about the project findings or participate in an interview on these topics? Please indicate below and leave your email address.

- ☐ I would like to receive a report of findings (1)

  _____

- ☐ I would participate in an interview about these topics (3)

  _____

- ☐ I am not interested (4)

End of Block: Outreach

Appendix C - Semi-structured Interview Consent Form

Consent for Participation in Research Interview

Project name: Patterns and Perceptions of Wildfire risk and Prescribed Burning on Private Conservation lands in Kansas: A Master's Thesis

Funded by: Department of Geography and Geospatial Sciences, Kansas State University

Research investigator: Wyatt C. Cheney (Graduate Student)

Thesis Advisor: Audrey J. Joslin, Ph.D.

Purpose of the Research Project:

This study is being conducted by Wyatt Cheney, a graduate student in the Department of Geography and Geospatial Sciences at Kansas State University, as a partial fulfillment of the requirement of the Master of Science degree. This study focuses on the challenges associated with conducting prescribed burns on private conservation lands in Kansas, such as lands enrolled in the Conservation Reserve Program. The interview component of this research serves to expand upon and clarify results obtained from a Qualtrics survey sent out to Prescribed Burn Association members across Kansas. This research will further develop knowledge about the barriers to expanding prescribed fire use in Kansas.

Project Description:

Prescribed burning has been used for meeting a variety of land management goals, such as combating the spread of woody encroachment, stimulating grass growth in cattle pastures, and enhancing livestock production. As Prescribed fire has been found to significantly reduce aboveground fuel loads, it may also constrain the severity of wildfire event. Despite the benefits, the adoption of prescribed fire across the state of Kansas has been slow in many areas; less than 20% of Kansas Counties have an active Prescribed Burn Association. Furthermore, while much of the literature focuses on the benefits, perceptions, and risks of prescribed fire, there is a lack addressing its use in managing private conservation lands, such as lands enrolled in the Conservation Reserve Program. This is one of the major conservation initiatives in the United States and is especially common in Kansas which is third in overall acres enrolled by state. This

project addresses these gaps by investigating how wildfire intersects with prescribed burning practices on CRP land in Kansas.

Project Procedures:

You have been asked to participate in this interview due to your knowledge and experience using prescribed fire, as well as your involvement in a PBA. The Institutional Review Board (IRB of Kansas State University) requires interviewees to explicitly agree to being interviewed and know how their information will be used. This interview will take approximately 30 minutes as we work through a range of questions regarding barriers to prescribed fire. We do not anticipate any risk associated with your participation. **Your participation is voluntary, and you have the right to stop the interview or withdraw from the research at any time.** Names will be retained on notes or transcripts generated from this interview but will not be included in any materials published or produced from this research. Only the name of the county and a generalized title/position will be included in any materials published or produced from this research. Identifiers will be removed from identifiable private information. After removal, the deidentified information could be used for future research studies or distributed to another investigator for future research studies without additional informed consent. Individual names will not be released and/or masked in any reporting of information. Any data shared for additional research purposes will likewise not include individual names. Although you may not directly benefit from participating in this research, the results may inform future outreach, policy, and land management practices.

Questions or Feedback:

For any questions or feedback please contact Wyatt Cheney (wccheney@ksu.edu) or Audrey Joslin (ajoslin@ksu.edu) at 1002 Seaton Hall, Department of Geography and Geospatial Sciences, Kansas State University, Manhattan KS, 66502.

For concerns or to gain further information about your rights as a participant, you may contact the IRB Chair Lisa Rubin in the University Research Compliance Office phone at 785-532-3224; fax at 785-532-3278; or email at comply@k-state.edu.

Please indicate your approval of audio recording to ensure accuracy in reporting:
I **do** agree to audio recording. [ ]
I **do not** agree to audio recording and prefer that information be recorded in note form by the researcher. [ ]
Your signature below confirms your understanding of the study and agreement to participate.

X: _____ Date: _____

Researcher's signature: _____ Date: _____

Copies: The participant will receive a copy of this consent form, and the signed and dated participant consent form will be placed in the main project file which must be kept in a secure location.

Appendix D - Semi-structured Interview Guide

Date_____ ID_____ County_____

Question Guide – PBA leadership

Topic	Questions
Introduction	*Explain research project, establish consent for interviewing and recording* *If recording, mention myself, who I'm interviewing. Say "Question x" before reading the question*
Q1	How long have you been active in this prescribed burn association? _____
Q2	What role do you play in PBA? What are your associated responsibilities? _____ _____
Q3	How many years have you been serving this role? _____
PBA Background Q4	How many members are part of this PBA? _____
Q5	A majority of the survey respondents indicated they had a Bachelor's or higher level of education. Would you say that represents your PBA well? _____
Q6	What year was this PBA established? _____
Q7	What led to your involvement with the PBA? _____
Q8	What can you tell me about how this PBA was formed? _____

Q9	_____ _____ How would you characterize your PBA burn activity? *Rapidly growing; Growing; Stable; Shrinking; Rapidly shrinking*
Q10	How would you characterize your PBA membership trends? *Rapidly growing; Growing; Stable; Shrinking; Rapidly shrinking*
Q11	What do you think is driving these changes in burn activity/membership trends? _____ _____ _____
Prescribed Fire – General Q12	Approximately how many prescribed burns does the PBA conduct annually? _____
Q13	Do you feel that your PBA is limited in the amount of burns they conduct? If so, explain.
Q14	What is the typical size of the area burnt in acres? _____
Q15	How many members are typically needed to conduct a burn? _____
Q16	What season does your PBA conduct the most burns? _____
Q17	What are the main reasons you conduct prescribed burns? (*CRP management, forage growth, manage woody encroachment, etc.)* _____

Q18	How common is it for a prescribed burn to be cancelled or postponed? *Very common; common; neutral; uncommon; Very uncommon*
Q19	How many prescribed burns have been cancelled in the last two years? _____
Q20	What are the causes for these cancellations or postponements? _____
Q21	How supportive is your broader community of prescribed fire? Why?
Prescribed Fire – CRP	*These questions may seem repetitive to the previous section but relate specifically to CRP. If there's no difference, simply say so and I can mark down what you answered previously.*
Q22	Approximately how many prescribed burns does the PBA conduct annually on CRP? _____
Q23	How many acres of CRP are typically burnt at a time? _____
Q24	How many members are typically needed to conduct a burn on CRP? _____
Q25	What season does your PBA conduct the most burns on CRP? _____
Q26	How common is it for a prescribed burn on CRP to be cancelled or postponed? *Very common; common; neutral; uncommon; Very uncommon*
Q27	How many prescribed burns on CRP have been cancelled in the last two years? _____
Q28	What are the causes for these cancellations or postponements on CRP?
Q29	What factors are most important to consider when conducting a prescribed burn on CRP?

Q30	How much of a concern is it that a prescribed fire on CRP may escape? How does that compare with other types of land?
Q31	Do you perceive prescribed burns on CRP to be riskier than burns on other lands? If so, what precautions are taken?
Barriers	
Q32	In my 'Top Two barriers limiting prescribed fire' question, "weather" was the most common. Specifically what conditions inhibit prescribed fire in your area?
Q33	Another recurring theme was overall effort. What part of conducting a prescribed fire involves the most effort in your opinion?
Q34	Do regulations in your county influence prescribed fire? If so, how?
Q35	In my results, I saw a trend of barriers like narrow burn windows, burn preparation, and fuel load regarding CRP land. In your opinion, do these barriers apply more to CRP? Or are they simply considerations common with conducting a burn?
Q36	There was a higher sense of agreement that fuel loads from grass on CRP increases risk of fire escape, however, a lower sense of agreement that burns on CRP involve more considerations or risk overall. Why do you think this is?
Q37	One of my survey questions asked about overall satisfaction with the amount of prescribed burning. On average, the score was low. Would you interpret this as too much or too little prescribed fire?
Q38	Are there any other challenges or barriers that weren't mentioned in the survey to conducting prescribed burns?

Q39	Is there anything I didn’t ask that you think I should know on this topic?