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Review

Barriers to Prescribed Fire in the US Great Plains, Part II: Critical Review of Presently Used and Potentially Expandable Solutions

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Abstract: This is the second paper of a two-part series on the barriers to prescribed fire use in the Great Plains of the USA. While the first part presented a systematic review of published papers on the barriers to prescribed fire use, specifically regarding perceptions and attitudes of land managers, this second part reviews the solutions that are employed to increase prescribed fire use by land managers in the Great Plains. First, the review compiled the solutions currently and ubiquitously employed to promote fire use and how they have been documented to address barriers. Second, potentially expandable solutions used in similar natural resource fields and communities were reviewed as possible solutions to the unaddressed aspects of remaining barriers that limit fire use.

Keywords: prescribed fire; prescribed burn association; socio-ecological

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1. Introduction

The first paper in this two-part series reviewed the known barriers to prescribed fire use in the Great Plains. The barriers were categorized as Social Perceptions (attitude, social norms, and risk), Conceptual Understanding, Technical Proficiency, Practical barriers (labor, equipment, changing landscapes, time, and economics), Policy, and Liability. While these barriers limit potential burners across a range of experience levels, the potential burner's attitude towards prescribed fire is the first hurdle to applying fire to the landscape.

Bronfenbrenner's ecological systems model [1] was originally developed to assess human development; its multileveled social systems approach to the influences that an individual might encounter is beneficial to understanding a variety of other topics in fields such as sustainability, economics, and health. Here, Bronfenbrenner's ecological systems model has been adapted to act as a framework for understanding the multi-scaled nature of barriers and how barriers at different scales impact a potential burner (Figure 1).

Barriers can extend across scales: for example, an individual could feel that their local community (microsystem), other potential fire practitioners (exosystem), and the other members of their state or country (macrosystem) have a negative perception of prescribed fire, which limits their own use of this land management tool. Alternatively, barriers can exist at individual levels such as a countywide burn ban (exosystem) limiting a potential fire practitioner. Understanding the scale at which a specific barrier occurs is imperative for selecting and applying effective solutions that address that barrier. Otherwise, intended

solutions risk being redundant or irrelevant if they fail to focus on the scale at which the barrier occurs.

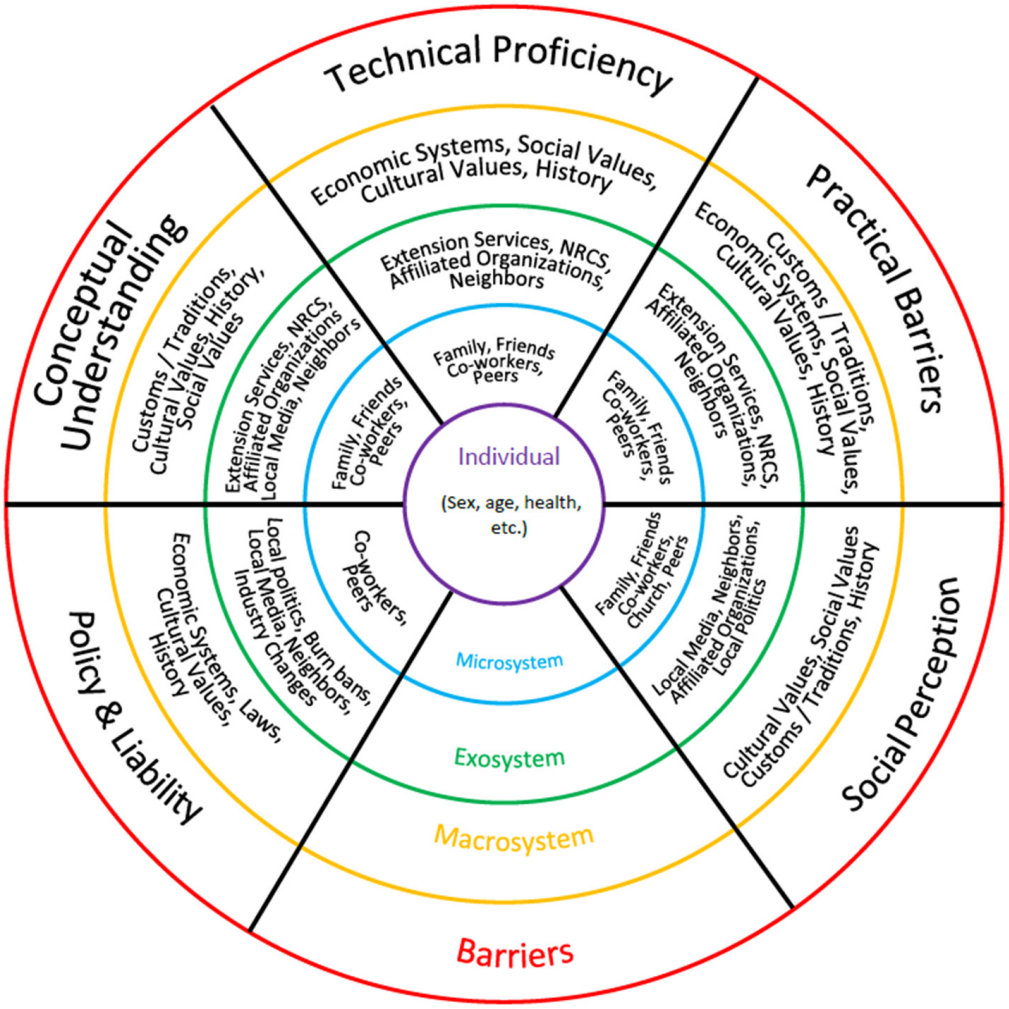

Figure 1. The adapted ecological systems model provides fire practitioners and researchers with a framework for understanding the multiple scales at which barriers to prescribed fire use occur. The microsystem represents the groups that most directly interact with and influence the individual. The exosystem represents the indirect community and industry of an individual. The macrosystem represents the history and values of the culture and country in which the individual exists.

The following literature review examines the more ubiquitously applied solutions that have successfully mitigated the impact of barriers on burners in the Great Plains. In addition, we reviewed topics and approaches with the potential to address barriers that have not yet been resolved and the potential to extend the reach of successful approaches with currently limited scopes.

2. Methods

This work was prompted by the systematic review conducted in the first article of this two-part series. While the systematic review provided initial insight into some of the ubiquitous solutions to barriers currently employed in the field of prescribed fire, it became clear that a broader view was necessary. To understand the solutions to barriers currently employed in the field of prescribed fire and to investigate solutions being applied in similar fields, we conducted a traditional literature review. Articles were located using Google Scholar, the North Dakota State University library, and Web of Science databases. Non-peer reviewed resources were located using Google.

3. Ubiquitous Solutions

The barriers to fire application described in the first part of this two-article review have begun to be addressed by fire practitioners and researchers. Here, we turn our focus to solutions that are actively being employed to address barriers to the use of prescribed fire. Specifically, engagement efforts, legal regulatory reform, and the development of fire organizations will be addressed in the following sections.

3.1. Engagement

Engagement efforts are opportunities for fire practitioners to disseminate information, engage in conversation, and provide hands-on experience to potential burners and fire officials. The three engagement types covered in this review are traditional efforts (workshops, demonstrations, trial plots), collaborative land management, and fire festivals. Research has shown that increasing engagement efforts can combat social perception, conceptual understanding, and technical proficiency barriers that can limit prescribed fire use.

3.1.1. Traditional Engagement

Workshops, demonstrations, and trial plots are manager-focused engagement opportunities that traditionally address elements of conceptual understanding and technical proficiency of prescribed fire. Workshops are provided sporadically based on land manager and agency interest. They are often organized and facilitated by state and federal land management agencies, extension, and non-governmental organizations [2–4].

Workshops can include demonstrations, often referred to as "learn and burn" sessions, but demonstrations can also be standalone events. They are a way for land managers to observe and potentially participate in the application of fire to gain further technical proficiency. Workshops and demonstrations provide an opportunity for bi-directional information exchange between land managers and hosting professionals [5].

Prescribed Fire Training Exchanges (TREX) training events include both workshops and demonstrations. They are a portion of the Fire Learning Network developed by The Nature Conservancy, US Forest Service, and other US Department of the Interior land management agencies that provide conceptual understanding and technical proficiency development, as well as opportunities for community building of event attendees [6].

Documentation that details how to host workshops have been produced so that interested parties can design and implement their own events [7]. Case reports that document workshop success and lessons learned provide useful insights for future fire practitioners as well [8,9]. Potential workshop hosts have an increasing variety of resources they can rely on to design successful events.

Demonstration sites and trial plots allow potential burners to see the impact of fire on their local landscape at various time intervals after the burns [10]. They illustrate fire effects on vegetation in settings such as prairies and pastures that are not often the focus of large media campaigns or coverage. They also help to alleviate an element of economic and ecological risk to the burner, as potential burners are able to view the outcomes of fire use without impacting available forage on their own land.

3.1.2. Collaborative Land Management

Collaboration between multiple stakeholder groups such as private land managers, researchers, state, and federal agents opens the door to group discussion, group learning, and group decision making. In the case of the Collaborative Adaptive Rangeland Management (CARM) project [11], stakeholders and researchers worked side by side to manage traditional plots and experimental plots. They conducted prescribed burns on experimental plots in three of the seven years included in this publication (2014, 2016, and 2017). The CARM project created a space where expertise and knowledge on both sides of the table could be shared and applied to the management practices.

This unique situation serves as a control for many of the barriers that are regularly listed by private land managers. The CARM project was conducted on federally owned

land, so the liability concerns were reduced. Operational risks, related to forage amount and economic loss, were non-existent. Additionally, practical barriers and technical proficiency needs were eclipsed by the size of the group, organizations the members represented, and the resources available. This presented a situation in which the greatest limitation placed on the decision to burn was the acceptance of burning by the group members.

While this unique approach provided solutions to legal and practical barriers for the group of private land managers, it only did so on a short-term basis. However, the opportunity to engage with prescribed fire could address long-term social perception, conceptual understanding, and technical proficiency barriers. Fire practitioners could replicate this model outside of Colorado in other areas where hesitancy related to perception and knowledge persists as a first step intervention.

3.1.3. Fire Festivals

Fire festivals are community events that promote the use of prescribed fire in conjunction with family-friendly activities [12]. Hosts of festivals partner with state and federal agencies, other conservation groups, and fire science organizations to provide educational programming. Festivals combat the barrier of conceptual understanding with these information sessions. Fire festivals often include demonstration burns. They increase technical proficiency by demonstrating fire application and welcoming potential burners in the community to handle burning tools and sometimes participate in the burn.

The unique strength of fire festivals lies in their community-wide reach. They are enticing events for the general public, and they help to develop cohesion in a community [13]. Festivals feature live music, food trucks, and family/youth-focused activities. The hosts work with local businesses and vendors and solicit volunteers from the area as well. The connection with the community from the start (local business participation) to finish (community members lighting demonstration fires) brings different groups into the conversation. It effectively brings the concept of "good fire" beyond land managers to the greater community. This larger community acceptance of prescribed fire can combat negative social perceptions and social norms in the broader general public regarding prescribed fire.

Fire festivals have currently primarily been held in the southeastern United States. Universities, extension, county government, non-governmental organizations (NGOs), and conservation cooperatives have worked together to host fire festivals throughout North Carolina, South Carolina, Georgia, and Florida since 2010 [14]. In contrast, community events such as fire festivals have not been hosted in the Great Plains, but fire practitioners in the region could consider a festival as a potentially positive introduction of fire to Plains communities currently unfamiliar with it.

3.2. Legal Regulations

As legal liability is the most commonly cited barrier to fire application, it has subsequently been the most actively addressed by fire practitioners to protect burning and burners. Specifically, policies have been introduced to train and protect burners, liability standard shifts have been promoted (and achieved in some states), and prescribed fire insurance has been made available for burners in some regions.

3.2.1. Policy

Certified prescribed burn manager (CPBM) programs are state-regulated training courses for people who want to apply prescribed fire on private land. Certified burner programs vary in existence and requirements from state to state. Fifteen states have active programs, four states are developing programs, and two states have legal authorization to do so but are not currently funded [15]. Some states incentivize enrollment in certified prescribed burn manager programs by offering reduced liability in the case of an escape for certified burn managers. Others offer CPBMs exemptions to burn during a burn ban or at times of the day or year when non-certified burners are prohibited from burning. For

example, in Florida, a certified burner would have a gross negligence standard applied in the case of an escape, whereas a non-certified burner would have a simple negligence standard applied [15].

While these state-regulated training programs do address conceptual understanding, technical proficiency, and policy and regulation barriers, they also require the investment of time and money of participants. However, researchers argue that in the case of certified burn manager training programs, reduced liability and increased opportunities to burn outweigh the costs for tests and classes [16,17].

Right to Burn acts or prescribed burning acts exist in many states across the nation to incentivize and promote the use of prescribed fire. Wonkka et al. [18] explain that in many states, these laws set standards and requirements in place that a burner would need to fulfill to qualify for reduced liability in the case of escape. These requirements can include needing a certified burn manager present, a written burn plan, and adherence to all other permitting and notification procedures as defined by other state laws [19].

3.2.2. Liability Shift

As the fear of liability looms over potential burners, prescribed fire liability research suggests that statutorily mandating courts apply lower liability (gross rather than simple negligence) when adjudicating cases of personal injury or property damage resulting from escaped prescribed fire or smoke is likely to encourage or increase the use of prescribed fire. Authors have suggested this change [20,21], and a survey of district court judges supports this [22]. In a review of prescribed fire use, states with less strict standards (gross negligence) burn more acres each year than those with more stringent liability standards (simple negligence) [18].

Lowering liability standards for certified prescribed burn managers is not ubiquitously supported as an effective solution in prescribed fire social science research. County commissioners in one study believed that a shift in liability would do little to change fire use perceptions, and reduced liability may lead to relaxed burn behaviors that ultimately result in a greater number of escapes [17,23,24]. Although other studies counter that if it incentivizes enrollment in certified burn manager programs, safety will ultimately be increased. In a recent publication by Kreuter et al. [25], they found that respondents did not feel that a shift in legal liability standards for applying prescribed fire would significantly affect their willingness to apply prescribed fire in the Southern Plains.

3.2.3. Insurance

Insurance policies designed to cover damages incurred by prescribed burners in the case of an escape have been made limitedly available in select southern states [21]. Yoder et al. [17] suggest that the availability of insurance could increase the use of prescribed fire by reducing the "cost" of liability from an escaped fire. However, Kreuter et al. [25] found that landowners in Texas and Oklahoma did not find that liability insurance affected their decision to apply prescribed fire. In addition to not impacting willingness to burn, prescribed fire insurance has apparently not been used by potential burners; Weir et al. [21] reported that when one insurance policy was made available to Oklahoma land managers in 2015, few policies were actually purchased.

While insurance policies have only been investigated in a small portion of the nation, the findings could partly reflect a solution–problem scale mismatch. Insurance policies are an exosystem scale solution (Figure 1), whereas barriers concerning policy and liability are microsystem scale barriers (Figure 1). This scale mismatch highlights a potential reason the solution was ultimately not successful in this setting and highlights the importance of appropriately scaled solutions for overcoming prescribed fire barriers.

3.3. Fire Organizations

We discuss two types of fire organizations: Prescribed Fire Councils and Prescribed Fire Associations. These organizations are invested in the promotion and application of

prescribed fire to landscapes across the nation. Here, we address the differing barriers addressed, management actions taken, and membership profiles of the organizations.

3.3.1. Prescribed Fire Councils

Prescribed fire councils (PFC) are organizations that consist of land managers, natural resource professionals, local politicians, and other community members who are interested in promoting prescribed fire use. PFCs operate at the state level and are associated with other state PFCs at the regional or national levels [26]. Bylaws of the national-level Coalition of Prescribed Fire Councils state that the mission of the Coalition is to facilitate the organization of state-level PFCs as well as to promote the appropriate use of prescribed fire [27].

As of 2019, 32 states across the U.S. have active PFCs [27] and their bylaws reflect the national desire to promote the safe and effective application of prescribed fire (Figure 2). Additionally, the state level councils can provide technical assistance, engage in outreach, and advocate politically on behalf of burners in their state [28]. For example, in Wyoming, the PFC engages in training fires as well as regular burns with the assistance of their members [29]. The latter is less common, as the primary barriers and activities undertaken by PFCs serve to increase conceptual understanding and reduce legal barriers. The varied activities of each state council reflect the flexibility and customization of the PFC framework to meet the needs of the local communities each PFC supports.

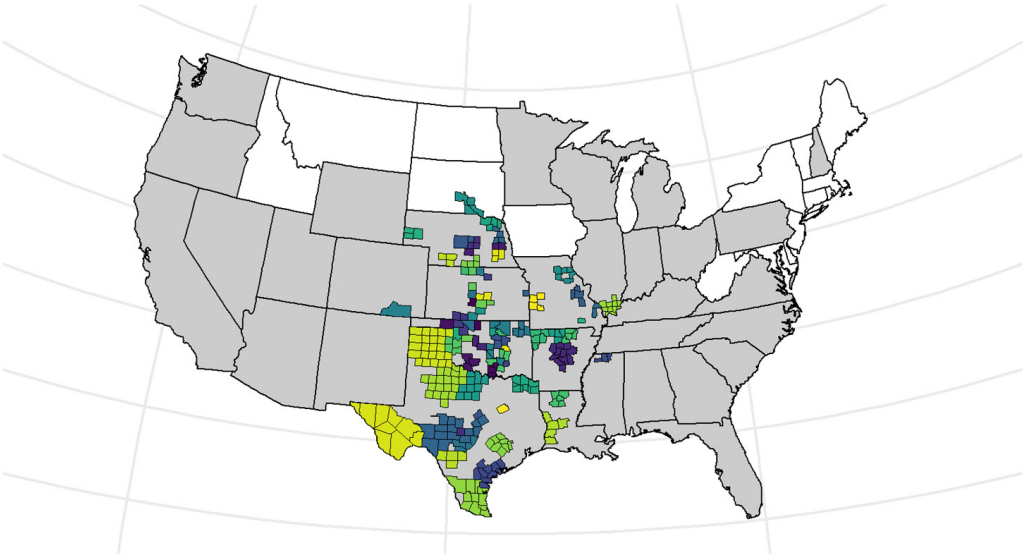

Figure 2. This map shows the 32 states with prescribed fire councils (PFCs). States that are gray have PFCs; those that are white do not. This map also shows known prescribed burn associations (PBAs) that are active in the counties of the Great Plains and adjacent regions. The colors do not indicate anything. This map is not intended to be used to identify specific PBAs so a legend is not included. A complete list of the PBAs presented here can be found in Table S1 in the Supplemental Materials. The Great Plains Fire Science Exchange website maintains an updated map of only PBAs across the country [30].

3.3.2. Prescribed Burn Associations

Prescribed burn associations (PBA) are coalitions of land managers who come together to share knowledge, equipment and labor to conduct prescribed fire [31]. The first PBA in the Great Plains was established in 1995 in Nebraska [32]. In 2015, 62 PBAs were active in the U.S. [33].

PBAs work to improve the conceptual understanding and technical proficiency of their members. They provide members with equipment and labor that can address the practical barriers to fire use. They work across multiple members' properties for larger-scale fires

that address the practical barrier created by fragmented landscapes. Some PBAs can even provide their members with liability insurance [21]. PBAs provide burners with social networks of other producers who actively use fire to manage their lands [32]. This enhances a potential burner's idea of burning being socially accepted in their communities. They also serve to promote a pro-fire culture that extends from one generation to the next, creating a legacy of fire use [32,34].

While both PBAs and PFCs are interested in the promotion of prescribed fire use, their differences go beyond the barriers they address. The organizational structure and development of the two fire organizations differ. PFCs operate at a state level and tend to reflect a top-down approach as they are often formed by academics and state/federal land managers. While this is common, it is not the rule; some PFCs are grassroots organizations that limit agency and academic influence [28]. Unlike PFCs, PBAs operate at an ecoregion or community level. PBAs are grassroots or ground-up organizations based at the landowner level. PBAs imply a pre-existing fire culture, as opposed to the desired development of one.

An arguable downside to both PFCs and PBAs is that they are often founded by, and kept in motion by, a strong leading member [31,35]. Only having a solo founder or leader can become a significant issue; if the organization loses that leading member, the organization can become inactive or cease to exist at all [36]. This weakness persists across organizations of many varieties in agriculture as a result of rural depopulation and changing land ownership motivation. This highlights the importance of involving and engaging many members of a community, so that leadership and enthusiasm for prescribed fire remains.

PBAs have widely been touted as the "silver bullet" to promote fire use, as they address many of the barriers that burners face. However, an important aspect that leads to development and keeps these organizations alive is a regional culture of fire. At the macrosystem scale, PBAs address practical and technical proficiency barriers, but that assumes a local fire culture exists at the microsystem and exosystem scales (Figure 1). This is not to say that PBAs cannot shift perceptions of fire towards acceptance, but at this time there is no evidence that they have done so. However, in regions where prescribed fire use is less socially accepted, PBAs have generally not been formed, as is the case in the Northern Great Plains (Figure 2).

4. Potentially Expandable Solutions to Barriers

This section of the review identifies solutions and interventions used in other agricultural and environmental fields that could be applied to increase prescribed fire acceptance and use in the Great Plains. Social marketing campaigns, diffusion of innovation, recognition and rewards, cost-sharing, and empowerment are presented along with the barriers they address.

4.1. Social Marketing Campaign

While marketing campaigns for or against fire (i.e., Smokey Bear) have been successful in the past, a targeted social marketing campaign could potentially promote the acceptance and use of prescribed fire. The concept of social marketing was first introduced by Kotler and Zaltman in 1971 [37]. Social marketing campaigns are not like advertising campaigns to encourage consumers to buy a product or service, but instead promote a concept that is beneficial to a community and attempt to go beyond knowledge exchange to behavioral change [38].

Social marketing starts by identifying the knowledge, behaviors, and beliefs of the intended audience. It then segments the audience into groups based on their shared beliefs. Then, targeted, value-laden interventions are developed, and a repetitive message is disseminated to audiences through various channels, in different media formats, and across multiple information sources [39]. A review of social marketing campaigns used to promote ocean conservation and sustainability efforts suggested that the social marketing campaign

is ideal for conservation because it integrates marketing concepts with approaches to social change [40]. There is just one catch: even if you do everything right, there is no guarantee of positive social change.

Current marketing efforts primarily serve to promote prescribed fire in forested landscapes to reduce hazardous wildfire fuels. Land managers and agency members in the Great Plains could extend this work to further and more publicly promote the other important ecosystem services that prescribed fire provides to prairie ecosystems. Social marketing has potential because natural resource professionals in the Great Plains (particularly the southern Great Plains) have a wealth of information regarding the target audience, their behaviors, and perceptions. This information could be used to develop agency- and region-wide materials that focus on the positive impacts of prescribed fire, while taking into consideration the local barriers to application. In the Great Plains, this could look like prairie and pasture images and production-specific statements, with wildlife and conservation elements. The key would be to have consistent and repetitive messages and imagery across all platforms.

As a portion of this marketing campaign, Smokey Bear could be repurposed to convey new management beliefs to the next generation. This idea was developed in a focus group of wildland–urban interface (where human development meets undeveloped land [41]) landowners, where participants stated that a change in fire spokesperson might cause mistrust [42]. While Smokey's original statements condemned all fire, his message has changed in recent years. The Smokey Bear Wildfire Prevention campaign website, smokeybear.com, now contains information on the benefits of prescribed fire use in forests. A national social marketing campaign featuring this well-known spokesperson could introduce prescribed fire benefits across diverse ecosystems to a new generation.

4.2. Applying Diffusion of Innovation Theory

Diffusion of innovation was formalized as a theory by Everett Rogers in 1962, following the synthesis of over 500 studies. Diffusion of innovation explains how, why, and at what rate innovation ideas and technologies spread in a community. Diffusion of innovation is a five-step decision-making process: awareness (exposure to innovation), persuasion (additional information on innovation), decision (accept or reject innovation), implementation (use of innovation), and then eventually adoption (continuation or rejection of innovation) [43]. Diffusion of innovation also posits that this diffusion reaches distinct groups at different times (Figure 3).

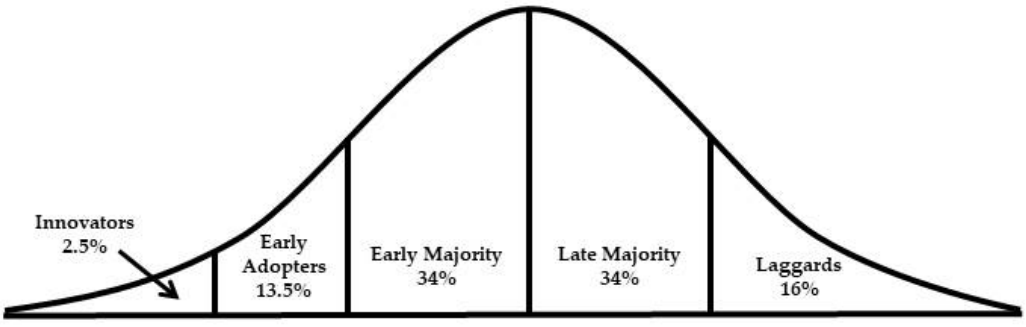

Figure 3. The distribution of the adoption of innovation by adopter group. Rogers assigned estimated percentages to each adopter group that are similar proportions in a bell curve; we present here a re-creation of the original figure presented in [44].

The first group to adopt a practice are innovators, the next are early adaptors, and the third are the early majority group, which takes a bit more time to accept a practice than the first two groups. This is followed by the late majority group that takes even longer to adopt a practice, and the last group are the laggards or those with the greatest aversion to change, thus they take the longest. These groups have distinct characteristics, and those characteristics influence the adoption process. Innovators are described as risk-takers with

a higher status in their community and have greater financial freedom and interaction with researchers [43], whereas majority members tend to be more risk-averse, with less flexible finances and rely on trusted colleagues in the industry. The laggards were described as skeptics who are interested in maintaining the status quo and traditional methods and are only interested in innovation if other alternatives are worse.

Studies of the spread of innovations and ideas across a community are not new in agricultural research. Extensive reviews of the diffusion of innovation in agricultural research have been previously compiled [45–49]. Some diffusion of innovation work has been carried out on rangelands that included but did not focus solely on prescribed fire [50]. In agriculture, a framework loosely reflecting the adoption of practice and diffusion of innovation has been developed called Reserves as Catalysts, designed to act as a roadmap for the transfer of conservation practices from public reserved land to private lands [51]. It has been applied to the Iowa-Missouri Grand River Grasslands to facilitate patch burn grazing on private lands in the region. This fire- and grassland-specific roadmap that makes use of conservation reserves has potential for widespread application.

While it was not designed or analyzed specifically using the diffusion of innovation framework, the development of the first PBA in the Southern Great Plains could be seen as a loose application of diffusion of innovation [31]. Dr. Charles Taylor acted as the innovator when he invited local land managers to see the effects of prescribed fire, and suggested they develop a land manager association to promote its use. That first group are arguably the early adopters, whose influence promoted the development of PBAs in other counties and states in the Southern Great Plains. This example of successful diffusion of innovation, specifically using prescribed fire, suggests it could be a successful approach to promote prescribed fire use in other portions of the Great Plains.

Federal, state, and local natural resource employees who regularly engage with members of the community addressing conservation and agriculture questions could identify local innovators and leaders who would be receptive to adoption. They could work with those local innovators to include prescribed fire in their management routine. Eventually, together, they could promote prescribed fire to others, starting diffusion within their community. The theory of diffusion could be complicated to orchestrate, as there are barriers within diffusion of innovation such as refusal by community members to ever adopt an idea, and homophily within innovators' direct contact groups. However, these are the realities of complex groups of individual actors in dynamic, multifaceted systems.

4.3. Recognition & Awards

From the late 1800s, early ideas in behavioral modification, such as Thorndike's Law of effect and B.F Skinner's operant conditioning, presented the concept that positive reinforcement, such as rewards and praise, increases a desired behavior. In addition to reinforcing personal behavior, public acknowledgment and praise are types of social recognition. Social recognition communicates an injunctive message, the perception of what is approved or disapproved of within a given culture [52].

Awards for stewardship are currently presented to rangeland managers from federal agencies, national organizations, and conservation trusts. Examples include the Bureau of Land Management's Rangeland and Sagebrush Steppe Stewardship Awards, which are presented to grazing lessees and collaboration teams. These awards recognize beneficial management practices and restoration efforts on public lands [53]. Another example is The National Cattlemen's Beef Association's Environmental Stewardship Award that is presented to a member who makes extraordinary efforts regarding stewardship and conservation while operating a profitable farm or ranch [54]. The announcement of this award recipient not only reinforces the behavior of that individual, but it also provides an opportunity to share ideas and examples of how real-life members of the community are implementing environmental change as a viable portion of their business.

Although researchers and resource managers cannot force or manufacture a pro-fire culture, they can work to engrain it into the pre-existing networks of the agricultural culture.

Reinforcement such as stewardship awards could positively reinforce conservation efforts. Recognition from respected organizations that hold sway in the agricultural community could reinforce desired behaviors such as the use of prescribed fire. An award along these lines from a trusted and valued organization that praises the use of fire and presents that praise to its members could begin to promote the social acceptance of fire use.

4.4. Cost Sharing

Federal and state agencies provide producers with an assortment of cost-share programs for a variety of crop and conservation initiatives. The Natural Resources Conservation Service (NRCS) offers Farm Bill programs such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP) that can offset the cost of conducting a burn [55,56]. State-level departments, such as Soil and Water Conservation Districts and Environmental Trusts, whose existence and function vary from state to state, may also provide funds for prescribed fire use. The Loess Canyons Rangeland Alliance in Nebraska has utilized funds from the US Fish and Wildlife Service (USFW), NRCS, Nebraska Game and Park, Natural Resources districts, and Nebraska Environmental trust to conduct burns in Nebraska [57,58]. These programs are prime examples of how cost-sharing can increase the use of fire on the Plains.

Cost-sharing for fire breaks and forage loss to increase the use of prescribed fire has been supported by respondents [20,25]. Cost-sharing initiatives could help to introduce or maintain burning practices at operations with less flexible monetary resources. While ranchers have stated that cost-sharing is a possible incentive that would result in an increase in burning, it likely would not be a successful first stage intervention. Cost-sharing would still require the rancher to invest their own money into prescribed burning. This investment would need to be precipitated by the perception that prescribed fire is an acceptable and beneficial management practice that the landowner was interested in practicing.

4.5. Empowerment

Empowerment has become a buzzword in the increasingly interdisciplinary field of conservation, and the oversimplification of this complex social concept has led to the incomplete application of the term to environmental efforts. Conservationists can be quick to claim empowerment of a community with an ambiguous definition and a lack of monitoring metrics or evidence to support the claim [59]. Empowerment is difficult to define or measure. Empowerment can mean different things to different stakeholders, it can occur at the individual and the community level, and it can be a process or an outcome [59].

There are distinct categories of empowerment, with some of the most prominent categories being economic, social, psychological, and political empowerment [60]. Achieved empowerment would consist of lasting economic gain to a community, maintained or enhanced community cohesion, increased self-esteem of community members, and a representative political system that is open to questions and concerns [60]. Potential Burners may likely be empowered by their participation in PBAs as suggested in the literature [23,31,32,36,61,62], but without any attempt to measure changes in power or capacity, it cannot be known for sure.

While empowerment in prescribed fire use can be defined across a variety of solutions to barriers, its present ambiguity can make it hard to evaluate successes over time. Presently, there has been no attempt to define, measure, or monitor empowerment in the case of prescribed fire use. Empowerment is critical to achieving long-term buy-in [63], so fire practitioners must work with stakeholders and interdisciplinary teams to co-develop a definition of empowerment among potential burners and determine monitorable goals to avoid potentially counterproductive outcomes.

5. Conclusions

While this review considers various potentially expandable solutions, it is by no means exhaustive. Future researchers could investigate additional solutions from other working landscapes or natural resource management fields to continue to address barriers. Additionally, information regarding solution application, actual impact on barriers, and adoption timelines from resource managers and researchers working in conjunction could help to address barriers and potentially increase prescribed fire use.

Before fire practitioners can offer producers escaped fire insurance, trailers full of drip torches and Nomex, or calls for the development of PBAs, the emotional components of fire aversion and acceptance must be addressed. Introducing emotional components during conceptual understanding activities such as workshops and demonstrations not only validates the emotional barriers or positive influences on decision making but plants the seed of an emotional rationale to burn as well.

Conservation is becoming increasingly interdisciplinary out of necessity. Rangelands are complex social-ecological systems, and as resource managers consider the reintroduction of fire to the landscape, the social elements of the system cannot be ignored, or reintroduction attempts may fail. Fire practitioners must look beyond traditional solutions to novel and innovative ones. As with many social-ecological systems, the complex problem of prescribed fire on rangelands with a variety of barriers may likely only be solved by the combination of many solutions.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land11091524/s1, Table S1: List of Prescribed Burn Associations in the Great Plains.

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