

# INVASIVE WOODY PLANT SOCIAL SCIENCE REVIEW

A synthesized report of landowner motivations, barriers, and future needs for invasive woody plant management across the Great Plains.



Prepared by Ryan Roberts, Lindsay Shorter, Ashley Gramza, and Miruh Hamend  
Funding provided by Natural Resources Conservation Service



# TABLE OF CONTENTS

---

<b>2</b>	<b>EXECUTIVE SUMMARY</b> <ul style="list-style-type: none"><li>• Primary Insights<ul style="list-style-type: none"><li>◦ Motivations</li><li>◦ Barriers</li><li>◦ Future Needs</li></ul></li><li>• Key Recommendations<ul style="list-style-type: none"><li>◦ Partnership Formation</li><li>◦ Communications and Outreach</li><li>◦ Program and Policy Improvements</li></ul></li></ul>
<b>6</b>	<b>PURPOSE</b>
<b>7</b>	<b>BACKGROUND</b>
<b>8</b>	<b>INSIGHTS FROM THE LITERATURE</b> <ul style="list-style-type: none"><li>• Motivations</li><li>• Barriers</li><li>• Landowner Needs</li></ul>
<b>14</b>	<b>APPLICATION AND FUTURE DIRECTION</b> <ul style="list-style-type: none"><li>• Partnership Formation</li><li>• Communications and Outreach</li><li>• Program and Policy Improvement</li><li>• Invasive Woody Plant Management Resources</li></ul>
<b>18</b>	<b>APPENDIX A. LITERATURE REVIEW METHODOLOGY</b> <ul style="list-style-type: none"><li>• Search String</li><li>• Table 1. Final Search String</li><li>• Study Screening</li><li>• Data Extraction Strategy</li></ul>
<b>20</b>	<b>APPENDIX B. THEORETICAL FRAMEWORKS</b>
<b>22</b>	<b>REFERENCES</b>

# EXECUTIVE SUMMARY

---

Invasive woody plant encroachment threatens millions of grassland acres, yet effective management needed to address the problem continues to challenge landowners and agencies. Adaptive approaches rooted in social science can be used to increase adoption and effectiveness of invasive woody plant management behavior, but social science data are rarely fully integrated into outreach or programming meant to improve management. This literature review summarizes existing knowledge of landowner motivations, barriers, and needs for conducting invasive woody plant management to support future application of social science insights into conservation delivery, communication, and outreach.



***Invasive tree and shrub species, such as eastern redcedar, honey locust, and sumac, are encroaching on grasslands throughout the United States, with some areas facing upwards of 50% conversion of grasslands into woodlands since 1990 (Morford et al., 2022).***



# PRIMARY INSIGHTS

Motivations, barriers and needs varied greatly depending on management practice with most studies (71%) focused on prescribed burning as a way to eliminate invasive woody plants. Future research should strive to create balance on landowner perspectives for different invasive woody plant management treatments to help address this gap.

## MOTIVATIONS

- The strongest motivations for management were related to the landowner's purpose for owning the property. Ranchers were more likely to manage than those who own land for hunting or other recreational purposes.
- Landowners who had conducted management in the past and held positive attitudes toward the experience often felt encouraged to continue managing into the future.
- Membership in a prescribed burn association was an important motivation for conducting prescribed burns, often tied to positive social norms at the community level around burning.
- Landowners who reported a moral responsibility to manage or hold an environmental stewardship ethic were driven to manage more often than those without this sense of stewardship.
- Landowners who understood the long-term cost-effectiveness of management reported this knowledge as a strong motivation to manage.

## BARRIERS

- Standard burn policies in place related to liability were cited as the number one barrier toward prescribed burning.
- Some landowners believed certain practices held inherent risks to their income or livelihood, such as less grass available for cattle post-burn.
- Given the relative novelty of prescribed burning, older landowners expressed a greater fear of unknown outcomes compared to younger individuals.
- Some researchers found evidence of a status quo bias, with landowners unwilling to behave counter to traditional management norms in place, such as fire suppression.
- Several practical barriers limited the ability to manage, including a lack of labor support and equipment, a lack of knowledge and technical expertise to carry out the management, and a lack of funding and time.
- Assistance programs as they are currently structured were viewed as being too complex, rigid, or occurring at a scale which made many landowners ineligible for participation.



## FUTURE NEEDS

- Establishing programs that provide peer-to-peer mentorship.
- Offering access to resources such as labor, equipment, and funding is crucial for successfully managing encroachment.
- Local leadership is important for successful collaboration around management, and helping communities identify these leaders is essential.
- Assistance programs need to be more adaptable and flexible to meet the needs of a diversity of landowners and environments.
- Current state and federal policies should be periodically assessed and adapted.



## KEY RECOMMENDATIONS

### PARTNERSHIP FORMATION

- Identify local leaders who are:
  - invested in invasive woody plant management,
  - a trusted member(s) of the community, and
  - willing to unite landowners and land managers with a shared set of values and goals.
- Identify individual and community perspectives around environmental stewardship
  - Work with a social scientist to use social science methodologies to collect this information in a systematic and generalizable fashion.
  - Interpret previously collected social science insights (where available).
  - Use those commonalities to unite landowners and catalyze future management.
- Work through and with established prescribed burn associations to:
  - improve prescribed burning program efficiency,
  - increase and expand community outreach, and
  - develop trust between involved stakeholders.

## COMMUNICATIONS AND OUTREACH

- Work with a social scientist to reveal landowner values around environmental stewardship and the social norms related to management to help determine messaging for appropriate audiences.
- During outreach with non-operating landowners, identify those making decisions about the land and determine their level of involvement with land management.
- Determine trusted information sources for your population of interest to understand the most effective messenger and communication platforms to use.
- Use messaging that strengthens existing individual and community management norms aligned with targeted behavior to catalyze future management.
- Conduct landowner-listening workshops and establish peer-to-peer mentorship programs that connect individuals interested in management with those already managing against encroachment.
- Seek out and use existing invasive woody plant management knowledge, tools, and resources (See 'Invasive Woody Plant Management Resources' in the 'Application and Future Direction' on page 17 of this report).

## PROGRAM AND POLICY IMPROVEMENTS

- Evaluate current and future assistance programs to make regular improvements and ensure programmatic effectiveness.
- Adjust the criteria and amount of support provided so smaller and resource-limited landowners can benefit from assistance.
- Change the program eligibility requirements to prioritize earlier levels of encroachment when woody plants are easier to manage.
- Update liability to gross negligence policies related to burning wherever possible to encourage a greater adoption of the practice.





# PURPOSE

---

Invasive tree and shrub species, such as eastern redcedar, honey locust, and sumac, are encroaching on grasslands throughout the United States, with some areas facing upwards of 50% conversion of grasslands into woodlands since 1990 (Morford et al., 2022). This conversion, hereafter invasive woody plant encroachment, often results in losses of ecosystem services, most notably the depletion of soil moisture and aquifer recharge (Zou et al., 2018), a decline of grasses available for livestock forage (Briggs et al., 2005) and a subsequent loss of grassland habitat vital for bird species (Coppedge et al., 2001).



A summary of knowledge around landowner experiences and decision-making processes related to invasive woody plant management practices and programs is needed to help managers and conservation delivery practitioners understand the factors that can encourage or hinder management. The following literature review summarizes 1) what is known about landowner motivations for engaging in invasive woody plant management, 2) barriers to management, and 3) current and future landowner needs for more effectively conducting management. We then provide recommendations about how this knowledge can be applied to improve policies and programs designed to increase management adoption.



# BACKGROUND

---



The causes of invasive woody plant encroachment are numerous and multifaceted. From an ecological lens, a changing climate and the topography and soil profile of a site can influence the rate of transition from grassland to woodland (Archer et al., 2017; Gaskin et al., 2021). Social drivers of woody encroachment include fire suppression, a decline of grazing animal species, and the transformation of grasslands into croplands (Briggs et al., 2005; Twidwell et al., 2013; Archer et al., 2017). Berg et al. (2015) found a higher prevalence of certain tree and shrub species in areas with increasing development pressures from human populations. These social and ecological processes do not exist in silos, but are inextricably linked with a combined influence that contributes to broader encroachment trends (Londe et al., 2022).

Landowner and manager behavior that limits new encroachment and eliminates existing woody plants is needed, yet, effective management practice adoption continues to challenge landowners and agencies. Adaptive approaches rooted in social science can be used to increase adoption of and effectiveness of invasive woody plant management behavior, but social science data are rarely fully integrated into outreach or programming meant to improve management.



Several studies have applied social science frameworks and theories to understand the human dimensions of invasive woody plant encroachment, one of the goals being to inform policy and programming intended to promote management behavior. However, there are very few literature reviews focused on the decision-making processes of those who are actively managing invasive woody plants using practices such as prescribed burning, mechanical control, chemical control and grazing management. Clark et al. (2022) published a systematic review on barriers to management across the Great Plains region, but the scope of the review was limited to prescribed burning.

To fill this gap, we summarize the existing literature related to landowner motivations, barriers, and needs for conducting invasive woody plant management. The goal of this report is to support future application of social science insights into conservation delivery, communication, and outreach to increase management adoption.

## INSIGHTS FROM THE LITERATURE

This literature review was conducted using a methodology adapted from the Collaboration for Environmental Evidence (2022). A series of search terms were tested and refined until the following search string was finalized (Table 1):

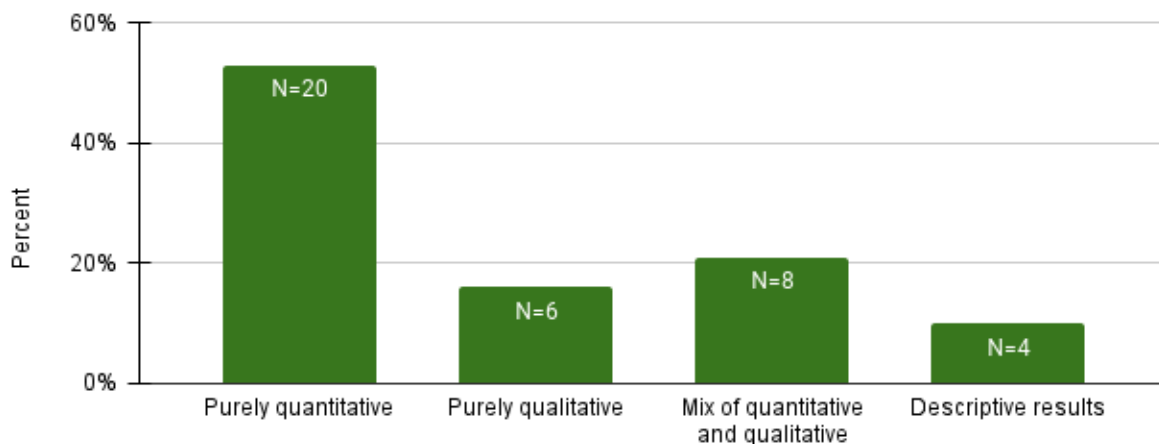
**TABLE 1. FINAL SEARCH STRING**

<b>Population</b>	'Producer' OR 'Landowner' OR 'Rancher'
<b>Population Adjacent Terms</b>	'Woody Plant Encroachment' AND 'Great Plains'
<b>Intervention</b>	'Perception' OR 'Motivate' OR 'Barriers' OR 'Belief' OR 'Attitude' OR 'Behavior'
<b>Outcome</b>	'Management' OR 'Thinning' OR 'Controlled' OR 'Prescribed' OR 'Burn' OR 'Fire'

The 277 papers generated from the search string went through a three-step screening process, where titles, abstracts, and finally the documents in full were evaluated for relevancy. The research team extracted data from 38 documents in total: 30 derived from the peer-reviewed literature, five graduate theses, and three technical reports. For a more detailed explanation of the review methodology, please refer to Appendix A.

The majority of papers (63%) were published after 2018, although the earliest year of data collection reported was 2003. Over three quarters of the studies reported on primary data, with the type of data collected and analyzed varying considerably:

### TYPES OF SOCIAL SCIENCE DATA COLLECTED



It is important to note that six out of the 38 papers did not collect social science data, but were rather a combination of technical reports, extension papers, or descriptive studies that discussed secondary data. Of the remaining 32 documents, 13 collected and analyzed social science data but did not connect their research to a theoretical framework. The other 19 graduate theses and peer-reviewed articles identified at least one social science theory in which their work was based. A list of the theoretical frameworks applied, a brief description of each, and the papers in which they are cited can be found in Appendix B.

Nearly three quarters of the studies focused exclusively on prescribed burning, highlighting a potential research bias toward studying burning as a management practice. More research is needed on landowner motivations and barriers regarding other forms of accessible invasive woody plant management tools to help address this gap. Most of the papers collected data from private landowners (74%) or individuals associated with prescribed burn efforts (29%). Several studies covered a geographic scope throughout the entire Great Plains region (16%), or within the Southern Great Plains (34%), with the remainder focusing on a specific state or portion of a state (50%). Many of these studies may be generalizable to other regions given their theoretical foundations.

## MOTIVATIONS

The most widely cited motivation for management was related to the landowners purpose for owning the property; those that managed their land for crop or livestock production were often more willing to engage in practices that remove invasive woody plants compared to those who manage their land for hunting or other recreational purposes (McDaniel, 2018; Hoffman et al., 2020). Landowners who resided on the land were also more likely to manage that those who identified as non-residential landowners (Abney, 2017). This motivation was followed by landowners who had conducted some sort of management in the past and held positive memories and attitudes toward the experience – such as previously being involved with a successful burn effort – which encouraged them to continue with the same or new management practices into the future (Toledo et al., 2013; Bendel et al., 2020).

A number of studies reported that membership in a prescribed burn association was an important motivation for management (Toledo et al., 2014; Abney, 2017; Jobes, 2019) often tied to positive social norms at the community level for conducting management. Four additional papers (Morton et al., 2010; Riechman et al., 2014; Coon et al., 2020; Rajala & Sorice, 2021) connected an internal moral responsibility to manage or environmental stewardship ethic with the likelihood of management. Morton et al. (2010) described how harboring a strong land stewardship ethic was an important factor in determining whether an individual managed for invasive woody plants, while Riechman et al. (2014) shared a case study of landowners uniting around a common land ethic that eventually led to the formation of a local prescribed burn association. Coon et al. (2020) recommended developing outreach messaging that taps into landowners' sense of moral responsibility and environmental stewardship to increase the adoption of invasive woody plant management practices.



Four papers in this review (Symstad and Leis, 2017; Kreuter et al., 2019; Starr et al., 2019; Jeffries et al., 2023) connected landowner understanding of the long-term cost effectiveness of continual management as a large motivator for management, while three studies (Riechman et al., 2014; Symstad and Leis, 2017; Jeffries et al., 2023) demonstrated that individuals were motivated to prevent future catastrophic wildfires by reducing fuel loads through invasive woody plant management. Coleman (2019) and Hoffman et al. (2021) shared that landowners based their management decision-making on credible, quantifiable evidence demonstrating how practices lead to management success from trusted sources, such as local prescribed burn associations or Natural Resource Conservation Service (NRCS) offices.



From a policy perspective, liability around prescribed burning damaging a neighbor's property was often brought up as a factor that strongly influenced the decision of whether or not to burn. Certain states hold gross negligence liability standards, where individuals conducting a prescribed burn are legally protected if a fire escapes and causes damage as long as the individual follows a series of regulations before the burn. In contrast, strict negligence standards create the highest form of liability by holding individuals responsible in every instance of an escaped fire, regardless of the circumstances. Wonkka et al. (2015) found that landowners operating within gross negligence liability counties tended to conduct prescribed burns more often than matching counties with stricter liability standards.



## BARRIERS

Over one quarter of the studies mentioned that some landowners believed certain practices negatively affected their income or livelihood, such as the perception that burning grass reduces livestock forage (Harr et al., 2014), or that the tree removal will negatively impact hunting-based operations (Stroman et al., 2020). Another seven papers found that landowners held negative feelings toward certain forms of management such as prescribed burning, often focused around perceived risks such as smoke and property damage (McDaniel, 2018; Stroman et al., 2020; Hoffman et al., 2021).

Some studies point to the fact that older landowners were hesitant to experiment with newer practices like prescribed burning (Stroman et al., 2020). Other landowners were unwilling to go against the established status quo with commonly used management practices in their community such as fire suppression, which is often still more widely accepted than newer approaches such as prescribed burning (Weir et al., 2019), resulting in negative attitudes toward burning in certain communities (Jeffries et al., 2023).

Of those landowners that were either currently managing invasive woody plants or had a desire to manage in the future, several practical barriers were found from this review that limited their ability to manage. These practical constraints included:

- A lack of funding, time, labor and equipment (Coon et al., 2020; Fagundes et al., 2020)
- A lack of knowledge or technical experience to carry out the management, especially related to prescribed burning (Symstad and Leis, 2017; Clark et al., 2022)
- A lack of local community-driven leadership (Jobes, 2019)



Several other studies stated that dealing with weather, biophysical, or development-related landscape conditions also generated logistical challenges for management, such as needing to navigate narrow burn windows (Wilber et al., 2021) or attempting to plan a burn across a subdivided landscape (Clark et al., 2022).

Nearly one third of the papers cited burn liability policies in place as the number one barrier toward prescribed burning. A related programmatic barrier was a



perceived lack of institutional support from government agencies for helping landowners deal with the logistical aspects of management preparation, such as program enrollment or the writing of burn plans (Harr et al., 2014). The need for further support was closely tied to the finding that assistance programs as they are currently structured were viewed as being too complex, rigid, or set up in a way which made many landowners ineligible for participation, such as requiring a minimum acreage size for enrollment. The Central Grasslands Roadmap (2021) surveyed landowners who had participated in a diversity of assistance programs for grassland management which included varying aspects of invasive woody plant management, such as the NRCS Environmental Quality Incentives Program. Respondents stated that the most common barriers toward program enrollment were lack of time for participation or not having a sufficient number of acres available for enrollment. Many believed that existing programs are too complex to benefit smaller or resource-limited landowners, who often lack the time and resources to successfully apply for programs or pay for a cost-share upon enrollment (Fagundes et al., 2020).

Even if certain individuals become eligible to participate, perceptions of programs rewarding poor management of large-scale operations, as well as issues with program inflexibility for local situations, were found to dissuade landowners from enrollment (Central Grasslands Roadmap, 2021). For example, enrollees in a NRCS contract such as through the Environmental Quality Incentive Program, are required to follow protocols found within Field Office Technical Guides, disqualifying many who employ more traditional or indigenous forms of management (Fagundes et al., 2020). Three papers (Coleman, 2019; Jobes, 2019; Central Grasslands Roadmap, 2021) note that a general sense of distrust with certain information sources, such as social media, or government agencies facilitating invasive woody plant management also served as a barrier toward program enrollment.



## LANDOWNER NEEDS

When examining landowner needs for management moving forward, one third of all papers cited the importance of programs that can provide mentorship for those dealing with invasive woody plant problems (e.g., McDaniel, 2018; Joshi et al., 2019; Starr et al., 2019; Adhikari et al., 2023). This could come in the form of outreach campaigns that employ producer-led methods that connect landowners wanting to learn more about management with landowners who have a history of management success. On the practical side, offering access to resources such as labor, equipment, and funding is crucial for successfully managing invasive woody plant encroachment. The ability of landowners and land managers to collaborate with agencies and with one another to share resources was often cited as a necessity for effective management (Twidwell et al., 2013). Case studies found throughout the literature demonstrate that successful reversal of woody invasion was often due to collaborations catalyzed by local landowners, and was usually initiated by a single motivated individual or a group of individuals who served as community leaders (Jobes, 2019; University of Nebraska, 2021). Two other papers (Jobes, 2019; Coon et al., 2020) mentioned the importance of trust building between landowners, government officials, prescribed burn associations, and conservation organizations to continue successfully managing for the removal and prevention of invasive woody plant encroachment.

Prescribed burn associations were commonly cited as one such form of collaboration that provided the means for effective and safe prescribed burns. Through these associations, active members were often able to combine resources such as burn equipment, specialized expertise and training, and labor to reduce costs and overcome technical constraints (Riechman et al., 2014; Jobes, 2019; Coon et al., 2020). Stroman et al. (2020) stated that investing in the development of local prescribed burn associations helped to catalyze management of invasive woody plant encroachment by providing resources and changing negative perceptions of practices such as burning.

Another four papers spoke to the need for assistance programs to evolve in order to become more adaptable and flexible to a variety of landowners and environments (Olenick et al., 2005; Leis et al., 2017; Central Grasslands Roadmap, 2021; University of Nebraska, 2021). For example, Olenick et al., (2005) stated that providing shorter term contracts and removing some of the mandatory components of programs such as uniform brush management was found to be more attractive to a wider diversity of landowners, which then incentivized them to re-enroll and continue management long-term. On a larger scale, current state and federal policies should be periodically assessed and adapted as needed.



# APPLICATION AND FUTURE DIRECTION

The results from this literature review point to several findings that can be used by managers and conservation delivery practitioners to more effectively engage with landowners who are facing invasive woody plant encroachment:

- Partnership Formation
- Communications & Outreach
- Program & Policy Improvement



## PARTNERSHIP FORMATION

The practical barriers reported in the literature that hinder successful invasive woody plant management were numerous, including a lack of labor, equipment, funding, technical experience, or time to carry out the management. Despite these constraints, several case studies demonstrate how effective partnerships and programs can help to overcome these barriers, often resulting from the sharing of information and resources. The University of Nebraska (2021) provided a [successful case study](#) from the Loess Canyons, where a group called the Central Platte Rangeland Alliance formed a long-lasting partnership between landowners, managers, agencies, and nonprofits organizations in the area. The partnership was able to first establish trust among all parties involved. From there, a process of knowledge and resource exchange allowed the partners to begin collaboratively managing to reverse invasive woody plant encroachment in the region and prevent further invasion via a large-scale, integrated approach informed by a multitude of diverse perspectives.

As previously mentioned, prescribed burn associations are just one type of collaborative partnership that can help to alleviate challenges toward invasive woody plant management. Twidwell et al. (2013) found that when neighboring landowners share their resources and collaborate on burn efforts, they are able to form fire crews that provide solutions to many of the practical barriers mentioned, such as perceptions around lack of time, knowledge, equipment or labor. Riechman et al. (2014) stated that the development of a burning partnership in their study region began with a mutual conservation ethic and an awareness of management impacts on encroachment, which helped to unite the involved landowners. One important recommendation for establishing a collaborative effort around management is to find a leader – preferably a local landowner or manager – who is invested in the work, has the capacity to lead, and is willing to unite stakeholders beneath their shared values and goals. Another recommendation includes working with a social scientist to collect new information or interpret previously collected insights that can unite landowners and catalyze future management. (Bartley and Brooks, 2022)

## COMMUNICATIONS & OUTREACH

The motivations for conducting management found through this review can serve as key starting points for targeted outreach. We recommend that future engagement efforts prioritize landowners whose operation is focused on crop or livestock production, or those who are actively involved in a prescribed burn association and have a positive past experience with burning, given their greater likelihood of management adoption. Working with a social scientist can help to reveal landowner attitudes around environmental stewardship and the social norms related to management, which can help people create targeted outreach content for certain populations of interest or communities. (Coon et al., 2020).

There is also a growing need for new or continued engagement with non-operating and outdoor recreation focused landowners, who are less likely to manage for invasive woody plants and whose forested properties often act as sources of seed dispersal to neighboring grasslands. Many of these landowners do not live on the property they own, yet Sorice et al. (2018) found that involvement in land management was a stronger predictor of management decision-making than simply residing on the property, and cautioned against making assumptions about landowner beliefs and actions based solely on their place of residence. Therefore, a recommendation for future outreach would be to identify the land management decision makers and determine their level of involvement on the property, rather than focusing on their distance from the land itself.

When communicating with landowners looking for information on prescribed burning, Coleman (2019) shared that credibility of the information source was the single most important factor influencing the use of that knowledge in future decision-making. Electronic outlets such as social media platforms or other online sources are often rated as least trustworthy, so one suggestion would be to understand the most credible sources of information for a population of interest to determine the most effective communication strategies to employ. Coon et al. (2020) also recommended identifying individual and community norms around environmental stewardship, and using those insights in communications outreach to relate to landowners and motivate future management.





Other studies cite high rates of success in the adoption of new conservation practices through peer-to-peer interactions versus remote pathways via electronic or printed materials (McDaniel, 2018). Another recommendation from this report is the establishment of a peer-to-peer mentorship program that connects individuals with landowners and land managers who already hold strong motivations for doing this type of work, along with those who have a positive track record of success. Sketch et al. (2019) conducted landowner-listening workshops with the goal of providing a space for those managing the land to share their challenges and needs of working on the landscape with conservation professionals, and found that listening to these stories resulted in positive outcomes in the form of unique knowledge exchange and trust building between all participants. Organizing these types of workshops can meet the desires for landowners to hear from their peers on challenges and solutions related to management. The [Partners for Conservation website](#) provides a list of resources for those interested in designing collaborative, landowner-driven workshops.

## PROGRAM & POLICY IMPROVEMENT

The literature mentioned several barriers regarding current management policies and programs in place, including:

- Multiple issues with liability standards
- The complexity, rigidity, and mismatch in scale of current assistance programs
- A perceived lack of institutional support to accomplish management

For agencies creating assistance programs, a large-scale, continual assessment of the current and future program components is recommended for making regular improvements, and to prevent negative attitudes toward program components and a perceived lack of institutional support. This can include adjusting the criteria and amount of support provided so smaller and resource-limited landowners can benefit from assistance, and changing the program eligibility requirements to prioritize earlier levels of encroachment when woody plants are easier to manage. Working to update liability to gross negligence standards related to burning wherever possible can also encourage a greater adoption of prescribed burn programs.

An additional suggestion is to work through and with established prescribed burn associations to spread invasive woody plant management awareness and knowledge to new communities and to develop trust between private landowners and government agencies (McDaniel, 2018; Wilber et al., 2021). Prescribed burn associations have been shown to successfully advocate for program and policy change, such as the implementation of gross negligence liability standards, and some have even aided landowners in legal battles around the use of prescribed burning in their communities by working with insurance agencies to help them acquire fire insurance (Riechman et al., 2014).

## INVASIVE WOODY PLANT MANAGEMENT RESOURCES

Many tools and resources for carrying out invasive woody plant management already exist. Twidwell et al. (2021) recently created a practical guide for landowners facing woody encroachment, which includes an eight step process for an effective management strategy. The University of Nebraska-Lincoln has an entire webpage dedicated to Eastern Redcedar education and outreach, called the [Eastern Redcedar Science Literacy Project](#). The website contains an extensive amount of information on Eastern Redcedar and the impacts of its encroachment, along with current scientific recommendations for successfully managing its spread. Oklahoma State University's Cooperative Extension Service has also taken strides in helping individuals understand liability law through the use of fact sheets (Weir et al., 2019), while Texas A&M, Oklahoma State University, and University of Nebraska have collaborated to create [The Prairie Project](#), an effort that aims to reduce woody plant encroachment across the Southern Great Plains. Taking advantage of these and other resources available will help managers more effectively collaborate with landowners on this work in the long run.

The issue of invasive woody plant encroachment is complex, and is intensifying as time passes. Despite the numerous programs and policies in place to aid landowners and managers with combating encroachment, this report highlights how a range of barriers continue to challenge effective management. By reducing those barriers while amplifying management motivations and meeting landowners' future needs, conservation delivery practitioners and managers can more effectively create strategic programming and outreach campaigns to promote management. This can aid in delivering on the goals of helping individuals effectively manage invasive woody plants on their properties and prevent further encroachment across the landscape.



## APPENDIX A

# LITERATURE REVIEW METHODOLOGY

---

### SEARCH STRING

The research team developed a list of potential search terms that could be placed into a search string (Collaboration for Environmental Evidence, 2022). The search string was vetted by colleagues at Playa Lakes Joint Venture and then tested in Google Scholar. The search string was further refined and tested until the research team felt confident that they had hit a saturation point in the relevancy of results produced. The final search string related to social science research on landowners, ranchers, or other producers facing woody plant encroachment in the Great Plains region, given the increasing threat of invasive woody plants these stakeholders face in this region (Table 1). The intervention included a clear social science element (e.g., motivation or barrier toward conducting the work) and the outcome was some type of impact on the management in question. [Producer OR Landowner OR Rancher] AND [Woody Plant Encroachment] AND [Great Plains] AND [Perception OR Motivate OR Barrier OR Belief OR Attitude OR Behavior] AND [Management OR Thinning OR Controlled OR Prescribed OR Burn OR Fire].

### STUDY SCREENING

Papers were limited to those written in English. The research team did not restrict the dates of study, and included both peer and non-peer reviewed literature to minimize publication bias. The team used Google Scholar as the primary search engine, supplemented with sources provided by professional contacts. Google Scholar generated 258 hits for inclusion and the team's contacts provided 32 documents in total. After removing 13 duplicates, the research team began screening the remaining 277 papers using a three step screening process (Collaboration for Environmental Evidence, 2022). In step one, titles that were clearly irrelevant were discarded, resulting in 84 documents that remained. In step two, the team screened the abstracts of all 84 papers and determined that only 38 were relevant for data extraction, which moved on to the final step of screening the entire document. Of these 38 documents that remained, 30 were derived from the peer-reviewed literature while the remaining 8 were a combination of graduate theses and technical reports.

### DATA EXTRACTION STRATEGY

The research team used a spreadsheet to store all the meta-data extracted from the studies. This included a study ID number, the type of study, journal/source, author, year of publication, title, data type, year of data collection, methodology, study location, stakeholders involved, paper topic or theme, type of management practice assessed, the management motivation(s), barrier(s), and/or need(s), conclusion or outcome, a link to the full-text document and any relevant notes.



## APPENDIX B

# THEORETICAL FRAMEWORKS

Theory	Definition	References
Adult Learning Theory	Describes how adult learning is highly distinct from the learning that humans do as children, emphasizing the determination of suitable learning techniques for adults.	Coleman, 2019
Collective Action Theory	Describes how successful collective action is possible through the shared governance of the commons as long as the actions build on common interests, mutual respect, and reciprocity among stakeholders.	Jeffries et al., 2023
Cultural Theory	Posits that social and cultural dynamics influence how individuals think, interact with others, and perceive risk from disasters.	Joshi et al., 2019
Diffusion of Innovation Theory	Explains how, why, and at what rate innovative ideas and technologies spread in a population.	Clark et al., 2022
Educational Theory	Describes how first-hand experience and participation can help to demonstrate facts and aid in knowledge retention.	McDaniel, 2018
Grounded Theory	Involves the construction of hypotheses and theories through the collecting and analysis of data using an inductive reasoning approach.	Riechman et al., 2014 Hoffman, 2020 Hoffman et al., 2021
Meaning-Dependence Framework	Accounts for the multiple ways meanings inform human connections to a place.	Rajala & Sorice., 2021
Norm Activation Model	Proposes that pro-environmental actions follow from the activation of personal norms, reflecting feelings of moral obligation to perform or refrain from actions.	Coon et al., 2020
Production Theory	Explains the principles by which an entity decides how much of a commodity it will produce, and how much of each kind of input it will use.	Adhikari et al., 2023
Random Utility Theory	Posits that people generally choose what they prefer, and random factors can explain the instances where they do not.	Adhikari et al., 2023

<b>Theory</b>	<b>Definition</b>	<b>References</b>
Reserves-As-Catalyst Model	Focused on land management on reserves and the surrounding landscapes in a way that fosters widespread implementation of conservation practices.	Harr et al., 2014
Social Capital Theory	Argues that social relationships are resources that can lead to the development and accumulation of human capital.	Jobes, 2019
Social Exchange Theory	Studies the social behavior in the interaction of two parties that implement a cost-benefit analysis to determine risks and benefits.	Toledo et al., 2014 Jeffries et al., 2023
Strengths Weaknesses Opportunities Threats (SWOT)-Analytic Network Process (ANP) Framework	Identifies strengths, weaknesses, opportunities, and threats for a specific group or individual, and structures a decision into a network with a goal, decision criteria, and alternatives.	Starr et al., 2019
Theory of Bounded Rationality	Posits that consumers have limited rational decision making, driven by three main factors – cognitive ability, time constraint, and imperfect information.	Hoffman, 2020
Theory of Planned Behavior	Posits that behaviors are determined by behavioral intentions, which are determined by attitudes toward the behavior, subjective norms, and perceived behavioral control.	Bendel et al., 2020 Coon et al., 2020
Theory of Reasoned Action	Argues that individuals use the information that is available to them in a reasonable manner at the time of making decisions, and that an individual's behavior follows a logical and systematic path based on available information.	Toledo et al., 2013
Transtheoretical Model of Behavior Change	Provides a model that conceptualizes intentional behavioral change.	Bendel et al., 2020
Two System Theory	Conceptualize individual decision-making processes as existing on a spectrum between entirely analytic (e.g. cost-benefit analysis) and entirely intuitive processes (heuristics).	Hoffman, 2020 Hoffman et al., 2021
Value-Beliefs-Norm Theory	Emphasizes the impact of personal values, beliefs, and social norms on an individual's perception of risk and behavioral intentions.	Joshi et al., 2019

# REFERENCES

---

- Abney, A.A. (2017). *Landowner perceptions of woody plant encroachment and prescribed fire liability*. [Master of Science thesis, Texas A&M University].
- Adhikari, S., Joshi, O., Sorice, M.G. & Fuhlendorf, S.D. (2023). Factors affecting the adoption of patch-burn grazing in the southern Great Plains in the US. *Land Use Policy*, 125.
- Archer, S.R., Andersen, E.M., Predick, K.I., Schwinning, S., Steidl, R.J. & Woods, S.R. (2017). Chapter 2 Woody plant encroachment: Causes and consequences. In Briske, D.D. (Ed), *Rangeland systems: Processes, management and challenges*. (pp. 25-83). Springer Nature.
- Bartley, K.A. & Brooks, J.J. (2022). Fusion of horizons: Realizing a meaningful understanding in qualitative research. *Qualitative Research*, 0(0).
- 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.
- Berg, M.D., Sorice, M.G., Wilcox, B.P., Angerer, J.P., Rhodes, E.C., et al. (2015). Demographic changes drive woody plant cover trends—an example from the Great Plains. *Rangeland Ecology and Management*, 68(4).
- Briggs, J.M., Knapp, A.K., Blair, J.M., Heisler, J.L., Hoch, G.A. et al. (2005). An ecosystem in transition: Causes and consequences of the conversion of mesic grassland to shrubland. *BioScience*, 55(3).
- Central Grasslands Roadmap. (2021). *Ranchers, landowners, and producers roadmap input survey*. Central Grasslands Roadmap. [https://static1.squarespace.com/static5e600ddcde3d9a12661c36a7/t/613bc8174f637724496409e5/1631307800906/Central+Grasslands+Survey+Report\\_Final.pdf](https://static1.squarespace.com/static5e600ddcde3d9a12661c36a7/t/613bc8174f637724496409e5/1631307800906/Central+Grasslands+Survey+Report_Final.pdf).
- Clark, A.S., McGranahan, D.A., Geaumont, B.A., Wonkka, C.L., Ott, J.P., et al. (2022). Barriers to prescribed fire in the US Great Plains, part I: Systematic review of socio-ecological research. *Land*, 11(1521).
- Coleman, L. (2019). Landowner Perception of Information about Prescribed Fire: Influence on the Application of this Land Management Tool in the Southern Great Plains. Texas A&M University.
- Collaboration for Environmental Evidence. 2022. Guidelines and Standards for Evidence synthesis in Environmental Management. Version 5.1 (AS Pullin, GK Frampton, B Livoreil & G Petrokofsky, Eds) [www.environmentalevidence.org/information-for-authors](http://www.environmentalevidence.org/information-for-authors). [02/02/2023].
- Coon, J.J., van Riper, C.J., Morton, L.W., & Miller, J.R. (2020). What drives private landowner decisions? Exploring non-native grass management in the eastern Great Plains. *Journal of Environmental Management*, 276.
- Coppedge, B.R., Engle, D.M., Masters, R.E., & Gregory, M.S. (2001). Avian response to landscape change in fragmented Southern Great Plains grasslands. *Ecological Applications*, 11 (pp. 47-59).
- Fagundes, C., Picciano, L., Tillman, W., Mleczko, J., Schwier, S., et al. (2020). Ecological costs of discrimination: racism, red cedar and resilience in farm bill conservation policy in Oklahoma. *Renewable Agriculture and Food Systems*, 35. <https://doi.org/10.1017/S1742170519000322>.
- Gaskin, J.F., Espeland, E., Johnson, C.D., Larson, D. L., Mangold, J.M., et al. (2021). Managing invasive plants on Great Plains grasslands: A discussion of current challenges. *Rangeland Ecology and Management*, 78(1).
- Harr, R. N., Morton, L.W., Rusk, S.R., Engle, D.M., Miller, J.R., et al. (2014). Landowners' perceptions of risk in grassland management: woody plant encroachment and prescribed fire. *Ecology and Society*, 19(2). <http://dx.doi.org/10.5751/ES-06404-190241>.
- Hoffman, J.K. (2020). Implementing fire with feeling: The role of heuristics and process modeling in navigating social barriers to landscape-scale prescribed fire use in the Southern Great Plains, USA. [Doctoral dissertation, Texas A&M University].



- Hoffman, J.K., Bixler, R.P., Treadwell, M.L., Coleman, L.G., McDaniel, T.W., et al. (2021). The Impact of Affective Heuristics in Decision-Making Regarding the Implementation of Prescribed Fire on Private Rangelands in the Southern Great Plains, USA. *Society & Natural Resources*, 34(5).
- Jeffries, K., Mishra, B., Russell, A. & Joshi, O. (2023). Exploring opinions for using prescribed fire to control Eastern Redcedar (*Juniperus virginiana*) encroachment in the Southern Great Plains, United States. *Rangeland Ecology & Management*, 86.
- Jobes, R.A. (2019). *Oklahoma's Prescribed Burn Associations Social Capital's Application and Solutions*. Oklahoma State University.
- 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.
- Kreuter, U.P., Stroman, D.A., Wonkka, C.L., Weir, J., Abney, A.A., et al. (2019). Landowner Perceptions of Legal Liability for Using Prescribed Fire in the Southern Plains, USA. *Rangeland Ecology & Management*, 72(6).
- Leis, S.A., Blocksome, C.E., Twidwell, D., Fuhlendorf, S.D., Briggs, J.M., et al. (2017). Juniper Invasions in Grasslands: Research Needs and Intervention Strategies. *Rangelands*, 39(2).
- Londe, D.W., Cady, S.M., Dwayne Elmore, R. & Fuhlendorf, S.D. (2022). Woody plant encroachment pervasive across three socially and ecologically diverse ecoregions. *Ecology and Society*, 27(3).
- McDaniel, T.W. (2018). *Prescribed Fire Outreach In the Southern Great Plains: Challenges and Opportunities*. Texas A&M University.
- Morford, S.L., Allred, B.W., Twidwell, D., Jones, M.O., Maestas, J.D., et al. (2022). Herbaceous production lost to tree encroachment in United States rangelands. *Journal of Applied Ecology*.
- 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 and Management*, 63(6).
- Olenick, K.L., Kreuter, U.P. & Conner, J.R. (2005). Texas landowner perceptions regarding ecosystem services and cost-sharing land management programs. *Ecological Economics*, 53.
- Rajala, K. & Sorice, M.G. (2021). Sense of place on the range: Landowner place meanings, place attachment, and well-being in the Southern Great Plains. *Rangelands*, <https://doi.org/10.1016/j.rala.2021.07.004>.
- Riechman, J.A., Park, L.O., Ruffner, C.M., & Groninger, J.W. (2014). Challenges and Motivations behind Sustaining a Volunteer-Based Forest Management Organization. *Journal of Forestry*, 112(2). <http://dx.doi.org/10.5849/jof.12-110>.
- Sketch, M., Dayer, A.A., & Metcalf, A.L. (2019). Engaging Landowners in the Conservation Conversation through Landowner-Listening Workshops. *Society & Natural Resources*, 33(5).
- Sorice, M.G., Rajala, K., & Kreuter, U.P. (2018). Understanding Management Decisions of Absentee Landowners: More Than Just Presence-Absence. *Rangeland Ecology & Management*, 71.
- Starr, M., Joshi, O., Will, R.E., & Zou, C.B. (2019). Perceptions Regarding Active Management of Cross-timbers Resources in Oklahoma, Texas, and Kansas: A SWOT-ANP Analysis. Oklahoma State University.
- 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>
- Symstad, A.J. & Leis, S.A. (2017). Woody encroachment in Northern Great Plains grasslands: perceptions, actions, and needs. *Natural Areas Journal*, 37(1).
- 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).
- 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.

- Twidwell, D., Rogers, W.E., Fuhlendorf, S.D., Wonkka, C.L., & Engle, D.M. (2013). The rising Great Plains fire campaign: Citizens' response to woody plant encroachment. *Frontiers in Ecology and the Environment*, 11 (Online Issue 1): e64–e71, doi:10.1890/130015.
- Twidwell, D., Fogarty, D.T., & Weir, J.R. (2021). Reducing Woody Encroachment in Grasslands: A Guide for Understanding Risk and Vulnerability. *Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University*.
- University of Nebraska. (2021). *Loess Canyons Experimental Landscape: Science Report*. University of Nebraska-Lincoln, Large-Scale Rangeland Conservation Lab. Lincoln, Nebraska. <https://www.wfw.org/wp-content/uploads/2021/10/Loess-Canyons-Experimental-Landscape-Report-LOW-RES-FINAL-102121.pdf>.
- Weir, J.R., Bauman, P., Cram, D., Kreye, J.K., Baldwin, C., et al. (2019). Prescribed Fire: Understanding Liability, Laws and Risk. *Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University*, NREM-2905.
- Wilber, R., Stanley, C., Maczko, K.A., & Scasta, J.D. (2021). Perceptions of NRCS Assistance with Prescribed Fires on U.S. Private Lands: A Regionally Stratified Case Study. *Fire*, 4(47). <https://doi.org/10.3390/fire4030047>.
- 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).
- Zou, C.B., Twidwell, D., Bielski, C.H., Fogarty, D.T., Mittelstet, A.R., et al. (2018). Impact of Eastern Redcedar proliferation on water resources in the Great Plains USA—current state of knowledge. *Water*, 10(1768).