Social Science Insights on Management Practices in the Central Grasslands of North America

A Literature Review

Cover photo: Conservation professional teaches agricultural producers the importance of soil health at a grasslands field day; Ashley Gramza

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Abstract

The Central Grasslands region of North America provides crucial habitat for a myriad of bird and wildlife species and vital resources for human communities. This ecosystem is in rapid decline mainly due to cropland conversion, climate change, and invasive plant species. Current conservation efforts have not stopped this decline, highlighting the need for a shift in conservation delivery strategies that incorporate local populations within this landscape. Furthermore, grassland management decisions are multidimensional and complex, requiring social science to understand, yet this research has not often been integrated into conservation delivery strategies. To improve the integration of social science knowledge into conservation delivery, existing conservation social science research related to grassland management decision-making has been synthesized so that actionable recommendations for effective conservation delivery could be offered. Utilizing a methodology adapted from the Collaboration for Environmental Evidence (2022), the research team compiled data from 88 peer-reviewed articles, eight technical reports, and eight graduate theses. The analysis focused on identifying the most studied grassland management behaviors, on understanding the variables that influence grassland conservation behaviors, and thus on recognizing the barriers that hinder grassland conservation behaviors. Other ways of understanding the grassland management context through participatory approaches and fields outside social psychology (the main field used to study decision-making) were also briefly explored and thus provide an overview of current social science research and needs related to this topic. The review concludes with considerations and thoughts on the future direction of social science as related to grassland conservation. While this summary is not exhaustive of all the research that exists, it provides a good foundation for understanding the current state of knowledge, while making this information available to grassland conservation professionals. It also provides a starting point for social scientists working on conservation to collaborate on future research that is useful and applicable to grassland conservation professionals and communities within the Central Grasslands. Collectively, this document underscores the importance of conducting more transdisciplinary and participatory grassland conservation strategies to increase the reach, effectiveness and equity of future conservation approaches, and ensure long-term grassland persistence across the Central Grasslands.

Executive Summary

1. Purpose: The Central Grasslands region of North America, extending from southern Canada to northern Mexico, provides crucial habitat for a very large number of bird and wildlife species and also provides vital resources for human communities. However, this ecosystem is in rapid decline, mainly due to threats from cropland conversion, climate change, and invasive plant species. Current conservation efforts have unfortunately not stopped this decline, highlighting the need for a shift in conservation strategies to incorporate the human populations that live, work, and recreate in this landscape. While applying social science research to understanding grassland management decision-making has increased, it has not often been integrated into actual conservation delivery strategies, perhaps due to a lack of synthesis, awareness, and access to this information. Further, little is known about what current social science research is being conducted and what future research is needed, both essential for future coordination among social scientists and the integration of this work back into conservation strategies. Filling these gaps involved:

1. Synthesized and interpreted social science research related to grassland management decision-making,

2. Identified current social science research and future research needs of social scientists who work in this field,

3. Identified areas within grassland management decision-making that have been extensively researched, while highlighting knowledge gaps, and

4. Provided recommendations for future investigation and application of relevant findings to grassland conservation delivery and outreach.

More specifically, the analysis has focused on identifying the most studied grassland management behaviors, understanding the variables that influence them, and recognizing the barriers that hinder conservation efforts.

Some 104 papers deemed appropriate for inclusion given the search strategy. The compilation primarily consisted of peer-reviewed articles (n=88), along with eight technical reports and eight graduate theses. Most papers focused on case studies exclusively within the United States (n=91), followed by Canada (n=7), Mexico (n=2), or some combination of two or more countries (n=4). The findings were heavily skewed toward research that studied the decisions of white landowners and ranchers in the US. To counter this bias, other ways of understanding grassland stewardship through different lenses were briefly explored, such as Indigenous ways of knowing, community and participatory approaches, and methods from anthropology and sociology that focus on populations other than white ranchers.

2. Grassland Management Actions: Prescribed burning was the most studied grassland conservation behavior and seemed to be over-represented in the social science literature. Papers on burning were followed in frequency by studies focused on voluntary grassland conservation assistance programs, grazing or haying that supports grassland conservation, invasive plant management, grassland restoration, and general rangeland management, such as reducing stocking rates as a conservation practice.

3. Predictors of Conservation Behavior: Positive attitudes towards specific grassland management behaviors and a sense of moral responsibility to conserve grasslands were associated with increased willingness to engage in conservation activities. Personal and social norms, along with positive prior management experience, were also found to play a key role in influencing individuals' conservation actions. This suggests that leveraging moral responsibility and influential social groups could help engage more landowners in landscape-scale initiatives.

4. Barriers to Conservation Actions: Major constraints to grassland conservation include a perceived lack of ability, time, and money to conduct specific conservation behaviors; concerns regarding safety and weather related to prescribed burning; and complexity, bureaucracy, and perceived program inflexibility related to voluntary grassland conservation assistance programs. Such barriers to grassland conservation could perhaps inform ways to improve assistance programs or other conservation efforts that target management behaviors to conserve grasslands, such as reducing program complexity and increasing participation. Conservation delivery professionals could work to alleviate some of these barriers through outreach to

landowners and technical assistance on appropriate management techniques, given landowners' specific needs. They could also help by providing resources and training to connect landowners to monetary and labor resources for engaging contractors and possibilities for cost-sharing.

5. Other Ways of Understanding Grassland Management: Incorporating diverse social science inquiries and knowledge gained through participatory or community-based approaches or other disciplines, such as anthropology and sociology, can enhance conservation strategies by addressing community dynamics and marginalized voices. Indigenous knowledge can offer critical insights into sustainable grassland conservation practices, by emphasizing the importance of co-producing conservation solutions with these specific communities. Conservation of the Central Grasslands will rely on engaging with Indigenous and local communities, in addition to white ranchers, to co-produce conservation solutions to grassland loss. The use of Indigenous and Western science together can yield more comprehensive information about grassland stewardship and elevate the importance of grasslands to the livelihoods of human communities across the region.

6. Current Research: Current research projects among grassland social scientists relate to evaluating new grasslands conservation programs (including payment for ecosystem services); identifying barriers and benefits to conducting specific grasslands management practices, such as ranch management plans; determining the perceptions of regenerative grazing, environmental grasslands stewardship and grasslands conservation program participation, as well as factors that predict them; and understanding perceptions surrounding new technologies (such as solar energy) and how these new technologies might affect grasslands management.

7. Limitations: The themes found within this review can be incorporated into outreach programming, conservation delivery, and real-world grassland conservation strategies as described above, yet these studies primarily fall within the realm of social psychology and mainly focus on the needs and decisions of white, male, English-speaking cattle producers and landowners. While grasslands conservation professionals still need to work within the dominant grasslands conservation framework to a certain extent, this research largely ignores the experiences of other populations in this landscape, including historically marginalized populations. The research team that conducted this review works for a US-based bird habitat

conservation organization and has struggled to find an adequate volume of papers related to Indigenous management, Mexican producers, and to a lesser extent, Canadian producers and non-white producers. This is due to limitations in research and the approach for data gathering, the paucity of research on these populations, and the availability of any of this research online. At a broader scale, social science as a field is based in Western scientific concepts. Other literature reviews have arrived at similar conclusions, pointing to the need for a deeper understanding of Indigenous, non-white, and female perspectives.

8. Application, Future Needs, and Recommendations: Future research needs, as identified by social scientists working on grasslands conservation, include understanding the heterogeneous livelihoods that ranchers hold and how off-ranch income affects grassland management decision-making. There was also a resounding need to learn more about and elevate the voices of non-white ranchers and grasslands stewards.

It is also important to understand the specific social science research needs of the practitioners of grasslands conservation delivery and include these practitioners in social science data collection and analysis that will ensure that the data are relevant and easily accessible. Future research should also collaboratively involve the communities and people who are the research subjects, to ensure that strategies that promote grasslands conservation can improve their wellbeing and livelihoods and promote conservation behaviors that people are willing and able to do.

Past and current social science research largely reflects traditional landowner perspectives and the mainstream conservation delivery paradigm of working with private landowners to conduct grassland conservation behaviors, often neglecting Indigenous and other diverse voices. Future applied research should prioritize inclusivity and community-led frameworks to effectively address conservation challenges and understand the diverse social and cultural backgrounds of populations and communities who rely on the Central Grasslands. However, these participatory and community-based approaches often require more time and effort to conduct and build trust with communities.

By applying the insights found in this review, grassland conservation practitioners can more effectively integrate social science information into their grassland conservation goals and strategies. Fostering transdisciplinary collaboration between grassland social scientists, ecologists, conservation delivery practitioners, and community members can ensure that a holistic approach to decision-making is applied, while facilitating the exchange of knowledge between partners. Developing strategies to communicate the findings of social science research related to grassland management are also essential. This can be accomplished using a variety of outreach tools to effectively communicate findings and recommendations, while tailoring messages to such different audiences as conservation delivery practitioners or conservation outreach professionals to ensure broad understanding and support.

Conclusion: Decisions pertaining to grasslands management are multidimensional and complex, requiring social science information to understand. This summary of past and current social science research related to making grasslands management decisions can aid in the application and integration of this research to improve future grassland conservation strategies. This summary is merely a starting point and does not exhaustively consider all existing research. It is intended as a foundation, a starting point, for understanding the current state of knowledge and making this information available to grasslands conservation professionals. Conservation social scientists should coordinate and collaborate on future, useful research that they find useful to grasslands conservation professionals and communities within the Central Grasslands. It also underscores the importance of conducting more transdisciplinary grasslands conservation strategies to increase the reach, effectiveness and equity in future conservation. This will help ensure long-term grasslands persistence across the Central Grasslands.

1   Purpose

The Central Grasslands of North America, extending from southern Canada to northern Mexico (Figure 1), provides crucial habitat for a myriad of bird and wildlife species (Keyser et al., 2019). Grasslands face considerable risks: conversion to cropland, renewable energy development, climate change, and invasive plants—all of which put many of these species in jeopardy (Stephens et al., 2008; Keyser et al., 2019). Grassland birds are particularly susceptible to these anthropogenic changes, which have resulted in an estimated loss of more than 700 million breeding individuals since 1970 (Rosenberg et al., 2019). Given that the status of bird populations can serve as a vital indicator of ecosystem health, this loss of abundance has motivated a call to action in the science community.

FIGURE 1. MAP OF THE CENTRAL GRASSLANDS REGION THAT SPANS CANADA, MEXICO AND THE UNITED STATES

Sources: ESRI; World Wildlife Fund.

The loss rate of grasslands remains alarmingly rapid, in spite of ongoing conservation efforts, and traditional approaches to conservation have struggled to stem the decline in grassland-reliant bird species (Augustine et al., 2021). A substantial portion of the Central Grasslands is used for human needs, such as food, fuel, and fiber production, so land management decisions made by individuals and communities play a large role in helping or hindering conservation efforts. Accordingly, professionals in the conservation field must increasingly pivot towards understanding land management decision-making across these landscapes if these declines are to be halted or even reduced (Coon et al., 2020; Hoffman et al., 2021a).

Despite this, existing efforts to conduct social science research related to grasslands management and conservation have often been uncoordinated and lacking any real-world application of results (Knight et al., 2008). This lack of coordination and integration creates a persistent research-implementation gap that is also reflected throughout the field of conservation (Knight et al., 2008). University faculty and students often lack support or funds to coordinate research and they lack time, funding, and professional incentives to ensure their work gets applied. Conservation professionals and managers may lack access to peer-reviewed literature and are often excluded from research efforts. Without a clear agenda to coordinate these efforts and prioritize future social science research that is useful to conservation practitioners, the generation of novel insights will not create the necessary changes within the conservation community to safeguard grassland biodiversity and ecosystem services. Rather, the gap will widen.

As a first step in bridging this gap, a literature review of applied work on grasslands conservation was conducted, synthesizing existing conservation social science work as it pertains to management throughout the Central Grasslands.

Specifically, the objectives of this report include:

1. Synthesizing and interpreting social science research concerning decision-making within grasslands,

2. Identifying areas of grasslands management decision-making that have been extensively researched, and highlighting knowledge gaps,

3. Identifying current social science research and future research needs of social scientists who work in this field, and

4. Providing recommendations for future investigation and the application of the findings to grasslands conservation delivery and outreach.

2 Insights from the Literature

The data for this literature review were collected primarily by a methodology adapted from the Collaboration for Environmental Evidence (2022) and by searching for keywords in Google Scholar until the following search string was finalized (Table 1).

TABLE 1. FINAL SEARCH STRING

Population	'Landowners' OR 'Land Managers' OR 'Communit(y)(ies)' OR 'Government' OR 'Non-Governmental' OR 'Ejido' OR 'Indigenous Nations'
Geography	'Great Plains' OR 'Grassland' OR 'Prairie' OR 'Chihuahuan Desert'
Intervention	'Management'

Both English and Spanish language results were included in the analysis without any restriction on dates of publication. Articles, reports and theses were selected for inclusion and more in-depth review based upon their research focus and scope. To increase the comprehensiveness of the search, literature suggestions were also solicited from social scientists and other conservation professionals who work in the Central Grasslands and included if relevant. The research team also collaborated with the North Central Climate Adaptation Science Center (housed at the University of Colorado-Boulder) to share relevant literature among complementary literature reviews, as they were concurrently conducting a similar social science

literature review. All data were stored in a spreadsheet and coded for themes around the following topics: types of management behaviors conducted to support grassland conservation, variables that predict grassland conservation behaviors, barriers toward grassland conservation actions, theoretical frameworks applied across the literature, and current social science research and needs.

One caveat to this process is the use of Google Scholar as the primary search engine. Google Scholar provides a ranking of results that involves "weighing the full text of each document, where it was published, who it was written by, as well as how often and how recently it has been cited in other scholarly literature" (www.scholar.google.com/about). This likely biased the findings to mainly peer-reviewed publications whose subject of examination was white ranchers in the United States and Canada. Preventing this by reaching out to project partners to uncover reports and other documents that might include perspectives from landowners and stewards that are often underrepresented in the peer-reviewed literature, such as from the perspective of Indigenous groups or non-English speaking populations. Additionally, the data compiled in this review are primarily focused on social psychology literature related to grassland management behaviors, which is meant to inform the currently predominant conservation delivery model of working with landowners in the Central Grasslands. It is possible that this model may not be the best fit for characterizing all grassland management work being conducted across the region. To partially alleviate this limitation, other methods of understanding this diverse management context were tried, such as participatory or community-based research or research from other social science fields, such as sociology and anthropology, which are often better suited for examinations of groups who hold less power in these contexts.

More than 100 papers were deemed appropriate for inclusion, given the aforementioned search strategy. The compilation consisted primarily of peer-reviewed articles (n=88), along with eight technical reports and eight graduate theses. Most of the studies (71%) were published or released in the year 2018 or later. The majority focused on case studies exclusively within the US (n=91), followed by Canada (n=7), Mexico (n=2), or some combination of two or more countries (n=4). This over-representation of US studies is most likely due to the smaller amount of published research around grassland management in Canada and Mexico compared to the

United States, but it may also reflect the previously mentioned limitations in the search methodology. The United States also contains most of the land area of the Central Grasslands region, which may account for most of the US-based work. Throughout the report, the usual themes found across studies were noted of course, but an effort to identify geographically specific data was made as well.

Most papers dealt with private landowners (85%), along with professionals from conservation agencies (17%) and members of prescribed burn associations (6%). Data were also collected from district court judges, county commissioners, volunteer fire departments, academics, and the general public. The included studies paid limited attention to Indigenous Peoples, who were the focus of only 2% of studies. Data were primarily collected quantitatively (58%), followed by qualitatively (23%) or a mix of both methods (19%). A list of the theoretical frameworks applied in the studies, a brief description of each, and the papers in which they are cited can all be found in Appendix A. While all the papers in the appendix were included in the literature review analysis and aforementioned summary statistics, some of the research is not specifically cited in the body of the review.

2.1 Grassland Management Behaviors

While grassland management can involve many unique and complementary behaviors or interventions, the following section outlines the most common behaviors that have been studied by social scientists. Nearly one-third (n=28) of the papers assessed some aspect of prescribed burning as the specific conservation intervention of focus. Many of these focused on the prescribed burning motivations of private landowners, such as improving the quality of their range following regrowth of grasses (McDaniel, 2018) and understanding the cost-effectiveness of burning to combat invasive plants (Jeffries et al., 2023). See Section 2.2 below for additional variables that promote prescribed fire as an effective management tool. Some of the other papers focused on burning discussed common barriers that prevent individuals from conducting this practice, including burn liability standards in place (Kreuter et al., 2019; Morton et al., 2010), a lack of knowledge or prior experience with burning (Harr et al., 2014; Morton et al., 2010), or

simply harboring negative feelings toward using fire as a management strategy (Polo et al., 2020). See Section 2.3 for a more robust list of barriers toward burning.

Studies of additional behavior included grazing or haying to support grassland conservation, invasive plant management, grassland restoration techniques, and general rangeland management, such as reducing stocking rates as a conservation practice (Raynor et al., 2019). See Table 2 below for the complete list of conservation interventions studied and their references.

2.1.1 Grassland Conservation Assistance Programs

Conservation programs that supported grassland conservation behaviors by providing financial and technical assistance were addressed in approximately 15% of the papers. For the most part, these programs have acted as a motivation for grassland management behaviors, mirrored in the positive perceptions of programs from respondents of several studies. Landowners viewed assistance programs that reduce woody plant cover favorably, especially those aiming to increase water yields or improve wildlife habitat (Olenick et al., 2005). The desire for environmental improvements through program participation was mirrored in a survey of Mexican producers, in addition to goals to increase production (CEC, 2025). A significant percentage of respondents expressed willingness to enroll in programs that provide cost-sharing for brush management practices, with short-term contracts seen as the most acceptable legal instrument for participation (Olenick et al., 2005).

One US program that has been thoroughly studied is the Conservation Reserve Program (CRP) which pays those who enroll a yearly payment in exchange for removing cropped agricultural land from their operation and planting mainly grass species instead which yield various environmental benefits (Barnes et al., 2019). The CRP has been found to partially offset declines of specialist grassland species in such landscapes as the US Central Grasslands that have been largely converted to agriculture (Pavlacky et al. 2022). Lute et al. (2018) found that a majority of Nebraska landowners valued CRP-related ecosystem services very highly, including the establishment of native pollinators. CRP contracts are from 10 to 15 years in length, with the potential for re-enrollment. Therefore, it is vital that these practices be maintained over the long-term for the benefits of these programs to last beyond the life of the program. See Barnes et al.

(2019), for more information on factors that may support or hinder persistence of conservation actions in the US southern Great Plains once Conservation Reserve Program contracts end. Conservation easements, which are legal agreements that restrict certain land uses for the protection of natural resources, have also been shown to result in indirect conservation-relevant outcomes, including improved relations among landowners, government agencies, and NGOs (Rissman and Sayre, 2012). There have also been some evaluations of the social, environmental, and economic benefits of other voluntary grassland conservation incentive programs, but these evaluations are beyond the scope of this literature review and the data often found in unpublished reports housed by funding agencies.

TABLE 2. MANAGEMENT BEHAVIORS

Intervention	Reference
Prescribed Burning	Abney, 2017; Ahamad et al., 2022; Bendel et al. 2020; Clark et al., 2022a; Clark et al., 2022b; Coon et al., 2020; Harr et al., 2014; Hinojosa et al., 2020; Hoffman et al., 2021a; Hoffman et al., 2021b; Jeffries et al., 2023; Joshi et al., 2019; Kreuter et al., 2019; Morton et al., 2010; Parajuli et al., 2019; Polo et al., 2020; Sliwinski et al., 2018; Stroman et al., 2020; Symstad & Leis, 2017; Toledo et al., 2013; Toledo et al., 2014; Twidwell et al., 2019; Twidwell et al., 2015; Watts et al., 2024; Weir et al., 2016; Weir et al., 2019; Wilbur & Scasta, 2021; Wilbur et al., 2021; Wonkka et al., 2015; York & Jager, 2021
Conservation Programs	Barnes et al., 2019; Barnes & Dayer, 2021; Brammer & Bennett, 2022; Caldas et al., 2016; Joyce et al., 2013; Lawley & Yang, 2015; Lute et al., 2018; Olenick et al., 2005; Rissman & Sayre, 2012; Roberts et al., 2023; Santo et al., 2021; Sorice et al., 2021; Stroman & Kreuter, 2014; Stroman & Keuter, 2015; Taylor et al., 2020
Grazing/Haying	Adhikari et al., 2023; Gruntorad et al., 2021; Harr et al., 2014; Hintze et al., 2021; Micheels & Nolan, 2016; Morton et al., 2010; Wang et al., 2019; Wang et al., 2021

Invasive Plant Management	Adhikari et al., 2023; Ahamad et al., 2022; Coon et al., 2020; Kaur et al., 2020; Roberts et al., 2023; Sorice et al., 2018; Symstad & Leis, 2017; York & Jager, 2021
Grassland Restoration	Tyndall et al., 2013; Vaske et al., 2021; York & Jager, 2021
General Rangeland Management	Maestas et al., 2022; Raynor et al., 2019; Wimberly et al., 2017; Wang et al., 2021

2.2 Variables that Predict Grassland Conservation Behavior

The literature revealed several variables that can help predict grassland conservation behaviors. These can include an individual's positive attitudes toward grassland management, their preferences for ecological features that support conservation (e.g., heterogeneity of grasses), personal norms and beliefs, social norms, positive prior participation in conservation programs, favorable policies that promote grassland conservation, and effective communication and outreach with partners.

Positive attitudes to grassland management were associated with a stronger sense of moral responsibility for conserving grasslands, which influenced an individual's willingness to take part in additional forms of conservation management, such as control of non-native grasses (Coon et al., 2020) and enrollment into assistance programs (Barnes et al., 2019). A significant percentage of cattle producers in the Grand River Grasslands region of southern Iowa and northern Missouri were willing to reduce stocking rates for conservation outcomes (Raynor et al., 2019), while most respondents in a study conducted by Gruntorad et al. (2021) were willing to delay hay harvesting across the US Great Plains for the sake of bird conservation, which positively correlated with livestock ownership and wildlife knowledge and hunting activity negatively correlated with this willingness. A preference for heterogeneous landscapes—diverse areas which promote biodiversity and ecosystem resilience—was generally consistent across ranchers, natural resource professionals, and respondents who valued open space and recognized the need for a varying

mix of grasses (Becerra et al., 2013; Joshi et al., 2017). Ranchers operating in North Dakota, South Dakota, or Nebraska with positive attitudes about fire and higher perceived control over prescribed fire and resultant outcomes had greater intention to engage in heterogeneity-promoting behaviors (Sliwinski et al., 2018).

Social norms are defined as the shared rules or beliefs that guide a group's actions, while personal norms relate to what an individual values and how that influences their own behavior (Bertoldo and Castro, 2016). Social norms related to neighbors' expectations of management often have a strong impact on individual behavior. For example, the placement of an easement on one property increased the likelihood of subsequent easements on neighboring lands in the prairie pothole region of western Canada (Lawley and Yang, 2015). Stroman et al. (2020) found that belonging to a prescribed burn association was correlated with increased use of prescribed fire in the US Southern Plains region.

Prior participation in conservation programs or specific management actions also played an important role in intention to participate in future management efforts. Joshi et al. (2019) found that respondents across 14 southern and midwestern US states, who had more experience with burning activities, perceived lower risk to conducting additional prescribed burns than those who did not. Similarly, a majority of participants in the Lesser Prairie-Chicken Initiative expressed satisfaction in the program and were likely to re-enroll (Sorice et al., 2021), while landowners who participated in the US Fish and Wildlife Service's Partners for Fish and Wildlife Program expressed high levels of satisfaction and were likely to continue conservation activities after the end of their contract (Vaske et al., 2021).

Policy has been shown to influence grassland conservation behaviors, particularly those related to prescribed burning (Hinojosa et al., 2020) and can help incentivize conservation efforts. For example, in US counties with gross negligence liability standards, which provide legal protection for fire damage if landowners meet a series of due diligence requirements, private landowners burn significantly more hectares compared to counties with stricter liability standards (Wonkka et al., 2015). In southwestern Saskatchewan, Ayambire and Pittman (2022) also outline several conditions of governance that support pro-conservation efforts, including local autonomy for landowners, trust-building between involved entities, and a suite of incentive options to carry

out the work. A social science literature review of invasive woody plant management conducted by Roberts et al. (2023) across the US Great Plains, found that policies for programs that incentivize grassland management behaviors should be more adaptable and flexible to meet the needs of diverse landowners and their operations. However, government policies pertaining to grassland conservation and management should be periodically assessed to determine their effectiveness in promoting management behaviors that conserve grasslands. Policies in Mexico that require government permits for cattle sales have the effect of increasing complexity for cattle ranchers, potentially leading to land-use decisions that don't support grasslands, such as crop production and mining (David Borre, personal communication, December 1, 2023).

Several studies pointed to the importance of using salient messaging and trusted communication sources in education and outreach to promote grassland management and conservation. The adoption of prescribed burning by private landowners or land-use stewards could be more widespread if the effectiveness of fire for controlling eastern red cedar were included in communications with these individuals (Morton et al., 2010). Overall, producers were more open to new practices when they were able to learn more about them through observation, trials, and two-way dialogues (Tarnoczi and Berkes, 2010). In the State of Oklahoma, when organizations are planning outreach and communication efforts, York and Jager (2021) suggested that they should work through the information sources that producers trust the most, such as extension offices and local individuals with positive management experience.

2.2.1 Emerging and Innovative Management Actions

Several new efforts have been launched, or are under development, that can support grassland conservation efforts. Producers fighting invasive plant encroachment can implement a mixed-species grazing operation by using goats or sheep to better manage non-native plant species that compete with grasses (Hintze et al., 2021). Kaur et al. (2020) described how a new industry to convert eastern red cedar into marketable products could contribute significantly to the economy of Oklahoma and also create employment opportunities. Through a spatial analysis, they identified two hotspot clusters indicating that existing biomass in certain counties could sustain the bioproducts industry for several decades. A similar industry could be developed elsewhere and may be an especially useful tool for communities plagued by poverty or economic insecurity.

Additionally, Wang et al. (2021) surveyed 4,500 producers across the US Great Plains region and found that rotation-intensive grazing—a process that promotes short but heavy grazing periods followed by a longer period of grass recovery—often led to a higher percentage of restored grassland, compared to areas that are continuously grazed. Wang also suggested that payments for ecosystem service practices, such as carbon sequestration via a carbon credit market, could facilitate the sustainability of grass-based agriculture. Brammer and Bennett (2022) supported the notion of landowners getting paid via an offset mechanism for avoiding the conversion of grasslands to crops. Berry et al. (2017) found that harvested cattails from retention systems could result in returns of over $18,000/hectare/year for farmers in the Canadian Prairie, due to avoided flood damages and the removal of phosphorus, nitrogen, and carbon from the system. Similarly, Tyndall et al. (2013) described how implementing prairie strips (a conservation practice meant to protect natural resources while providing wildlife habitat) under a CRP contract in central Iowa could reduce per acre costs to farmers by over 85% in avoided costs. Managing a combination of livestock and game animals by allowing hunting on the same property as a cattle operation could also help offset the cost of management for ranchers based in the US (Holechek et al., 2020).

2.3 Barriers to Conservation Actions

Data from many studies also highlighted constraints that hinder grassland management. Coon et al., (2020) found that landowners' perceived lack of ability, and limited access to time, money, or other resources, were major barriers to non-native grass management in the eastern Great Plains of the United States. These same barriers were also common for individuals seeking to conduct prescribed burns (Symstad and Leis, 2017; Clark et al., 2022a; Toledo et al., 2013, 2014). Perceived risks associated with fire, and particularly concerns related to safety, weather, and legal liability, often outweighed the benefits associated with prescribed burning, such as reducing plant encroachment and increasing forage (Harr et al., 2014; Joshi et al., 2019; Kreuter et al., 2019).

Studies also revealed numerous economic constraints related to conservation efforts. Joyce et al. (2013) found that programs designed to sequester carbon by using native grasses was not an

economically viable practice for many landowners due to high transaction costs associated with short-term carbon dioxide accounting. High initial investment costs were identified as a major challenge in rotational grazing, along with labor and resource constraints (Wang et al., 2021). Parajuli et al. (2019), on the other hand, described how many landowners across the US seek the lowest-cost plant removal alternatives, thus influencing respondents' decision to forgo burning as an option, given the required additional cost of fire insurance. Both Lute et al. (2018) and Raynor et al. (2019), in their studies, posit that the practitioners and producers tended to focus more on economic than environmental concerns when making grassland management decisions.

Legal and policy barriers were also found to discourage landowners from carrying out conservation behaviors. Factors such as rule complexity, bureaucracy and perceived program inflexibility often dissuaded individuals from taking part in assistance programs (The Central Grasslands Roadmap, 2021), while Barnes and Dayer (2021) found that low rental rates, eligibility requirements, and restrictions on practices like grazing or haying, all acted as deterrents for landowners to keep land in grass after their Conservation Reserve Program contracts ended. In the Chihuahuan Desert grasslands of northern Mexico, land tenure that promotes fragmentation has resulted in decreasing parcel sizes, reducing the profitability of cattle operations and forcing landowners to shift to cropped systems that require irrigation in an already arid landscape (Hruska and Toledo, 2017). Across Mexico, lack of technical assistance and planning support were cited as two of the primary barriers to program enrollment (CEC, 2025).

Varied and often conflicting perceptions and preferences of individuals across the landscape can also serve as a barrier to grassland conservation. For example, many hunters preferred woodland habitat for wildlife and did not desire native heterogeneous landscapes, which is important for many grassland-dependent wildlife species (Joshi et al., 2017). Lopez Porras et al. (2018) found that disparities in opinions over ecosystem services led to user conflicts in grassland ecosystems, while a lack of trust in the government and fear of federal mandates were identified for some individuals as barriers to working with agencies that promoted conservation (Santo et al., 2021; Blauwkamp and Longo, 2002). Overall, contrasting perceptions in different regions, influenced

by cultural roots and environmental conditions, had made collaboration around grassland management difficult (Lopez Porras et al., 2020).

2.4 Other Ways of Understanding the Human Components of Grassland Management

There are other ways of understanding grassland management and stewardship decision-making than social psychology and the economic-based approaches used in the dominant North American (primarily US and Canada) grassland conservation and management paradigm. This paradigm tends to focus on the individual decisions of private landowners and the ecological impacts of those management decisions. A brief description of some of these additional ways of understanding, and social science disciplinary insights, are given below to mitigate some potential gaps in this review and any bias in its literature search strategy.

2.4.1 Other Social Science Disciplines

Ranch and grassland management decision-making is complex, often influenced by community, cultural and political context, as well as ecological conditions (Wilmer et al., 2020). It is important to understand this broader context to scale up grassland conservation efforts, which is essential for conserving the Central Grasslands region. This knowledge can be gained through applied grassland conservation work that is transdisciplinary, or inclusive of ecological, sociological and local knowledge, from the start (Wilmer et al., 2021a). It can also be gained through other forms of participatory, collaborative social science research, or from other social science disciplines such as anthropology, sociology, and political science, among others. Integrating additional social science fields and ways of understanding grassland management and decision-making (such as through oral histories, ethnographies, and other qualitative approaches) can give those working in grasslands conservation deeper insights with which to understand marginalized communities. Further, bringing in additional ways of knowing increases understanding of how people connect to and manage grasslands, and helps managers make more informed decisions by integrating community members into management through community-based, participatory, or co-management frameworks (Wilmer et al., 2021b). Participatory research frameworks and those from disciplines other than social psychology can also decrease some of the gender, racial, and cultural bias present in individual-focused and survey-based research approaches. Many of these

qualitative methods require researchers to gain trust and become embedded in the communities where they are working, which increases the potential for understanding populations that don't hold as much social or political power in the Central Grasslands, such as non-white ranchers (Peña, 1998), women ranchers (Wilmer and Fernández-Giménez, 2016), Indigenous communities, and non-landowners who live, work, and relax in the region.

A full literature review could be conducted that would relate to many of the topic areas mentioned above. Although that is beyond the scope of the present review, it does provide some examples of relevant work that relates to grassland management beyond the scope of individual decision-making, to showcase the breadth and importance of other social science methods and study populations not captured in the main literature review. Wilmer et al. (2021a) showcased three studies that use transdisciplinary research to better understand grassland management systems, by conducting ranch-scale, long-term experiments, folklore and oral history, and community-based social-ecological research. Reid et al. (2021) examined how collaborative rangeland processes, on an international scale, can uncover whose knowledge is used in rangeland management systems and important power dynamics between players in these systems. Wilmer et al. (2022) illustrated the benefits and challenges of a long-term collaborative adaptive management grazing experiment. Wilmer and Fernández-Giménez (2016) show how women's ranching experiences and gendered practices of cultural resilience are different from the dominant narrative of rancher resilience. The women ranchers they interviewed focus on independence through community connectedness, passing knowledge down by mentoring the next generation, and lessening their own standards of living to make ends meet on the ranch. Gouveia and Stull (1997) examined immigrant and workers' experiences in the meatpacking industry in a small community in Nebraska: a human community that is essential to the economic resilience of grassland systems but often overlooked and ignored. Reiter (2023) captured oral histories of Canadian ranchers across the Canadian prairies, and Embry (2013) used oral histories to understand the dynamics of labor and community in the American West. Lastly, Gooden and Moir (2019) used a Q methodology to elucidate and analyze—qualitatively and quantitatively— stakeholder objectives for the creation of a new private lands' grassland conservation program in northern Mexico. Taken together, these examples give a much fuller picture of the complex human communities that make up the Central Grasslands and how they connect to and rely on

grasslands. These diverse communities will be essential to understand and engage to conserve the Central Grasslands at scale and in ways that benefit all communities, not just ones with the most power, influence, and money.

2.4.2 Indigenous Ways of Knowing

Indigenous Peoples have been stewards of the Central Grasslands since time immemorial. During that long period, they have ensured the persistence of many essential ecosystem processes that function to support human and non-human life across the Central Grasslands—through a variety of management strategies and ways of knowing, including prescribed fire (Blackstock and McAllister, 2004; Hoffman et al., 2021a; Hoagland and Albert, 2023). Grasslands are sacred to Indigenous Peoples and are used for subsistence, medicine, and spiritual and ceremonial purposes (Blackstock and McAllister, 2004). European colonization of North America has brought its own ways of knowing how to manage and steward grasslands—privatization and dispossession of land and water resources—resulting in restricted ability to move across the landscape and use the full panoply of other resources (Blackstock and McAllister, 2004). Reducing access to traditional lands also reduces the ability for Indigenous Peoples to adapt and be resilient to environmental changes (Pickering Sherman et al., 2010). Traditional ecological knowledge and ways of knowing have often been overlooked, ignored, or silenced, with Western science leading ecosystem management and restoration, and traditional management tools such as prescribed fire being co-opted without proper acknowledgement and credit (Werdel et al., 2024).

Hundreds of Indigenous nations exist across the Central Grasslands, each with unique ways of knowing and grasslands stewardship strategies that are specific, place-based and have been developed and passed down over generations (Blackstock and McAllister, 2004). It is challenging to make broad generalizations related to Indigenous stewardship. However, this knowledge and stewardship often involve careful observations and a mutual respect for all living and nonliving parts of the landscape and processes that make up the grassland ecosystem (Blackstock and McAllister, 2004; Hoagland and Albert, 2023). Social science can be used to preserve, communicate, and elevate these ways of knowing when the work is co-produced with Indigenous populations. Researchers should pay careful attention to ensure that Indigenous ways

of knowing are not exploited for research gains and that research data ownership and management plans are discussed and agreed upon by all parties (Werdel et al., 2024).

The initial search strategy and request to the social science community resulted in very few papers related to Indigenous grasslands stewardship or ways of knowing. To bolster this, a deeper dive outside the initial search terms was necessary to showcase examples from the scientific literature that recorded Indigenous knowledge related to the management of grasslands, and projects that merged Indigenous and Western science (Gilbert and Kohl, 2024). Much traditional ecological knowledge related to Indigenous stewardship of grasslands is not available via peer-reviewed literature, or even found in written format, which makes it challenging to uncover via the methods that Western science typically uses to summarize research literature, such as in this review.

Instead, Indigenous ways of knowing are very place-based and specific to a particular Indigenous group. Much of the traditional ecological knowledge related to specific ecosystems, like grasslands, uses qualitative anthropological methods such as oral history or ethnographic research. While falling outside the Central Grasslands region (Figure 1), the work of Blackstock and McAllister (2004) explored First Nations' perspectives on grassland management and restoration in the interior of British Columbia. This involved interviews with tribal elders, who were considered experts within the community on grasslands management, to record changes in the composition of grasslands from the period prior to European settlement to the present, and their understanding of traditional grasslands management techniques and cultural use. Blackstock and McAllister also brought in historical ecological information, collected with Western science techniques, concerning regional changes in grasslands land cover. Devon Peña, in his edited volume entitled: Chicano Culture, Ecology, Politics: Subversive Kin (1998), explores Chicano/a farmer and ranchers' lived experience through a variety of lenses (such as feminism), disciplines, and social, political, and economic viewpoints: thus providing a holistic view of the lived experience of this mixed-cultural community on the montane grasslands of the upper Rio Grande watershed.

Conservation of the Central Grasslands will depend on engaging with Indigenous communities to co-produce conservation solutions to grassland loss. The use of Indigenous and Western science together can yield more comprehensive information about grassland stewardship (Hoagland,

2017; Gilbert and Kohl, 2024; Werdel et al., 2024) and elevate grasslands' importance to the livelihoods of human communities across the region.

2.5 Current Social Science Research and Needs

While past social science research is extremely important to understanding and integration into current grassland conservation strategies, it is also important to understand current research and future needs, to avoid duplicating efforts and to ensure that future research needs become reality. Professional grasslands social science networks were used to collect information on current social science research and social science needs related to grassland management decision-making. Also, information was collected on current social science research via an online survey and submitted to two virtual discussions in December 2023 and January 2024 where gaps in the grasslands management social science literature were discussed, along with current research and future research needs. A list of grasslands social scientists was compiled for the invitations to attend a grasslands-specific social science discussion at the Pathways Human Dimensions of Wildlife conference in 2023. Knowing that there would likely be omissions on this list, those on the initial invitation list were encouraged to contact others in the field to attend and fill in knowledge gaps.

The social scientists who joined the virtual meeting noted a variety of future needs, such as understanding the heterogeneous livelihoods that ranchers maintain and how these complex interests might affect their grassland management decisions. For example, many ranchers are now seeking off-ranch income to keep their ranches going and for us to understand these complexities is potentially important. Learning more about non-white ranchers and grassland stewards and elevate their voices was also necessary. More research has recently been focused on these traditionally underrepresented groups (see above sections on Indigenous Ways of Knowing and Other Social Science Disciplines), but there is still much to learn. The social scientists who attended the meetings also desired to learn more about adaptive decision-making and about what resources would be needed for management of grazing to adapt to changing environmental, social, and economic conditions. Last, the meeting participants questioned whom exactly future grassland social science coordination and collaboration truly benefits: just the scientists in the room or can the work end up making a difference to grasslands conservation across the Central Grasslands? Working together to ensure that evaluations become part of this

work is necessary so that it benefits the conservation of grasslands and the communities that rely on these grasslands throughout the region.

Despite the efforts at inclusion, the current research list is as biased as past research that has been summarized in this report: mainly focused on the United States and studying white landowners. However, current work to elevate the voices of traditionally marginalized populations, such as women, ranchers of color and Indigenous groups, is being done through working groups (Central Grassland Roadmap's Indigenous Kinship Circle and Social Ecological Working Group), social science labs at Universities (e.g., the Indigenous Land and Data Stewards Lab at Colorado State University), and advocacy organizations who serve these communities (e.g., the Oklahoma Black Historical Research Project serving Black farmers and ranchers in Oklahoma and National Latino Farmers and Ranchers, whose mission is to empower and lift up Latino farmers and ranchers).

The main directions for current social science research include evaluating new grassland conservation programs (including payment for ecosystem services), identifying barriers and benefits to conducting specific management practices for grasslands, such as invasive plant management and adopting ranch management plans, determining the perceptions of and predictive factors for regenerative grazing, environmental grasslands stewardship and participation in grasslands conservation program, and understanding new technologies, such as solar energy and the effect of these new technologies on agriculture in the Central Grasslands. This research is being conducted by researchers across a variety of organizations, including universities and governmental and nongovernmental conservation organizations. Full summaries of this current research, as submitted via online survey, have been submitted in Appendix B. In the survey, participants were asked to supply a title, a brief summary, and any links to current reports related to the projects.

Social scientists at the North Central Climate Adaptation Science Center (NC CASC) are also synthesizing social science related to resource management and climate change across the US Great Plains, identifying knowledge gaps where future research should be directed, and providing insights on how this information can be applied to grassland management challenges. The research is very similar to this current work, yet covers a broader swath of social science insights and a narrower geographic region. Because of the similarity of this work and its stage of project development, close collaboration with these scientists and sharing data collection information was possible. Without seeking current research, this project and these collaborators

might not have been uncovered. The NC CASC group is also conducting work to discuss research findings from a larger [ecological grassland synthesis project](#) (Miller Hesed and Yocum, 2023; Miller Hesed et al., 2023a), incorporating grassland managers to build relationships with these managers. This project involves seeking information on manager perspectives on challenges, capacity-building, and research integration related to climate smart grassland management in the region served by the NC CASC (Colorado, Wyoming, Montana, North Dakota, South Dakota, Nebraska, and Kansas).

3 Application and Future Direction

3.1 Summary and Application

This literature review has summarized past and current social science research and future research needs related to grassland management decision-making across the Central Grassland region. By summarizing this information in an open-access format, this research synthesis is available to conservation professionals who have cited a need to integrate social science research into grassland conservation strategies (Miller Hesed et al., 2023b). This information can also help social scientists specializing in applied conservation and grassland issues to better understand the current state of research, coordinate social science efforts, and conduct future work that benefits grassland conservation professionals as well as human populations who live, work, and enjoy recreational activities in the Central Grasslands.

Research focused on individual landowner decision-making by white cattle ranchers and landowners was the main research uncovered, as reflects the dominant North American (mostly US and Canada) grassland conservation landowner, who promotes grassland conservation on privately owned land. The following sections summarize findings and supply recommendations for applying these findings to grassland conservation delivery and outreach. However, they also identify limitations in the present methods and approach, the gaps in research, and the future direction for social science research integration into grassland conservation.

Prescribed burning emerged as the most studied grassland conservation behavior and seemed to be over-represented in the social science literature (for example, see Morton et al, 2010; Harr et al., 2014; McDaniel, 2018; Kreuter et al., 2019; Polo et al., 2020; Jeffries et al., 2023). Papers on burning were followed in frequency by studies focused on voluntary grassland conservation assistance programs (Olenick et al., 2005; Lute et al., 2018; Barnes et al., 2019; Pavlacky et al., 2022; CEC, 2025), grazing or haying that supports grassland conservation (Harr et al., 2014; Gruntorad et al., 2021; Adhikari et al., 2023), invasive plant management (Kaur et al., 2020; Ahamad et al., 2022; Roberts et al., 2023), grassland restoration (Tyndall et al., 2013; Vaske et al., 2021; York and Jager, 2021), and general rangeland management (Wimberly et al., 2017; Raynor et al., 2019; Wang et al., 2021; Maestas et al., 2022), such as reducing stocking rates as a conservation practice. Research on specific management behaviors (outside of burning) such as chemical and mechanical treatments for non-native plants, mulching, and mixed-species herbivory to reduce woody plants were also examined to a much lesser degree.

Several variables that predict conservation behavior, which can be effectively integrated into communications and outreach campaigns aimed at promoting grassland conservation behaviors, were found in the literature. Positive attitudes toward management and a sense of moral responsibility to conserve grasslands were associated with increased willingness to engage in conservation activities (Barnes et al., 2019; Coon et al., 2020). Personal and social norms, along with positive prior management experience, were also found to play a key role in influencing individuals' conservation actions (Lawley and Yang, 2015; Stroman et al., 2020). This suggests that leveraging moral responsibility and influential social groups could help engage more landowners in landscape-scale initiatives.

Common barriers to grassland conservation behaviors included a perceived lack of ability, time and money to conduct specific behaviors (Coon et al., 2020), concerns regarding safety and weather related to prescribed burning (Symstad and Leis, 2017; Clark et al., 2022a; Toledo et al., 2013, 2014), and complexity, bureaucracy, and perceived program inflexibility in relation to voluntary grassland conservation assistance programs (Barnes and Dayer, 2021; The Central Grasslands Roadmap, 2021). These barriers to grassland conservation that were found in this review can point to improvements in assistance programs or other conservation efforts that

target specific management behaviors that conserve grasslands, such as reducing program complexity and increasing flexibility of participation requirements. Conservation delivery professionals can work to alleviate some of these barriers through landowner outreach campaigns and technical assistance that focuses on the most appropriate management techniques given landowner's specific needs, providing resources and training that increases confidence in the ability to conduct behaviors, and connecting landowners to monetary and labor resources where needed (e.g., availability of contractors and possibilities for cost-sharing).

Legal responsibility associated with prescribed burning was another commonly cited challenge, along with policy issues like burn bans and complex regulations (Harr et al., 2014; Joshi et al., 2019; Kreuter et al., 2019). Weir et al. (2016) posited that there is an opportunity to develop an organized network of prescribed burn associations at local, state, and national scales to address some of the ecological and jurisdictional challenges associated with burning. Economic constraints and costs of transactions were also identified as barriers to effective management (Joyce et al., 2013; Parajuli et al., 2019; Wang et al., 2021. Creative, low-cost solutions should be considered in the future to increase the attractiveness of certain approaches, such as community-owned equipment that can be shared among neighbors. Conflicting perspectives and preferences also hindered grassland conservation (Joshi et al., 2017; Lopez Porras et al., 2018), pointing to the need for facilitated discussions between conservation practitioners, landowners, and community members, where common goals can be determined (Gooden and Moir, 2019).

Emerging, innovative management approaches, such as mixed-species grazing operations (Hintze et al., 2021), the development of new industries that incentivize grassland conservation (Kaur et al., 2020), and unique approaches to land management (Wang et al., 2021; Brammer and Bennett, 2022), were identified as potential ways to promote grassland conservation, which can help to alleviate some of the economic constraints related to conservation. Education and effective outreach were also highlighted as important tools to support grassland management and conservation, strengthening the argument for communications with landowners that integrate the results found within this review.

Substantial current research is being conducted that relates to grassland management decision-making. Among grassland social scientists, current research projects relate to evaluating new

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grassland conservation programs (including payment for ecosystem services approaches); identifying barriers and benefits to conducting specific grassland management practices; determining the perceptions of regenerative grazing, environmental grassland stewardship and grassland conservation program participation, as well as factors that predict them; and understanding perceptions surrounding new technologies (such as solar energy) and how these new technologies might affect grassland management.

3.2 Future Direction and Limitations

Future research needs, as identified by social scientists working on grassland conservation, include understanding the heterogeneous livelihoods that ranchers hold and how off-ranch income affects their grassland management decision-making. There is also a resounding need to learn more about non-white ranchers and grassland stewards and elevate their voices. Recently, there has been more research focused on these traditionally underrepresented groups (see above sections on Indigenous Ways of Knowing and Other Social Science Disciplines), but there is still much left to learn. It is also important, moving forward, to understand the specific needs of social science researchers and grassland conservation delivery practitioners. While grassland managers clearly see the need for social science research (Miller Hesed et al., 2023b), what specific research questions need to be answered is a different matter. Identifying and filling gaps between past and current social science research and the future needs of grassland managers and conservation delivery practitioners can make social science research integration into conservation strategies easier. However, this future social science data collection and analysis should involve conservation delivery practitioners in the research process so that the data are relevant and easily accessible. Future research should also involve the communities and people who are the research subjects, to ensure that strategies that promote grassland conservation benefit their wellbeing and livelihoods: promoting conservation behaviors that people are willing and able to do.

The themes found within this review can be incorporated into outreach programming, conservation delivery, and real-world grassland conservation strategies as described above, yet these studies fall primarily within the realm of social psychology and focus on the needs and

decisions of white cattle producers and landowners. While grassland conservation professionals still need to work within this framework to a certain extent, this research largely omits the experiences of marginalized populations within this landscape. The conservation delivery paradigm should be challenged and expanded, as more community-based approaches to research and management are most likely needed to make a substantial impact across the landscape. However, these participatory and community-based approaches often require more time and effort to conduct and require building trust with communities (Wilmer et al., 2022)

Understanding the diverse social and cultural backgrounds of populations and communities who rely on grassland and how these factors shape their perceptions of grasslands and behaviors that affect grasslands is extremely important. These considerations were briefly touched on in section 2.4 above (Other Ways of Understanding the Human Components of Grassland Management). The research team that conducted this review works for a US-based bird habitat conservation organization, and finding an adequate number of papers related to Indigenous management, Mexican producers, and to a lesser extent, Canadian producers and non-white producers, was difficult due to limitations in research approach, lack of research, and availability of this research online. At a broader scale, social science as a field is Western, and most studies to date have focused on producers who are white, male, and English-speaking (Brunson et al., 2022). Other literature reviews have been conducted which have arrived at similar conclusions (e.g., Bruno et al., 2020), pointing to the need for a deeper understanding of Indigenous, non-white, and female perspectives (Brunson et al., 2022).

While this study looked for common themes across the grassland conservation decision-making literature in the Central Grasslands, many other studies have been conducted in specific regions or with specific populations, which often makes the insights of specific papers challenging to apply across the landscape. This study did not uncover major differences across Canada, Mexico, and the United States, likely because the available data tend to be so over-represented by studies conducted in the United States. Conservation delivery practitioners still need to understand which specific insights apply to the populations with whom they are working but can use this review as a starting point to understand broad themes that can be used for regional conservation approaches.

Burger et al. (2019) states that a new type of natural resource professional who harbors a deep understanding of landowner goals, knowledge of various conservation tradeoffs, and who is familiar with multiple sub-disciplines of conservation (e.g., agriculture and wildlife management) is needed for effective conservation delivery. They also argue for the necessity of conservation delivery that is targeted and intentional, backed by science, focused on long-term outcomes and occurring on a regional scale. Regarding the political borders that exist throughout the Central Grasslands Region, Fore et al. (2015) posits that there should be a stricter focus on conservation across country lines, while Bruyneel (2010) described how success may be achieved through informal collaborative partnerships between communities, agencies, NGOs, and other involved entities in the absence of formal transboundary support for conservation.

Lastly, it is also important to integrate knowledge about the ecological, social, and economic benefits of grassland conservation behaviors and voluntary grassland conservation programs into outreach that promotes these programs. Literature on the ecological, social, and economic impacts of grassland conservation behaviors and programs exist but are often examined separately. Integrated social-ecological systems approaches can help social scientists, ecologists, and conservation practitioners recognize the complex and interconnected nature of decision-making challenges and develop strategies that address multiple dimensions simultaneously, yet it is difficult to do in a real-world environment.

By applying the insights found in this review, conservation decision-makers and practitioners can more effectively integrate social science information into their grassland conservation goals and strategies. Fostering transdisciplinary collaboration between grassland social scientists, ecologists, conservation delivery practitioners, and community members can ensure a holistic approach to decision-making while facilitating knowledge exchange between partners. Community-based and participatory approaches to grassland conservation offer a way to do this. Developing strategies to communicate the findings of social science research related to grassland management is also essential. This can be accomplished using a variety of outreach channels to effectively communicate findings and recommendations, while tailoring messages to different audiences such as conservation delivery practitioners or conservation outreach professionals to

ensure broad understanding and support. Using the deep social network of the Central Grasslands Roadmap conservation effort is one such way to communicate these findings.

Grassland management decisions are multidimensional and complex, requiring social science information to understand. This summary of past and current social science research related to grassland management decision making can aid in the application and integration of this research to improve future grassland conservation strategies. While this summary is not exhaustive of all the research that exists and it has limitations, nonetheless it provides a good foundation for understanding the current state of knowledge and a way to make this information available to grassland conservation professionals. It also provides a starting point for conservation social scientists who study grassland management decision-making to coordinate and collaborate on future research that is useful and usable to grassland conservation professionals and benefits the Central Grasslands communities. Collectively, this document underscores the importance of conducting more transdisciplinary, community- and participatory-based grassland conservation strategies that can increase the reach, effectiveness and equity of future conservation approaches that can ensure long-term grasslands persistence across the Central Grasslands.

Appendix A. Theoretical Frameworks

TABLE 3. THEORETICAL FRAMEWORKS

Theory	Definition	Example Application
Absorptive Capacity Theory	Conceptualizes a firm's ability to recognize the value of new information, assimilate it, and apply it.	Micheels & Nolan, 2016
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
Agency Theory	Explains and resolves issues between business principals and their agents.	Rissman & Sayre, 2012
Analytic Network Process (ANP) Framework	Structures a decision into a network with a goal, decision criteria, and alternatives.	Starr et al., 2019
Attitude Theory	Suggests that beliefs and attitudes are influential to various psychological functions.	Sorice et al., 2022
Bioeconomic Model	An analytical tool to facilitate management decisions related to natural resources.	Leistritz et al., 2004
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 those involved.	Jeffries et al., 2023

Community Capitals Framework	Views the various elements, resources, and relationships within a community and their contribution to the overall functioning of the community.	Sketch, 2018
Constructivist Grounded Theory	Interprets data and derives theories from concepts that emerge.	Wilmer et al., 2017 Wilmer & Fernández-Giménez, 2015
Contagion Theory of Risk Perception	Explains how people's perceptions of risk are influenced by their social connections and interactions.	Joshi et al., 2019
Contract Theory	Studies how people and organizations design and enforce agreements that involve conflicting interests.	Rissman & Sayre, 2012
Cultural Theory	Posits that social and cultural dynamics influence how individuals think, interact with others, and perceive risk from disasters.	Joshi et al., 2019
Demand Theory	Studies how consumers' demands for goods and services are influenced by their prices in the market.	Dias & Belcher, 2015
Diffusion Of Innovation Theory	Explains how, why, and at what rate new ideas and technology spread.	Adhikari et al., 2023
Educational Theory	Describes how first-hand experience and participation can help to demonstrate facts and aid in knowledge retention.	McDaniel, 2018

Generalized Ordinal Logit (GOL) Model	Allows the effect of each explanatory variable to vary across different cut points of the ordinal outcome variable without data restructuring.	Wang et al., 2019
Goal Framing Theory	Explains how people's goals influence their information processing and behavior in different situations.	Sorice et al., 2023 Rajala, 2018
Grounded Theory	Involves the construction of hypotheses and theories through the collecting and analysis of data using an inductive reasoning approach.	Hoffman et al., 2021b
Innovation Adoption Theory	Explains how and why people and organizations decide to adopt new ideas, products, or practices.	Wulfhorst et al., 2022
Life Course Framework	A way of understanding how people's health and well-being are shaped by different factors throughout their lives.	Hurst et al., 2017
Linear Mixed-Effects Model	Allows a researcher to examine the condition of interest while also considering variability within and across participants and items simultaneously.	Sorice et al., 2023
Logistic Regression Model	Statistical model that models the log-odds of an event as a linear combination of one or more independent variables.	Sorice et al., 2018
Minimalist Inductive Process-Tracing Approach	Systematic examination of diagnostic evidence selected and analyzed in light of research questions and hypotheses posed by the investigator.	Ayambire & Pittman, 2022

Modified Grounded Theory	A variation of grounded theory that is more systematic and concerned with coding and structuring qualitative data.	Wilmer et al., 2019
Multinomial Logit Models	A type of regression model that predicts the probability of each possible value of a categorical dependent variable.	Caldas et al., 2016
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 Rajala, 2018
Ordered-Logistic Regression Analyses	A statistical method used for modeling the relationship between predictor variables and the propensity to be in each higher ordered category.	Bergtold et al., 2022
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
Prospect Theory	Explains how people make decisions under risk, uncertainty, loss, and gain.	Wardropper et al., 2021
Protection Motivation Theory	Explains how people evaluate threats and decide whether to engage in protective behavior.	Rowen, 2023 Joshi et al., 2019
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 Parajuli et al., 2019 Dias & Belcher, 2015

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
Resilience Theory	Explains how and why people and organizations cope with and overcome challenges.	Twidwell et al., 2019
Risk Theory	Describes how people and organizations deal with uncertainty and potential harm.	Parajuli et al., 2019
Self-Perception Theory	Explains how people form their attitudes and beliefs by observing their own behavior and the context in which it occurs.	Lute et al., 2018
Social Capital Theory	Argues that social relationships are resources that can lead to the development and accumulation of human capital.	Jobes, 2019
Social–Ecological Systems (SES) Theory	Traces the parallel interactions between human systems (actors) and natural systems (resources).	Wilmer & Fernández-Giménez, 2016
Social Exchange Theory	Studies the social behavior in the interaction of two parties that implement a cost-benefit analysis to determine risks and benefits.	Jeffries et al., 2023 Joshi et al., 2019 Stroman and Kreuter, 2015 Toledo et al., 2014
Social Power Theory	Explains how people and organizations use and respond to different sources of power in social interactions and relationships.	Twidwell et al., 2019
Strengths Weaknesses	Strategic planning and management technique used to identify Strengths,	Biemiller, n.d.

Opportunities Threats (SWOT) Analysis	Weaknesses, Opportunities, and Threats related to business competition or project planning.	
State-Change Theory	Describes how people and organizations design and implement agreements, interventions, or reforms that involve conflicting interests or goals.	Wilcox et al., 2018
Technological Innovation Barrier Framework	Highlights key obstacles to innovation by emphasizing three factors that influence decisions on technological adoption: 1) technology characteristics, 2) organizational peculiarities, and 3) environmental factors.	Adhikari et al., 2023
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.	Rowen, 2023 Bendel et al., 2020 Coon et al., 2020 Rajala, 2018 Sliwinski et al., 2018
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 et al., 2021a
Value–Beliefs–Norm Theory	Emphasizes the impact of personal values, beliefs, and social norms on an individual's perception of risk and behavioral intentions.	Gruntorad et al., 2021 Joshi et al., 2019 Stroman and Kreuter, 2015

Appendix B. Summary of Current Research

Below is the full summary of the current social science of grassland management research submitted via Google form by social scientists who were invited to attend virtual discussion sessions in December 2023 and January 2024. The goals of these discussion sessions were to uncover past research that may have been missed for this literature review, summarize current research, and uncover future needs decision-making within grassland systems.

The participants were asked to title, to briefly summarize, and to list any links to current reports and have included the information submitted, in that format, below. The submitting person or organization has been included in parentheses.

1) Invasive Woody Plant Project (Ryan Roberts and Ashley Gramza, Playa Lakes Joint Venture)

The goal of this project is to develop an effective outreach model by integrating social science insights into targeted strategic communications that increase brush management and prescribed fire on rangelands; the model is being piloted within three focus areas each in Kansas and Oklahoma.

Link to invasive woody plant management:
https://pljv.org/docs/PLJV_Invasive_Woody_Plant_Social_Science_Review.pdf

2) Human Dimensions of North American Grassland Conservation (Callie Berman, University of Wyoming)

Current efforts to conserve grasslands remain limited due to an array of overlapping and multi-scale human factors implicated in governance and decision-making within each of these issues. The objective of this research is to assist in identifying policy and governance solutions to the interrelated challenges of grasslands conservation. This study aims to enhance existing conservation measures by highlighting areas of collaboration between private landowners and conservation program managers, as well as identifying paths for more efficient use of grassland resources.

3) Perceived benefits, barriers, and enabling conditions of ranch management planning across the Northern Great Plains (Clare Kazanski, The Nature Conservancy)

In this work, researchers at CSU and TNC surveyed "range cattle ranchers across 7 western states (CO, MT, ND, NE, NM, SD, WY) to assess their use of [ranch management plans], rancher

and operational characteristics associated with [ranch management plan] adoption, perceived benefits and outcomes of [ranch management plans], and rancher information needs and preferences related to [ranch management plans]."

There is one paper in review and another in prep resulting from this research. An initial report is available here:
https://www.researchgate.net/publication/359757038_Perceived_benefits_barriers_and_enabling_conditions_of_ranch_management_planning_across_the_Northern_Great_Plains

4) Priorities, needs, and motivations of ranchers for monitoring (Clare Kazanski, The Nature Conservancy)

In this work, researchers at JG Research and Evaluation (Bozeman, MT) and TNC explored rancher opinions and approaches to ranch monitoring. The purpose was to explore diverse rancher perspectives on the role that ranch monitoring currently plays, and the priorities, motivations, and barriers to expanding or enhancing monitoring activities. The team used a mixed-methods approach, including surveys, focus groups, and interviews. A final report summary and paper for peer-review publication are both in prep.

5) Metrics, Monitoring, and Management: Producer perspectives on informal and formal monitoring approaches to inform grazing management - (Ada Smith (and others - Hannah Gosnell, Jenny Hodbod, Ethan Gordon), Oregon State University)

There is a need to better understand the social dimensions of monitoring in grazing management, which, compared with technical issues and advancements, have received relatively little attention. In the 3M (Metrics, Monitoring, and Management) project, annual qualitative interviews are being conducted with 60 farmer/rancher participants in three US ecoregions (Michigan, Oklahoma/Texas, and Colorado/Wyoming) to understand if and how they use monitoring in grazing management and decision-making. Specifically, the interest lies in understanding what monitoring approaches—including both informal and formal techniques—provide meaningful feedback to producers and support adaptive and/or regenerative grazing management practices.

6) Enhancing Voluntary Grassland Conservation Programs: Insights from Logan and Gove County Kansas Landowners (Nellie Hill, Kansas State University)

The objectives of this project are to identify landowner barriers and motivations to participating in voluntary grassland conservation programs and practices in priority areas. Specifically, to

identify the economic, awareness, and structural barriers and what solutions would be ideal for these landowners. Interviews (completed) and focus groups (Spring 2023) are the methods of data collection.

This project is a collaborative effort within the Generational Grasslands project that is led by The Nature Conservancy and supported by conservation partners including PLJV, NRCS, Pheasants Forever, and the Kansas Grazing Lands Coalition. Results are being used to support TNC and Lesser Prairie Chicken Landowner Alliance policy change efforts related to conservation programs and payment for ecosystem services.

So far, a report is available upon request, and a journal article is in preparation.

7) Agri-environmental conservation incentives in a wildfire context (Jason Bergtold, Kansas State University) and Solar Power as a Mechanism to Strengthen Food Security, Rural Development, and Land Conservation

This project is examining the influence of wildfires and conservation programs on agricultural and marginal lands, as well as Conservation Reserve Program land use and management. Particular interest lies in wildfire perception, experiences and risk; role of payment for ecosystem services (PES) programs; and influence of wildfires and PES programs on land use and CRP choices and persistence. The region of study is Southern Great Plains. Interviews and surveys are being conducted with producers and land managers, as well as land uses analyses with an extensive geodatabase being developed. This is an NSF-Funded project with Audrey Joslin and Marcelus Caldas at Kansas State University.

The second project is examining support from rural Kansas residents for community solar and agrivoltaics in rural Kansas and across the Great Plains. Related to this project is suitability for solar power on marginal lands and CRP lands and willingness of land managers and producers to lease land for solar projects.

8) Improving the Retention and Uptake of Tillable Grazing Land in the Conservation Reserve Program: A Qualitative and Quantitative Analysis of Economic and Environmental Factors (University of Nebraska - Lincoln), Gwendwr Meredith and Timothy Pape - social science, Craig Allen and Mitch Stephenson - ecology, Simanti Banerjee and Elliott Dennis - agricultural economics

This Farm Service Agency funded project is aimed at understanding the potential for incorporating regenerative ranching practices within the Grassland CRP. Ranchers in MT, SD, and

ND identifying as regenerative (~25) were interviewed in Fall 2023. Based on ecosystem service benefits mentioned in interviews, ecological sampling of ~10 properties will occur in Summer 2024. A survey and profitability analysis will occur in Summer/Fall 2024. Interview questions addressed producers' definition of what constitutes regenerative ranching, management practices implemented for various ecosystem service benefits and related costs, perceived tangible and intangible benefits received from these regenerative ranching practices, and perceived tradeoffs.

9) TX Coastal Grasslands Restoration Incentive Program evaluation/participatory approach for Gulf Coast Joint Venture (Danielle Ross-Winslow, US Fish and Wildlife Service)

Participatory approach with project managers for the Texas Coastal Grasslands Restoration Incentive Program (C-GRIP) practitioners to design recommendations and practical tools that improve enrollment success, gather evidence of what works, and create feedback mechanisms for continued improvement and learning across the network of C-GRIP project managers and private lands biologists.

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