

Running Title: An assessment of structural themes associated with prescribed burn associations in the United States and their potential application to family forest landowners

**Prescribed Burn Associations in the United States:
The Potential Application to Family Forest Landowners**

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Abstract: Reintroducing fire to the landscape through prescribed burning has the potential to restore fire-dependent ecosystems, yet major barriers exist to its implementation. Prescribed burn associations (PBAs) are cooperative units of private landowners that pool resources to achieve scale that allows them to overcome barriers to burning. Currently most common among ranchers in the Great Plains, there is growing interest in the replication of PBAs to new regions and to the application of family forest (FF) landowners. However, there is a lack of literature that critically assesses the efficacy of PBAs as management units. This study identified major structural themes associated with the internal and external factors of PBAs in the United States, and analyzed interactions between those themes using a strengths, weaknesses, opportunities, and threats (SWOT) analysis framework. The Delphi process was applied to identify themes and build consensus among a panel of experts. All 17 participants successfully completed three iterative surveys, resulting in 29 themes across the four SWOT categories. The interactions between those themes identifies that ample opportunities exist for PBAs to enhance their strengths to gain access to opportunities and minimize threats, and reduce their weaknesses to seize opportunities and mitigate threats. The interactions between these themes should be utilized by practitioners and policy-makers to improve strategic planning outcomes. Themes should also be contextualized based on biophysical, socioeconomic, and demographic differences between ranchers in the Midwest and FF landowners elsewhere in the United States.

Keywords: family forest landowners, prescribed burn associations, landowner cooperatives, strategic planning, prescribed fire, SWOT analysis

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1. Introduction

Human and lightning ignited fire has played a significant role in shaping the structure and composition of the Western mixed conifer and pine forests (Agee, 1993; Evans et al., 2011; Sackett et al., 1992), Midwestern central grasslands (Anderson, 2006), and Eastern pine and oak woodlands (Arthur et al., 2012; Delcourt & Delcourt, 1997; Elliott & Vose, 2005; Glitzenstein et al., 1995) in North America. Varying in their fire return interval, fires have burned through ecosystems at different severities and intensities, resulting in ecosystems and vegetation that are adapted to fire (Ryan et al., 2013; Whelan, 1995). Decades of fire suppression policy in the United States has shifted the structure and composition of ecosystems favoring more mesophytic (generalist) tree species and associated forest types, increasing the amount of vegetative fuel, and consequently increasing the risk of catastrophic wildfires that threaten human well-being and property in the aforementioned forest types (Nowacki & Abrams, 2008; Stephens & Ruth, 2005). Reintroducing fire to the landscape through prescribed burning has the potential to restore fire-dependent species and ecosystems, decrease the threat of wildfires to human communities, and accomplish other ecosystem management and forestry goals. However, major barriers exist to its implementation (Brose et al., 2001; Sackett et al., 1992; USDA United States Forest Service: Southern Research Station, 2012).

Nationally, natural resource managers have reported barriers to implementing prescribed burning such as perceived risk (Twidwell et al., 2015; Yoder, 2004), liability and regulation (Wonkka et al., 2015; Yoder et al., 2003), narrow burn windows, lack of adequate personnel, inadequate funding (Evans et al., 2017; Melvin, 2015; Quinn-Davidson & Varner, 2012), state-level regulation relating to federal environmental laws such as the Clean Air Act and Clean Water Act (Haines & Cleaves, 1999), and negative public opinion (Haines et al., 2001). Furthermore, fragmented landownership poses an additional barrier to accomplishing broader landscape-level forestry and ecosystem management goals.

Family forest (FF) landowners own approximately 42.7% of all forestland of the conterminous United States, a significant proportion of the overall forestland in the country (Butler et al., 2016). FF landowners in the United States represent a diverse group of people that report a variety of reasons for owning their forestland, including mostly nonmarket values (e.g. beauty and scenery, biodiversity, protection of water resources) (Butler et al., 2016). Prescribed fire has the potential to help meet the diverse goals of FF landowners and many of these landowners are supportive of the practice (Busam & Evans, 2015; Butler et al., 2016). However most lack the financial, educational, and personnel-based resources needed to effectively implement a burn (Busam & Evans,

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2015). With increasing urbanization and the ongoing intergenerational land transfer in the United States, parcellation and fragmentation of FF landowner forestland is expected to increase into the future, exacerbating the barriers to prescribed burn implementation (Busam & Evans, 2015; Shifley & Moser, 2016; Wear & Greis, 2013). Previous studies have found that private landowner perceptions towards prescribed burns in the United States are shaped by level of knowledge, previous experience with fire, and perceptions of wildfire risk (Blanchard & Ryan, 2007; Busam & Evans, 2015; Fischer, 2011; Jarrett et al., 2009; Kreuter, Woodard et al., 2017; Morton et al., 2010).

Prescribed burn associations (PBAs) are cooperative units of private landowners that pool resources and labor to achieve scale that allows them to overcome the barriers associated with implementing prescribed burns (Taylor, 2005). As of 2017, there were 64 PBAs known in the United States, ranging across 10 states, two statewide burn associations (Texas and Oklahoma) and one regional alliance in the Great Plains (Diaz et al., 2016; North Carolina State University, 2018). PBAs take different structural forms, but all consist of members that work together to overcome barriers to prescribed burning by providing training, pooled equipment, and labor to apply burns safely, thereby decreasing risk and cost (Toledo et al., 2014; Weir, 2010). PBAs create peer-to-peer learning networks for burn implementation and education events, thereby increasing landowner social capital and increasing positive perceptions of prescribed fire (Toledo et al., 2012). In some cases, PBAs have obtained prescribed burn liability insurance plans for their members that allow them to cover their members, officers, directors, and technicians, thus further reducing the cost, liability and facilitating more ecological restoration of fire-dependent ecosystems and vegetative control (Toledo et al., 2012). While most common among ranchers in mid-western rangelands, there are PBAs working in forest ecosystems in the mid-western and eastern United States (Riechman et al., 2014; Sandhills Prescribed Burn Association, 2016). There is growing interest in applying this model to other regions of the country (Twidwell & Wonkka, 2016).

In support of the PBA model, previous studies have highlighted the value of forming prescribed burn associations in fire-dependent systems in the southern United States (Diaz et al., 2016). Other studies have identified the activities and needs of PBAs in the Great Plains (Weir et al., 2015), and effective communication strategies for increasing prescribed fire use with FF landowners (Fawcett & Busam, 2015). Riechman et al. (2014) utilized a participant-observer approach to highlight the challenges and motivations of a PBA in Illinois focused on FF landowners and oak woodland management. However, no study to-date has critically assessed the structural

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characteristics of PBAs as management units. This is a critical knowledge gap because understanding the internal and external factors associated with PBAs is important for assessing how they are performing and planning strategically for their replication in forested regions.

The primary objective of this study was to identify major structural themes associated with the strengths (positive internal factors), weaknesses (negative internal factors), opportunities (positive external factors), and threats (negative external factors) to PBAs in the United States. The tertiary objective was to assess major themes identified using a Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis framework to aid in PBA strategic planning and application of the PBA model to FF landowners.

2. Methods and Data Analysis

Originally developed by the RAND Corporation in the 1950's to guide military policy decisions and forecast likely events, the Delphi process elicits the opinions of a panel of experts through a series of sequential questionnaires that are interspersed over a finite period of time with feedback derived from respondents during the process (Brown, 1968). The Delphi Process replaces direct confrontation and debate to achieve consensus, with the underlying assumptions that through repeated measurements the range of participant responses will converge towards the midrange and that the total group response will move towards the "correct" answer over time (Jolson & Rossow, 1971). Selecting 10-15 highly knowledgeable and experienced participants is generally recommended for most topics (Hsu & Sandford, 2007). The Delphi process has been applied to a variety of natural resource topics including urban forestry research and technology transfer needs, forestry research planning for the USDA Forest Service, innovations in recreation management, and understanding forest landowners cooperatives in the United States (Blinn et al., 2007; Gregersen et al., 1989; Schneider et al., 1993; Wolf & Kruger, 2010).

This study applies the Delphi process to identify structural themes associated with the strengths, weaknesses, opportunities, and threats of PBAs in the United States (Brown, 1968). A panel of experts was identified during the fall of 2017 using snowball sampling by 1) identifying potential participants from the literature and through professional and academic networks and 2) asking initial participants to review a list of potential participants and provide referrals to key stakeholders not yet identified. Participants in this study represented a diverse geographic range and held diverse backgrounds and affiliations, though most were concentrated in the Midwestern Great Plains region of the United States. Three participants were from the East Coast (FL and NC) and

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one participant was from the West Coast (CA). Participants were concentrated geographically in the Midwest because this is where most PBAs are located, and therefore where people with the most experience and knowledge on the topic are. While the grassland ecosystems of the Great Plains are considered fire adapted, the predominant ecoregions of the Eastern and Western United States are also substantially composed of fire-dependent ecosystems (Anderson, 2006; Ryan et al., 2013).

A series of three sequential questionnaires were then administered to the “expert” participants through a web-based Qualtrics survey (Qualtrics, Provo, UT). The first questionnaire consisted of four questions with open-ended text response asking participants to identify major themes associated with the strengths, weaknesses, opportunities, and threats to PBAs. Responses from the first questionnaire were exported from Qualtrics into an Excel spreadsheet and manually coded based on common themes. The second questionnaire asked participants to identify which of the themes from the first questionnaire they would consider “important”. Participants could deem as many of themes important as they wished. Themes that were identified as “important” by at least 50 percent of the participants (9 of 17) during the second questionnaire were then utilized in the third questionnaire, while those identified as “not important” were discarded. In the third questionnaire, participants were asked to rank the relative importance of each of the “important” themes from the second questionnaire on a 4-point Likert scale (1=not important, 4=very important). Participants were also asked to identify which of the themes in each category they considered to be “most important”. Consensus was considered reached on the importance of a theme when at least 50 percent of participants (9 of 17) ranked a theme with a value of 3 or 4.

Major themes that were identified through the Delphi participants were then summarized using a strengths, weaknesses, opportunities, and threats (SWOT) analysis. SWOT analysis is a well-respected tool for strategic planning that works to address complex situations by reducing the quantity of information and improving decision-making (Helms & Nixon, 2010). Similar to Blinn et al. (2007), themes identified from the Delphi process were further analyzed based on a strength-opportunities analysis, strength-threats analysis, weaknesses-opportunities analysis, and weaknesses-threats analysis (Blinn et al., 2007). Essentially, PBAs were assessed based on their ability to leverage strengths to realize new opportunities and counteract threats, and to understand how weaknesses can be improved to facilitate progress towards opportunities and minimize threats. Social network mapping was also performed using Gephi software to visualize and understand the interactions between the internal and external

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structural themes conceptually (see Figure 1) (Bastian et al., 2009). The size of nodes in the social network were weighted based on the percentage of participants who agreed on the relative importance of each theme. The directionality of edges and their connections was performed subjectively by the author based on professional experience and participant feedback.

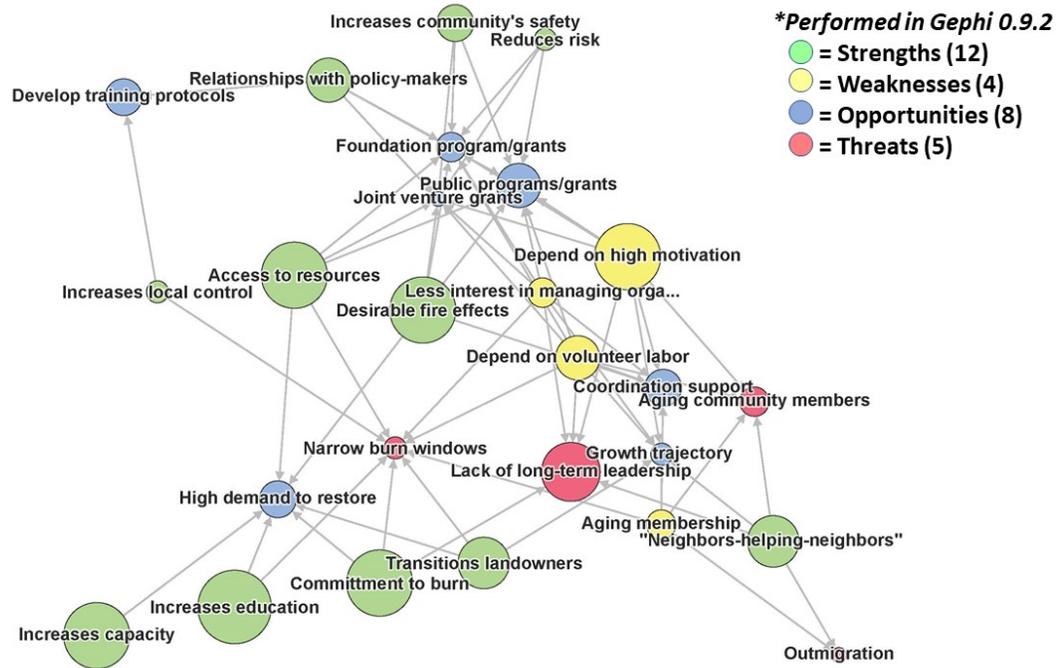


Figure 1: Social network mapping of structural themes associated with PBAs (Yifan Hu algorithm). The size of the nodes corresponds to percentage of respondents who agreed on the importance of a theme and the connecting arrows (edges) between nodes was based on a qualitative assessment by the authors. The direction of arrows is based on internal to external factors. Themes that had no connection were discarded from the social network.

All 17 participants successfully completed each round of questionnaires, resulting in a 100 percent response rate. In the first questionnaire, coding of the participant’s open-ended text responses resulted in 86 themes across the four SWOT categories (see Appendix 1). The proportionately lower number of themes identified for the “opportunities” category is consistent with findings from similar studies that utilize the Delphi process (Blinn et al., 2007). Emergent themes from round one were then narrowed to a total of 31 “important” themes in round two including 12 strengths, 4 weaknesses, 8 opportunities, and 7 threats. Finally, those themes were further narrowed to 29 themes in round three when participants ranked each theme on a 1-4 Likert scale, resulting in 12 strengths, 4 weaknesses, 8 opportunities, and 7 threats (see Table 1). The percentage of participants who felt a theme was the “most important” for each category was also summarized in a separate column (see Table 1).

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Table 1: Results from final round of the Delphi process. Consensus was considered reached on the importance of a theme based on a ranking of either 3 or 4 on a 1-4 Likert scale by at least 50 percent of participants. Participants also identified which of the themes they believed was the most important for each SWOT category.

Themes:	Percentage who agree the theme is "important" (3 or 4 on 1-4 Likert scale)	Percentage who believe theme is "most important" for given category
Strengths		
Increases the education, training, experience, and skill-set of landowners	100%	47%
Increases landowner access to resources	94%	18%
Increases capacity to implement burns at larger scales	94%	18%
Increases landowners' willingness/commitment to burn their land	94%	12%
Achieves desirable fire effects on the environment when they implement burns	94%	0%
"Neighbors-helping-neighbors" reaches rural landowners and resonates with past histories	82%	6%
Transitions landowners from "interested" parties to "active" burners/managers of their land	82%	0%
Builds good relationships with policy-makers	76%	0%
Increases the community's safety to wildfires	71%	0%
Overcomes negative public opinion of fire by spreading a "good fire message"	65%	0%
Reduces the risk of escape fire during prescribed burning	59%	0%
Local control increases responsiveness to local problems and potential success	59%	0%
Weaknesses		
Depend on high levels of interest, dedication, and motivation among members	94%	47%
Dependence on volunteer labor and leadership	76%	18%
The age of participants	65%	12%
Landowners are interested in betting burns done, but less interested in managing the organization	65%	24%
Opportunities		
Programs/grants from public agencies	76%	6%
Coordination support is available from other interested parties	71%	24%
High demand to restore fire-dependent ecosystems	71%	18%
Develop training protocols that are more appropriate to private landowners	71%	18%
Programs/grants from institutional foundations and other nonprofits	65%	0%
Surplus equipment available from State Forestry/Rural Fire program	65%	0%
Growth trajectory into nationwide umbrella organization and/or multiple regional organizations that support PBAs	59%	35%

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Joint venture grants	53%	0%
Threats		
Lack of long-term leadership and coordination	88%	47%
Aging members will be less physically capable of implementing burns	65%	6%
Lack of annual burn days - narrow burn windows	59%	18%
Increase in land fragmentation and parcellation	59%	12%
Less people in rural areas available to participate	53%	0%
Perceived liability and risk issues	47%	12%
Lack of short-term and long-term funding	35%	6%

3. Results

Themes that emerged among participants in this study illustrate structural characteristics associated with PBAs as management units and provide insight into their management strategy and potential for replication to new regions. The highest number of themes identified and ranked by participants were associated with the strengths of PBAs (see Table 1). Participants identified many positive internal attributes of PBAs relating to their benefits to members of the association (e.g. increased capacity), benefits in achieving positive environmental and social impact (e.g. desired fire effects), and the sociopolitical benefits of PBAs to communities (e.g. improved relationships with policy-makers) (see Table 1).

Several weaknesses were identified in round one, but only four themes emerged by the end of round three. The final emergent themes related to PBAs lack of ability to effectively manage themselves and to attract and retain new members to their organizations (Table 1). The number of themes identified as weaknesses of PBAs was significantly lower than the other four categories in the SWOT analysis (see Table 1). This may be due to a lack of self-scrutinizing by participants who are actively involved with PBAs.

Several external factors associated with opportunities for PBAs were identified by participants relating to the availability of financial support, coordination support, and access to resources (see Table 1). Findings suggest that there is currently a high demand in some regions to restore fire-dependent ecosystems, and programs in place to help PBAs increase their scale to meet that demand (see Table 1). There are also opportunities for PBA members to improve the quality of policy and management relating to prescribed burning, making them more appropriate to small private landowners (see Table 1).

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Negative external factors relating to the environments in which PBAs function threaten their successful formation and longevity. Dominant threats identified by Delphi participants related to the effects of urbanization and outmigration from communities, lack of social cohesion and capital, and challenges in achieving scale due to land consolidation (see Table 1). Logistical challenges such as narrow burn windows and limited annual burn days, also inhibit the ability of PBAs to get burns accomplished and achieve desired impacts (see Table 1). Perceived liability and risk issues and a lack of funding were identified in round two as being “important” threats, but they were not ranked as being important in the final Delphi round.

Important themes were identified among Delphi participants relating to the internal and external characteristics of PBAs. The largest number of themes emerged relating to strengths, indicating that PBAs are working well in many regions, and have a large portfolio of successes to choose from when counteracting negative forces (see Table 1). Many of the emergent themes across SWOT categories include technical factors (e.g. “access to resources” or “high demand”), but many were inherently social (e.g. “neighbors-helping-neighbors” or “lack of community leadership”) (see Table 1). This indicates that if PBAs are going to increase or enhance their strengths to gain access to opportunities, they need to understand the weaknesses and threats which impede them in the context of the complex social-ecological networks in which they operate, and not merely render the solution technical.

4. Discussion

This study identified major structural themes associated with the strengths (positive internal factors), weaknesses (negative internal factors), opportunities (positive external factors), and threats (negative external factors) to PBAs in the United States, and assessed major themes using a SWOT analysis framework (see Table 1). Dominant themes emerged among Delphi participants that relate to the four SWOT categories and can be used to improve PBA strategic planning and the application of the PBA model to FF landowners. Additionally, the interactions between those internal and external themes provides insight onto how PBAs can navigate complex social-ecological networks to improve their successes and growth (see Figure 1).

4.1 Comparing Internal to External Factors

Comparing internal factors to external factors using a SWOT analysis framework illustrates how the organizational units of PBAs can utilize their strengths to gain access to opportunities and counteract threats, and

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how their weaknesses can be reduced to realize opportunities and minimize the impact of threats (Blinn et al., 2007). This can help PBAs think critically about their management strategy and decide where to concentrate limited resources on growth opportunities, thus improving their strategic planning and ability to replicate to new regions.

PBAs should embrace situations where their strengths correspond to opportunities. One of the major strengths of PBAs that emerged from this study, is that they achieve positive social and environmental impact in the places they operate (see Figure 1). These impacts include achieving desired fire effects on the ground and increasing the community's safety to wildfire (see Figure 1). PBAs have an opportunity to better articulate these positive impacts to the general public and potential donors to gain access to the financial services available to them from sources such as public agencies, institutional foundations, and other nonprofits (see Figure 1). Delphi participants identified that such funding is indeed available, and represents a significant opportunity for PBAs (see Figure 1). Previous studies have found that securing funding is a major constraint to PBAs, suggesting that while funding is available, PBAs may not be communicating their achievements adequately enough to gain access to the funding (Riechman et al., 2014).

Additionally, Delphi participants identified the ability of PBAs to burn at scale as a significant strength, and the increasing demand to restore fire-dependent ecosystems as a significant opportunity (see Figure 1). As society becomes more aware of the ecological role of fire and the benefits associated with using prescribed burning to restore fire-dependent ecosystems, PBAs are strategically positioned to provide the supply of landowners that are willing and equipped to implement burns. The existing scholarship on PBAs supports the claim that PBAs provide an avenue for using prescribed fire at larger landscape scales (Taylor, 2005; Toledo et al., 2014). PBAs can utilize their ability to burn at scales larger than the individual landowner to effectively apply burns to larger acreages and meet what is a sensed increasing demand.

External threats to PBAs can be effectively counteracted by utilizing strengths that increase their ability to resist or overcome threats. The “neighbors-helping-neighbors” approach that PBAs take to implementing prescribed burns collaboratively, appears to resonate with rural landowners and their shared histories (see Figure 1). This study suggests that by articulating and embracing their collaborative approach, PBAs can maintain strong social networks that help overcome a lack of community engagement and leadership (see Figure 1). Overcoming social constraints and obstacles to burning has been identified by other authors as a significant barrier to the application of prescribed

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fire among private landowners (Riechman et al., 2014; Twidwell et al., 2013). Previous literature on PBAs and social exchange theory (SET) illustrates that such peer-to-peer social networks have the potential to increase social capital and social cohesion in rural communities, thus facilitating more adoption of prescribed fire and benefits to the community at large (Cropanzano & Mitchell, 2005; Toledo et al., 2014).

The overdependence of PBAs on volunteer labor is a potentially major weakness of the PBA model, and could undermine their ability to implement burns and sustain themselves long-term (see Figure 1). PBAs can overcome this weakness by embracing the opportunity to collaborate in cross-scale partnerships with federal agencies or nonprofit organizations (see Figure 1). Existing literature suggests that such larger entities may be better equipped to handle the logistics, development (e.g. grant-writing), and overhead necessary for sustaining a PBA as a viable organization (Diaz et al., 2016; Riechman et al., 2014; Twidwell & Wonkka, 2016). Delphi participants identified aging membership as another potential weakness to PBAs (see Figure 1). This study suggests that aging membership on a local level can be overcome by embracing and continuing PBA's current growth trajectory into larger regional and national umbrella organizations to gain more access to leadership, support, and personnel (see Figure 1). Functional linkages between local level PBAs, and larger regional networks, have been identified in the literature as a means for addressing such challenges that cannot be overcome by an individual PBA (Twidwell & Wonkka, 2016).

Situations where internal weaknesses correspond to external threats should be considered detrimental to the longevity of a PBA. Ultimately, PBAs that have high numbers of aging members within the organization and exist in regions with high levels of outmigration and an aging population in the community, may not be sustainable long-term (see Figure 1). This finding is consistent with Weir et al. (2015), where authors identified the recruitment of new members as a top need for PBAs (Weir et al., 2015). Additionally, many PBAs lack strong leadership and coordination within the organization (see Figure 1). This weakness is exacerbated by the threat of narrow burn windows and limited annual burn days (see Figure 1). Without strong leadership and structure, PBAs may not be able to assemble necessary personnel and equipment to implement burn operations with short notice. These findings are supported in the literature as a challenge for PBAs (Twidwell & Wonkka, 2016; Weir et al., 2015)

4.2 Applications to Family Forest Landowners

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There is reason to believe that the PBA model has applications for engaging FF landowners throughout the United States, yet we need to further understand what the limitations are to its replication (Diaz et al., 2016; Riechman et al., 2014; Twidwell & Wonkka, 2016). The ability of PBAs to maximize positive factors and minimize negative factors identified in the SWOT analysis of this study may be complicated by biophysical differences between the grassland ecosystems of the Great Plains and the broadleaf forests of the western and eastern United States (Anderson, 2006; Ryan et al., 2013). For instance, differences in fuel type and fuel loading may influence the level of perceived risk to burning, thus decrease the magnitude of some of the strengths associated with PBAs (e.g. increased safety to wildfires) and increase the magnitude of some of the threats (e.g. perceived liability and risk issues) (see Figure 1). In the Great Plains fire is typically used to restore grassland ecosystems and improve forage for cattle by controlling invasive woody vegetation such as juniper (*Juniperus* spp.) trees, whereas in the eastern United States practitioners typically use prescribed fire as a tool for restoring fire-dependent systems and accomplishing silvicultural objectives (Little & Moore, 1949; Taylor, 2005; Toledo et al., 2012; USDA United States Forest Service: Southern Research Station, 2012). These fundamental differences may ultimately influence FF landowner behavior differently than ranchers.

The interactions between themes identified in the SWOT analysis of this study may be further complicated by socioeconomic and demographic difference between ranchers and FF landowners regarding their adoption of prescribed fire and participation in PBAs. For example, the opportunity for external funding identified in this study may be less available to FF landowners in some regions of the eastern United States compared to the Midwest, thus decreasing the ability of PBAs to gain access resources and achieve desired fire effects (see Figure 1). Ranchers have a direct financial motivation for prescribed burning and participating in a PBA, as it is a more cost-effective means to control woody vegetation and improve the quality of forage for livestock (Taylor, 2005). The literature suggests that FF landowners mostly own their forestland for the nonmonetary, amenity values it poses, therefore the financial motivation to participate in a PBA may be less convincing for this demographic (Butler et al., 2016). We also know that FF landowners differ with regards to their previous experience and interest in prescribed burning across the landscape, with a higher proportion of FF landowners in the South who have experience with burning, and are planning to burn in the future, than those in the North (Butler et al., 2016).

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The feasibility of forming a PBA in a given community and the services a PBA provides, may also be influenced by social-ecological factors within a community such as existing knowledge on the ecological role of fire, sharing a common vision, and previous experience with prescribed fire (Piatek & McGill, 2009; Riechman et al., 2014). Previous studies have found that PBAs flourish in regions where landowners share a common land ethic and where the application of prescribed fire is accepted by the general public (Riechman et al., 2014). If such factors are not already in place, as they may not be in many regions dominated by FF landowners, PBAs may need to focus more on education, outreach, and capacity building before they actually begin implementing burns.

5. Conclusion

To ensure the sustainability of current PBAs and promote their formation to new regions and new types of landowners, we need to understand how to maximize the positive factors and minimize the negative factors associated with them. This study identified emergent themes associated with the strengths, weaknesses, opportunities, and threats of PBAs across the country (see Table 1) and identified significant interactions between those themes in the SWOT analysis framework and visualized them in social network mapping (see Figure 1). The interactions between these themes should be utilized by practitioners and policy-makers to improve strategic planning outcomes and focus the attention of programs and initiatives surrounding PBAs. While useful, the themes from this study need to be further contextualized based on differences between Midwestern landowners and FF landowners elsewhere in the country, to truly understand PBA adoption and replication potential. Additionally, we need to further understand the nuances between different typologies of landowners in a given region regarding their interest and willingness to participate in the cooperative enterprise of a PBA.

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Appendix 1: Themes identified from the first questionnaire of the Delphi process.

Strengths	Weaknesses	Opportunities	Threats
Increases landowner access to resources (tools, personnel, funding)	Do not work in every region (state liability standards, landowner willingness to participate)	Coordination support is available from other interested parties (cooperative extension, volunteer fire departments, nonprofits, public agencies)	Resistance to forming in new regions (landowner support, state regulation/liability standards)
Expands liability protection to burners and landowners (limited liability from state)	Depend on high levels of interest, dedication, and motivation among members	Growth trajectory into nationwide umbrella organization and/or multiple regional organizations that support PBAs	Less people in rural areas available to participate (land consolidation, urbanization, aging populations)
Increases landowner access to education and training	Some PBAs perceive a limited number of annual burn days	High demand to restore fire-dependent ecosystems (land available, landowners willing, habitat needs)	Long distances between people living in rural regions leads to difficulty coordinating
Increases flexibility for burning	Evolving and changing within PBA can be difficult	High demand among volunteer fire departments for help with "non-bunker gear" activities (e.g. patrol)	Lack of broader public support (anti-fire norms, insular messaging)
Increases partnership between public agencies and private landowners	Dependence on volunteer labor and leadership	Unrealized opportunities to address prescribed burning issues overall (legal and educational)	Lack of short-term and long-term funding
Increases social networks between private landowners (friendships, bonds, trust, help)	Some lack professional coordination and leadership (e.g. fundraising, communication between PBAs, burn scheduling)	Programs/grants from public agencies (NRCS, USFWS)	Lack of overarching umbrella organization for PBAs
Increases control and empowerment for private landowners	"Too close to the situation" to be knowledgeable about what they're doing	Programs/grants from institutional foundations and other nonprofits (e.g. the Nature Conservancy)	Aging members will be less physically capable of implementing burns
Increases capacity to implement burns at larger scales (more acreage/number annual burns)	Past personal interactions between members affects group dynamics	Joint venture grants	Increased air quality issues as result on increased burning
Lowers costs for implementing burns	Lack of experience and training among members	Surplus equipment available from State Forestry/Rural Fire program	Breakdown in cohesion between participants (public agencies, private landowners, environmental regulators)
"Neighbors-helping-neighbors" reaches rural landowners and resonates with past histories	Failure to convince "anti-fire" public that prescribed fire is different than wildfire	Support from local equipment companies and funds	Lack of long-term leadership and coordination (fundraising, burning, training)
Increases landowners' willingness/commitment to burn their land	New burners spend money on unnecessary things	Financial support from cooperative extension	Increase in out-of-state hunters and absentee residents who are less interested in burning
Increases the capacity of local county government	The age of participants	Develop training protocols other than NWCG that are more appropriate to private landowners in PBA	Laws and regulations about prescribed fire use that misunderstand ecological role of fire

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Increases the experience and skillset of private landowners to burn implementation	Can be socially insular (clique)	Engage in other land management activities	Issues with smoke management
Increases the community's safety to wildfires	Some members have strong egos	Increased national-level awareness of fire	Perceived liability and risk issues (lack of insurance, low incomes among practitioners)
Reduces the risk of escape fire during prescribed burning	Landowners are interested in betting burns done, but less interested in managing the organization	Development of national wildfire plan/policies that align with diverse commodities and ecosystem services	Lack of annual burn days - narrow burn windows
Increases training opportunities for volunteer firefighters	Depend on leadership from area resource managers (wildlife agencies, state forestry agencies, NRCS, nonprofits) to train and mentor	Society increasingly desires to conserve fire-dependent resources	Trend towards people hiring out burns rather than implementing through a PBA
Builds good relationships with policy-makers (county officials, state representatives, and senators)	Hesitance for members to continue paying dues		Lack of support from federal agencies other than NRCS
Transitions landowners from "interested" parties to "active" burners/managers of their land	Fear among landowners that they will lose control over what happens on their land- PBA will dictate too much		Lack of time and resources among supporting organizations (public agencies, other nonprofits, cooperative extension)
Helps people accomplish common goals	Federally qualified burn bosses overstep their bounds by trying to impart NWCG value system on PBA members		Lack of institutional knowledge within PBA and ability to pass to next generation
Increases the sharing between community members (time, knowledge, energy, resources)	NWCG affiliated burners are at legal risk when burning on private land		Lack of social values supporting ecosystem health
Promotes natural leaders to take on leadership roles	PBAs with less skilled members have increased risk when burning		Increase in land fragmentation and parcellation
Overcomes negative public opinion of fire by spreading a "good fire message"	Lack of a political voice locally and statewide		Loss of private property rights
Increases unity and sense of purpose among community members for combating a common threat	Do not adequately communicate with volunteer fire departments		Financial interests in continuing to promote fire suppression policy
Local control increases responsiveness to local problems and potential success	Lack alignment with national fire priorities		Increases in litigations
Increases support and assistance to landowners from local fire control authorities	Are more "reactive" than "preventative" to problems (burn to reduce fuel loading once encroachment has already occurred rather		No insurance available for burn schools

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	than restoring fire regime)		
Change local laws pertaining to prescribed fire use	Uncertainty regarding how to adapt current land management systems (e.g. livestock production) to prescribed fire		Development and infrastructure (e.g. energy development or urban development) in areas where PBAs are managing with fire