

Perceptions of Texas Landowners Regarding Fire and Its Use

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Abstract

Growing recognition that periodic fire is critical for maintaining the health of many rangeland ecosystems and concerns over more frequent catastrophic wildfires have focused attention on prescribed fire as an ecosystem restoration and fuel management tool. In states such as Texas, where most land is privately owned, the level of success of outreach activities aimed at expanding the adoption of specific management practices is influenced by the extent to which landowners' perceptions, interests, and concerns regarding such practices are addressed. This is particularly important for prescribed fire, which has been perceived by many landowners to be a dangerous or wasteful practice. Here we report the results of a mail survey of 185 members of the Edwards Plateau Prescribed Burn Association (EPPBA) and a random sample of 600 nonmember rural landowners in four counties in the Edwards Plateau and two counties in the Rolling Plains ecoregions of Texas. The overall response rate was 46.6%. Primary reasons respondents did not apply fire on their land were insufficient resources, legal concerns, and lack of assistance with burn plan development. EPPBA members had more positive attitudes than nonmembers about the ecological role of fire and the use of prescribed fire. Our study suggests that adoption of prescribed burning as an integral part of land management plans by private landowners could be expanded by forming new prescribed burning associations. The EPPBA model for such associations provides learning opportunities that are consistent with adult learning and innovation adoption principles. It facilitates fire safety training, reduces concerns over legal liability associated with fire ignition, and enhances access to shared fire management equipment and labor on burn days. The two-tiered structure of the EPPBA with some form of state-level representation appears to be an efficient organizational structure for these associations.

Resumen

El reconocimiento cada vez mayor que el fuego periódico es crítico para mantener la salud de muchos ecosistemas de pastizales y las preocupaciones sobre los fuegos silvestres catastróficos más frecuentes ha enfocado la atención en los fuegos prescritos como una herramienta en la restauración de un ecosistema y el manejo de combustible. En estados, tales como Texas, donde la mayoría de la tierra es propiedad privada, el nivel de éxito de las actividades de sobrepasar los objetivos en ampliar la adopción de específicas prácticas de manejo esta influenciado por el grado de las percepciones, los intereses, y las preocupaciones de los propietarios con respecto a las direcciones de dichas practicas. Esto es importante particularmente para el fuego prescrito, el cual ha sido percibido por muchos propietarios de tierras como una práctica peligrosa o costosa. Aquí nosotros mostramos los resultados de una encuesta por correo de 185 miembros de la Asociación de Quema Prescrita del Edwards Plateau (EPPBA) y una muestra al aleatoria de 600 propietarios tierras rurales no miembros en cuatro condados en el Edwards Plateau y dos condados de los Rolling Plains de Texas. La tasa de la respuesta total fue de 46.6%. Las razones de los encuestados de no aplicar fuegos en sus tierras fueron recursos insuficientes, preocupaciones legales y la falta de asistencia con el desarrollo del plan de quema. Los miembros de la EPPBA tuvieron aptitudes más positivas que los no miembros sobre el rol ecológico del fuego y el uso del fuego prescrito. Nuestro estudio sugiere que la adopción de la quema prescrita como una parte integral de los planes de manejo de tierras de propietarios privados pudiera ampliarse mediante la creación de nuevas asociaciones de quema prescritas. El modelo de la EPPBA para tales asociaciones les brinda oportunidades de conocimiento que sean consistente con el conocimiento adulto y la innovación de los principios de adopción. Esto facilita el entrenamiento de seguridad contra incendio, reduce las preocupaciones sobre la responsabilidad legal asociada con la ignición del fuego, y facilita el acceso a compartir el equipo de manejo de incendio y la labor en los días de quemas. La estructura de dos niveles de la EPPBA con alguna forma de representación legal estatal parece ser una estructura organizacional eficiente para estas asociaciones.

Key Words: landowner associations, landowner attitudes, prescribed fire, rangelands

INTRODUCTION

In recent years, there has been a growth in recognition that periodic fire is a key driver in the evolution of many rangeland ecosystems around the world (Pyne 2001) and that fire exclusion, combined with overgrazing, has led to the conversion of many open grasslands and savannas to woody shrub lands (Schlesinger et al. 1990; Archer and Smeins 1991; Ansley et al. 1995; Archer 1995; Collins et al. 1998; Teague and

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Dowhower 2004). Woody plant invasions, in turn, have been associated with increased likelihood of irreversible changes in plant species composition, as well as reduced biodiversity, herbaceous productivity, and ecosystem resilience (Westoby et al. 1989; West 1993; Knopf 1994; Archer 1995; Peterson et al. 1998). By contrast, the repeated application of prescribed fire can provide a competitive edge for herbaceous plants, especially if the affected woody plants are nonsprouting (Scifres and Hamilton 1993; Bovey 2001). Due to the suppressive effect of fire on woody plant proliferation and the lower cost of applying it compared to chemical and mechanical treatments (Scifres and Hamilton 1993), prescribed burning has been touted as an effective tool for containing or reversing plant species composition shifts (Babbitt 1995; Pattison 1998).

In addition to the recognition of the ecological importance of periodic fire in rangelands, concern has grown over the more frequent catastrophic wildfires (Jacobson et al. 2001; Arno and Allison-Bunnell 2002). This increase has resulted from the combined occurrence of three factors: drought, fire suppression in fire-prone ecosystems, and expansion of residential developments (Cortner and Field 2007). Public alarm following the 2000 fire season led to the development of the National Fire Plan, a major emphasis of which is reduction of fuel loads through, among other measures, clearing of fire breaks and burning under prescribed conditions (Daniel et al. 2007).

Studies have been conducted to determine factors influencing the adoption of innovation (Rogers 2003) and the effectiveness of outreach methods aimed at improving land management, including prescribed fire in western states (Didier and Brunson 2004; Toman et al. 2006). Others have focused on the economics of using prescribed fire to manage woody plants (Ortmann et al. 1998; Teague et al. 2001; Yoder et al. 2003a, 2003b), and some have examined landowner perceptions regarding woody plant management in Texas (Kreuter et al. 2001, 2004; Olenick et al. 2004; Kreuter et al. 2005). Yoder et al. (2003a) pointed out that the use of fire carries risks of legal liability and short-term forage loss. In addition, the public frequently views the use of prescribed fire as a dangerous and wasteful practice (Jacobson et al. 2001).

No previous study has elucidated the attitudes of rural landowners in private land states, such as Texas, about the use of prescribed fire on their land. Therefore, the objective of our study was to explore perceptions of rural landowners in Texas about fire and how prescribed fire as a rangeland management tool might be more readily adopted by them. To do this, we compared perspectives of members of the Edwards Plateau Prescribed Burning Association (EPPBA; Taylor 2005) with those of randomly selected nonmember landowners in six counties. Based on information obtained from a presurvey focus-group meeting with selected landowners, we developed three hypotheses: 1) The use of prescribed fire by landowners is positively related to property size, residence of landowners on their ranch, annual household income, proportion of household income derived from the land, and positive attitudes about the ecological role and use of fire; 2) Landowners are reluctant to apply fire on their land because of concern over legal liability, lack of knowledge about fire, lack of resources, and lack of assistance with the development of burn plans; and 3) Members of the EPPBA have more optimistic perspectives regarding the

ecological role of fire and are more willing to apply prescribed burns.

METHODS

A mail survey of 600 Texas landowners who were free to join the EPPBA but were not members, and all 185 members of the EPPBA, was conducted in the summer of 2004. Samples of nonmember landowners were selected from four counties (Sutton, Schleicher, Mason, and Llano) in the Edwards Plateau and two counties (Throckmorton and Shackelford) in the Rolling Plains ecoregions. In each of the six counties, 100 landowners possessing at least 20 ha of land were randomly selected for the study from county tax records.

The mail survey was implemented with the use of a pretested mail survey questionnaire (which can be accessed at <http://rangeland.tamu.edu/people/kreuter/>), and it was administered with the use of Dillman's (2000) multiple-contact method, including 1) notification letter mailed on Day 1 of the survey, 2) survey questionnaire on Day 7, 3) reminder card on Day 16, 4) replacement questionnaire to nonrespondents on Day 24, and 5) final reminder card to nonrespondents on Day 42. The questionnaire consisted of five areas of inquiry including property and management characteristics, perceptions about fire ecology, perceptions about prescribed burns, perceptions about cost-share programs, and personal information. EPPBA members were also asked to provide information about their Association.

Quantitative data about participant perceptions were obtained using 7-point scales to represent a range of possible response options for given questions. The meanings of these response scales are described in the results section to facilitate explanation of the associated data. Statistics used to analyze the survey data include Goodman and Kruskal's gamma (γ) to compare response frequency distributions, t tests (t) to compare mean response values of two independent normally-distributed variables, and Mann-Whitney (represented by Z -score statistic) or Kruskal-Wallis (χ^2) tests to compare two or more independent categorical data sets.

RESULTS

Of the 785 survey participants, 46.6% returned completed questionnaires, but the response rate was higher among EPPBA members (76.2%) than landowners who were not members of the EPPBA (36.7%). In comparing responses, the terms "EPPBA members" and "nonmembers" refer to the *respondents* from each of these two subsets of survey participants. We adopt this abbreviation to avoid excessive use of the term "respondents." However, in doing so, we do not extrapolate our findings to the general Texas landowner population because our study was restricted to six counties and we could not conduct a nonrespondent bias analysis. A prior landowner survey in the same study area found no differences between demographic characteristics of respondents and nonrespondents (Jackson-Smith et al. 2005).

Table 1 presents general demographic characteristics of respondents as well as differences between EPPBA members

Table 1. Comparison of mean response values of demographic characteristics of survey respondents: Edwards Plateau Prescribed Burn Association (EPPBA) members versus nonmember respondents, and respondents who had used fire versus those who had not used fire.

Demographic characteristic	EPPBA vs. nonmember				Used fire vs. did not use fire			
	EPPBA members	Non-members	Difference	Statistic (<i>P</i> value)	Used fire	Did not use fire	Difference	Statistic (<i>P</i> value)
Age	60.5 yr	60.1 yr	0.4 yr	$t = 0.337$ ($P = 0.736$)	60.9 yr	60.0 yr	0.9 yr	$t = 0.660$ ($P = 0.510$)
Years ranching experience	30.7 yr	26.6 yr	4.18 yr	$t = 2.182$ ($P = 0.030$)	29.8 yr	27.4 yr	2.4 yr	$t = 1.172$ ($P = 0.242$)
Residence on property	55.3%	40.0%	15.3%	$\gamma = 0.258$ ($P = 0.011$)	54.5%	41.3%	13.2%	$\gamma = 0.269$ ($P = 0.015$)
Property size	3 067 ha	644 ha	2 423 ha	$t = 6.283$ ($P < 0.001$)	3 119 ha	961 ha	2 090 ha	$t = 5.047$ ($P < 0.001$)
Annual income > \$75,000	63.7%	46.1%	18.3%	$\gamma = 0.319$ ($P = 0.002$)	67.0%	46.8%	20.2%	$\gamma = 0.395$ ($P < 0.001$)
> 25% of income from property	59.6%	32.9%	26.7%	$\gamma = 0.431$ ($P < 0.001$)	61.3%	34.7%	26.6%	$\gamma = 0.484$ ($P < 0.001$)
% of ranch income from livestock	50.9%	51.2%	-0.3%	$t = 0.087$ ($P = 0.931$)	52.3%	51.0%	1.3%	$t = 0.386$ ($P = 0.700$)
% of ranch income from wildlife	30.6%	21.0%	9.6%	$t = -3.325$ ($P = 0.001$)	28.7%	22.5%	6.2%	$t = 2.106$ ($P = 0.045$)

and nonmembers, and differences between those who had used fire on their land and those who had not. On average, respondents were about 60 yr of age and had 28 yr of ranching experience, and 46% lived on their property. Their properties ranged in size from 21 ha to 39 660 ha and averaged 1 598 ha. With respect to household income, just over half of the respondents earned more than the \$75 000 (the median value for income categories in the survey), and 43% earned more than a quarter of their household income from their land, about half of which was derived from livestock enterprises and about a quarter from wildlife.

Compared to nonmembers, EPPBA members had about 4 yr more ranching experience and nearly five times larger properties. In addition, a significantly greater proportion of EPPBA members than nonmembers lived on their land, earned more than \$75 000 per year, earned over a quarter of their household income from their land, and earned more of their ranch income from wildlife. Similarly, on average, respondents who had applied prescribed fire on their land had over three times larger properties than those who had not used fire, a significantly greater proportion earned in excess of \$75 000 per year and over a quarter of their income from their land, and they earned more of their income from wildlife. These results indicate that respondents who had applied fire on their land and/or were EPPBA members had above-average size properties, tended to live on their land, and earn proportionately more income from their land, especially from wildlife.

Perceptions about Fire

To understand their perceptions about fire, survey participants were asked to use a seven-point scale (+3 = strongly agree . . . -3 = strongly disagree) to indicate their level of agreement with statements about the ecological effects and use of fire as a management tool. For ecological effects, statements focused on nutrient cycling, forage supply, woody plant, and wildlife habitat. For use of prescribed fire, statements focused on season of burn; cost, effectiveness, and selectivity of fire as a woody plant treatment relative to chemical and mechanical treatments; and planning requirements for applying prescribed fire. Statements to which survey participants were asked to respond and the mean response values are presented in Table 2.

Mean response values for all statements exceeded zero, indicating respondents generally agreed with them. However,

mean response values differed significantly among the statements ($\chi^2 = 51.37$, $P < 0.001$). With respect to the ecological effect of fire, respondents agreed most strongly and consistently (as reflected by the largest mean response values and smallest standard errors) with statements about the positive influence of fire on the amount and quality of forage supply (2.15 and 2.11, respectively), habitats for browsers (2.03), and nutrient cycling (2.02). Perceptions regarding fire effects on plant species composition and on woody plant mortality were less optimistic and more diverse (response values ranged from 0.53 to 1.96). With regard to the use of prescribed fire as a management tool, respondents agreed most strongly with statements about the planning and notification requirements for applying prescribed fire (2.50 and 2.06, respectively), and the lower cost of prescribed fire compared to chemical and mechanical treatments (2.21). Respondents tended to agree less strongly with statements about the effect of season of burns and the selectivity and efficacy of prescribed fire versus mechanical and chemical woody plant treatments (values ranged from 0.70 to 1.76).

Pairwise comparisons of responses for each statement about the effect and use of fire were conducted with respect to EPPBA membership versus nonmembership and the use of fire versus nonuse by survey respondents (Table 2). Not all EPPBA members had applied fire on their land and not all respondents who had applied fire on their land were EPPBA members. The analysis revealed that in most cases members of the EPPBA were significantly more positive ($P < 0.005$) about each statement than nonmembers with two exceptions. Response values did not differ significantly between EPPBA members and nonmembers for statements about accelerated onset of herbaceous growth following late winter or early spring burns, and about the efficacy of fire for controlling woody plants versus mechanical and chemical treatments. Respondents who had applied prescribed fire on their land (regardless of EPPBA membership), on average, also provided more positive responses for each statement ($P < 0.05$) compared to respondents who had not used fire, with two exceptions. Differences between mean response values of burners and nonburners were not significant with respect to statements about the selective effects of fire versus mechanical and chemical woody plant treatments, and the notification requirements for applying prescribed fire. The significantly different response values suggest that EPPBA members and, more generally, respondents who had used fire on their land (whether or not they were members of the EPPBA)

Table 2. Mean response values for statements about which participants were asked to indicate their level of agreement based on a 7-point scale (+3 = strongly agree ... -3 = strongly disagree).

	Mean (SE)	Edwards Plateau Prescribed Burn Association (EPPBA) member vs. nonmember difference (Z; P) ¹	Fire user vs. nonuser difference (Z; P) ¹
Ecological effect of fire			
Nutrient cycling			
Fire generally accelerates the cycling of nutrient cycling in ecosystems.	2.02 (0.069)	0.51 (3.708; <0.001)	0.40 (2.734; 0.006)
Forage supply			
Occasional fire has a long-term positive impact on the supply of quality forage.	2.15 (0.064)	0.47 (4.454; <0.001)	0.41 (3.841; 0.001)
Forage quality of rangeland grasses is generally greater following fire.	2.11 (0.063)	0.69 (4.292; <0.001)	0.47 (3.897; <0.001)
Late winter or early spring burns can accelerate the onset of herbaceous spring growth.	1.95 (0.066)	0.23 (1.789; 0.074)	0.41 (3.434; 0.001)
Woody plants			
In the absence of fire, grasslands often convert to woodlands.	1.96 (0.073)	0.82 (5.920; <0.001)	0.54 (4.120; <0.001)
Woody plants are generally more susceptible to fire than rangeland grasses.	0.53 (0.114)	1.15 (5.194; <0.001)	0.95 (4.061; <0.001)
Woody plants that sprout from the base often survive a single fire event.	1.73 (0.084)	0.39 (2.958; 0.003)	0.45 (2.872; 0.004)
Woody plants that do not sprout from the base can be killed by a single fire event.	1.03 (0.102)	0.69 (3.768; <0.001)	0.61 (3.224; 0.001)
Wildlife habitat			
Habitats of browsing wildlife (e.g., white-tailed deer) can be positively affected by occasional fire.	2.03 (0.071)	0.76 (5.716; <0.001)	0.40 (3.195; 0.001)
Habitats of grassland birds can be positively affected by occasional fire.	1.72 (0.086)	0.91 (5.393; <0.001)	0.54 (3.202; 0.001)
Use of prescribed fire			
Season of burn			
Cool season burns can result in increased species diversity in an ecosystem.	1.40 (0.093)	0.94 (4.904; <0.001)	0.93 (4.814; <0.001)
Hot summer burns can be used to convert rangelands dominated by woody plants to grasslands.	1.76 (0.077)	0.97 (6.422; <0.001)	0.72 (4.692; <0.001)
Cost and selectivity compared to mechanical and chemical treatments			
Prescribed fire is less expensive than mechanical or chemical treatments for controlling brush.	2.21 (0.067)	0.66 (5.343; <0.001)	0.58 (3.879; <0.001)
Prescribed fire is generally less selective than mechanical or chemical treatments for brush control.	1.60 (0.088)	0.59 (3.775; <0.001)	0.19 (1.506; 0.132)
Prescribed fire is generally more effective than mechanical or chemical treatments for brush control.	0.70 (0.099)	0.11 (0.643; 0.520)	0.56 (2.626; 0.009)
Planning and notification requirements for the application of prescribed fire			
Requires specification of where, when, and what to burn and who is to be present.	2.50 (0.114)	0.37 (4.900; <0.001)	0.13 (2.006; 0.045)
Entities that must be notified include the sheriff's office, fire department, and Texas Forest Service.	2.06 (0.082)	0.45 (2.957; 0.003)	-0.18 (0.418; 0.676)

¹Mean response values for EPPBA members, nonmembers, fire users, and nonusers were excluded from Table 2 for the sake of parsimony. However, these mean values can easily be obtained for each statement by calculating the upper and lower bounds represented by the reported difference value centered on the overall mean response value (shown in the first column).

had more positive perspectives about the ecological role of fire and its use as a management tool.

Application of Prescribed Fire

Only 38% of the 364 respondents reported that they had used prescribed fire on their land, with a higher proportion of EPPBA members having done so than nonmembers (53% vs. 17%, $\gamma = 0.633$, $P < 0.001$). The fact that nearly half of the EPPBA members had not used fire on their land was explained by the founder of the EPPBA to be due to the long drought that had affected much of Texas before the study, and by the fact that EPPBA members are required to assist with three prescribed fires on other properties before they can obtain assistance to burn their own land. The rapid growth in membership before the study combined with the prolonged

drought meant many EPPBA members had neither sufficient fuel nor time since joining the EPPBA to burn their land.

Survey participants who *did not use fire* were asked to use a seven-point scale (+3 = very important . . . -3 = not at all important) to indicate the importance of specified reasons for not doing so (Fig. 1a). The mean response values differed ($n = 252$, $\chi^2 = 185.92$, $P < 0.001$). On average, lack of resources to put in fire breaks (1.08), insufficient knowledge (0.83), liability concerns (0.66), and lack of assistance with prescribed burning plans (0.56) were considered to be important ($P < 0.05$). Using the same seven-point scale, the survey participants who *did not use fire* were also asked to indicate the importance of a list of seven measures that could encourage them to incorporate prescribed fire on their land (Fig. 1b). Respondents rated all measures as being important (mean score > 0), but the mean scores for the measures differed

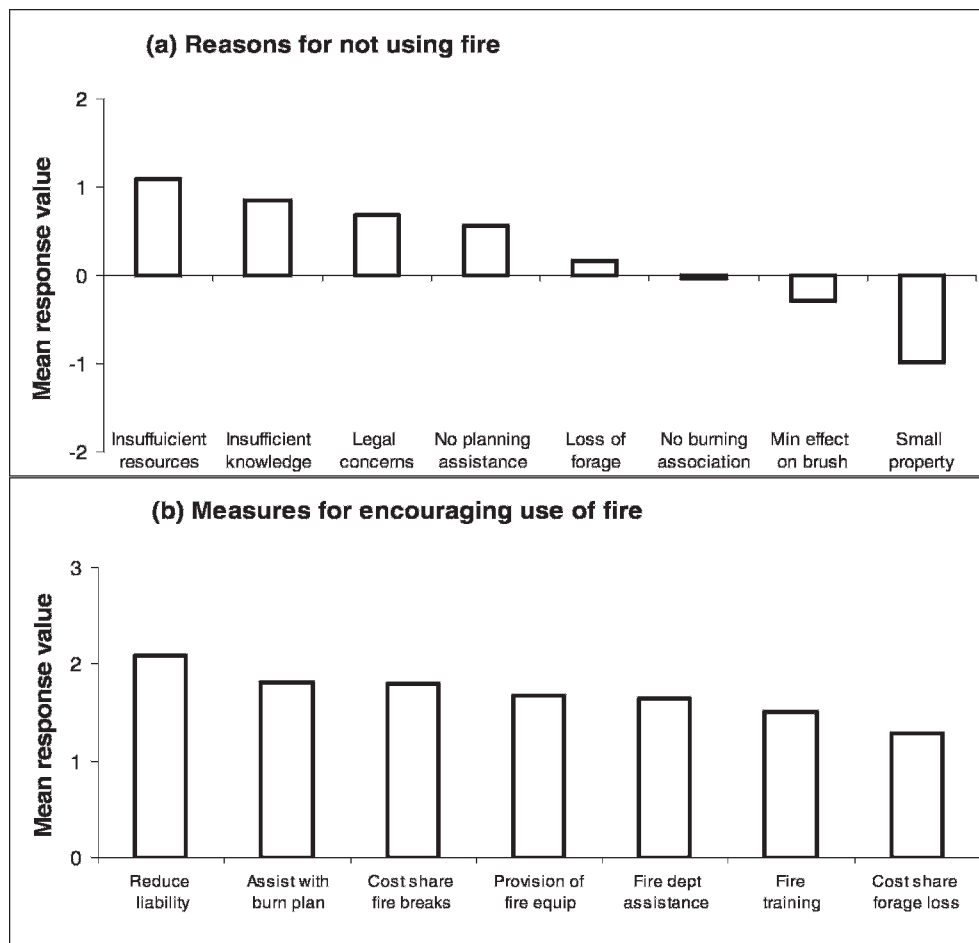


Figure 1. Mean response scores for two questions asked of landowners who *did not use* fire as a management tool: a) “How important is each of the following reasons for you not using prescribed fire?” and b) “How important would each of the following measures be in encouraging you to incorporate prescribe fire as a management tool?” (+3 = very important . . . -3 = not at all important).

significantly ($\chi^2 = 39.14$, $P < 0.001$). Reduced liability was ranked highest (2.08), followed by assistance with burn plans (1.82), cost-sharing for fire-break preparation (1.80), provision of fire equipment (1.69), assistance by fire department with application of prescribed burn (1.65), fire management and safety training (1.51), and last, cost sharing for forage loss (1.29).

Survey participants who *did use fire* on their land were asked to indicate how frequently they had done so during the preceding 10 yr, primary reasons for using fire, and what measures would encourage them to apply prescribed fire more frequently. Sixteen percent of the respondents ($n = 112$) reported having used fire every 2–3 yr, 12% every 4–5 yr, 10% every 6–10 yr, 21% once only, and 6% had not applied fire during the preceding 10 yr. Using the same seven-point scale as before, survey participants were asked to score the importance of 10 listed reasons for using fire (Fig. 2a). Respondents indicated that all the reasons were important (mean score > 0) but mean scores varied significantly ($\chi^2 = 136.83$, $P < 0.001$). The reasons for using fire that were scored highest included control problem plants (2.35), improve forage quality (2.32), lower cost than other brush control methods (2.18), increase plant species diversity (2.09), and improve wildlife habitat (1.92). Presence of a burning association, assistance with preparation of burning plans, ease

of application compared to other brush management treatments, environmentally less hazardous than chemical treatments, and reduction of biomass to minimize risks of wild fires were considered to be somewhat less important reasons for using fire. Respondents who had applied fire on their land and who were EPPBA members valued the following reasons for using fire more highly than nonmembers ($P < 0.05$): controlling problem plants, increasing plant species diversity, lower cost relative to other brush treatments, presence of a burning association, and assistance with preparation of burn plan.

Using a similar seven-point importance scale (+3 = very likely . . . -3 = very unlikely), survey participants who *did use fire* were asked to indicate the likelihood that seven measures would result in them applying prescribed fire more frequently. On average, respondents indicated that all of the measures would likely result in them using fire more frequently but the mean likelihood scores varied significantly ($\chi^2 = 42.95$, $P < 0.001$; Fig. 2b). Reducing legal liability (2.19) was the single most important measure for increasing the likely use of fire. Slightly less important measures included cost-sharing for clearing fire breaks and to offset forage loss (1.65), greater state-level representation of landowners that apply prescribed fire (1.62), opportunities for fire safety training (1.38), greater assistance with development of prescribed burn plans (1.38),

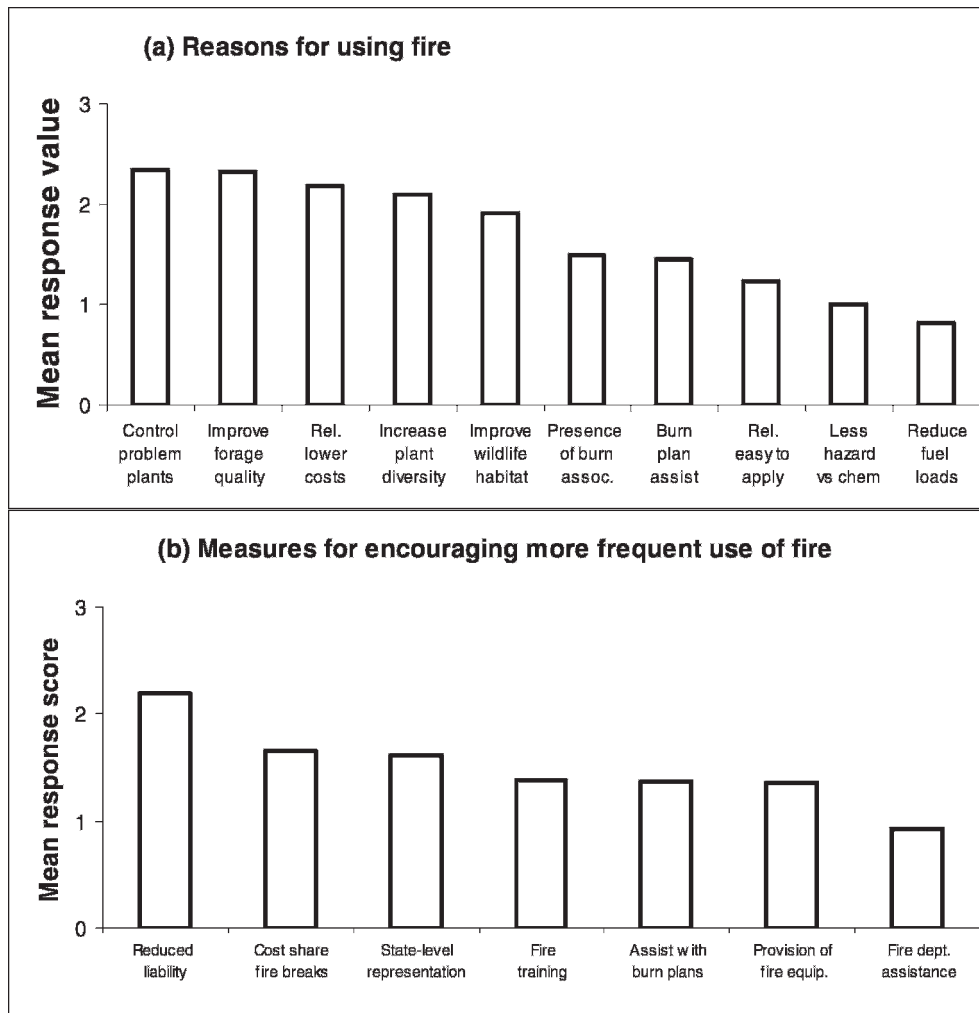


Figure 2. Mean response scores to two questions asked of landowners who *did use fire* as a management tool: **a**, “How important is each of the following reasons for you using prescribed fire?” (+3 = very important . . . -3 = not at all important) and **b**, “How likely would each of the following encourage you to use prescribed fire more frequently as a land management tool?” (+3 = very likely . . . -3 = very unlikely).

and provision of fire equipment (1.36). Greater assistance from their fire department was considered to be least important (0.93). The only significant difference between EPPBA members and nonmembers with respect to these measures was that EPPBA members valued more highly state-level representation of landowners who apply fire prescribed ($P < 0.001$).

Institutional Issues

Survey participants were asked to use a seven-point scale (+3 = very interested . . . -3 = not at all interested) to indicate their preference for six contractual arrangements for participating in a cost-sharing program. These included 5- and 10-yr performance contracts and lease agreements, transferable contracts, and group contracts. Performance contracts compensate landowners for part of the costs of participating in a program after meeting specified performance criteria, and lease agreements provide landowners with an annual payment in exchange for giving up part or all of their land use right for the duration of the lease. The interest level for alternative contract types varied significantly ($\chi^2 = 318.07$, $P < 0.001$) with 5-yr contracts being the only type to draw a positive response (1.13)

and EPPBA members showed a greater interest in this contract type than nonmembers ($Z = 3.510$; $P < 0.001$). Interest in 10-yr contracts was neutral (-0.18), but there was general disinterest in the other four contracts types (mean scores < 0). When asked about the minimum cost sharing necessary for landowners to participate in a program aimed at increasing fire use, 47% of the respondents selected 50% cost sharing. Smaller proportions of respondents (1–10%) selected other cost-sharing categories ranging from 20% to 100%. This distribution pattern did not differ significantly between EPPBA members and nonmembers.

To obtain information about the perceived benefits of the EPPBA, members were asked to use a seven-point scale (+3 = very valuable . . . -3 = not at all valuable) to evaluate 10 listed benefits. Although the mean response values for these items differed significantly ($\chi^2 = 88.39$, $P < 0.001$), in general they were all considered to be valuable. They were ranked as follows: greater availability of expertise regarding the use of fire (2.78), increased availability of labor on burn days (2.69), reduced liability for igniting fire (2.64), availability of shared fire management equipment (2.61), increased opportunity for fire safety training (2.59), assistance with burning plans (2.54), improved landowner relationships (2.33), increased landowner

representation at the state level (2.20), improved relationship with fire department (2.18), and improved relationships with state and federal agencies (1.77). EPPBA members were also asked to indicate their preference for five prescribed burn association models. Of the 102 respondents, 46% selected a two-tiered model. Of these, 78% preferred *regional associations* with local chapters (the current EPPBA structure) and the remainder preferred a *single statewide association* with local chapters. A three-tiered model with either a *state-level advocate* or a *state-level board* representing regional associations was selected by 28% of the respondents. A one-tiered structure was selected by 24% of respondents who favored *local burning organizations* without any broader associations.

DISCUSSION

The periodic use of prescribed fire is an effective management tool for suppressing woody plant dominance in grasslands and savannas thereby maintaining their productivity. By contrast, fire suppression has led to increasing dominance of woody plants in many rangeland ecosystems (Scifres and Hamilton 1993), which led to lower forage production and elevated risks of catastrophic wildfires under hot, dry conditions. Despite the advantages of periodically applying prescribed fire, this rangeland management tool has faced stiff public resistance due to antifire sentiments propagated through campaigns, most notably Smokey Bear, that promoted fire suppression as good and natural for forests (Shindler 2007). For prescribed fire to become widely accepted as a legitimate land management practice, a change in public perception is needed. To achieve this, some land management entities have engaged in “community outreach activities to influence citizens’ understanding of fuel reduction practices” (Toman et al. 2006, p. 322).

The traditional agricultural innovation diffusion model is based on the assumption that innovation is generated by a centralized institution and then transferred to relatively passive end users in an organized manner (Rogers 2003). However, research on the effectiveness of outreach activities in influencing citizens’ attitudes has produced mixed results (Arcury 1990). For fuel reduction practices, some studies identified a positive association between knowledge and public support (Carpenter et al. 1986). Loomis et al. (2001) found evidence that the introduction of educational brochures led to increased knowledge about and support for prescribed fire. However, method of communication about prescribed fire can substantially influence outreach effectiveness (McCaffrey 2004). To better understand communication effectiveness for land management outreach activities, Toman et al. (2006) used adult learning principles and survey data from four western states to examine reaction to numerous commonly used communication methods. They consolidated adult learning principles (Knowles et al. 1998; Merriam and Caffarella 1999) into a four-concept framework as follows: 1) adults usually adopt a problem-based approach to learning; 2) adults seek autonomy in their learning experiences; 3) varied prior experiences and knowledge is of substantial value in finding solutions to management problems; and 4) the creation of a trusting and safe environment is important for

effective information exchange. They concluded that the primary advantage of this framework over persuasive communication models, which are based on the assumption that individuals are passive recipients of information (Rogers 2003), is the greater emphasis on citizens as outreach participants. Their findings suggest that interactive methods facilitate connection to real-world problems, better incorporate participant experiences, and provide greater flexibility for addressing questions and concerns within local contexts. Interactive approaches that encourage open discussion and deliberation are not only consistent with the principles of the adult learning framework, but can be useful for eliminating concerns regarding the use of fuel-reduction treatments, such as the use of prescribed fire.

Other factors also influence the adoption of innovation. For example, a survey of Texas county extension agents (Kreuter et al. 2001) and a survey of landowners in 48 Texas counties (Kreuter et al. 2005) found that the effective dissemination of user-friendly information about low-cost techniques that produce quick results was a primary reason for the success of Brush Busters, an outreach program aimed at increasing the use of safe chemical brush management treatments. Visible demonstration sites and establishment of cooperative groups were also found to encourage the use of these practices. In a study of Utah ranchers, factors that positively influenced rangeland management innovation included a desire to demonstrate good land stewardship, and barriers to innovation included inadequate time and resources, peer influences, perceived drawbacks of innovations, and perceptions about political/legal constraints (Didier and Brunson 2004).

Although the results of our study cannot be extrapolated to the general landowner population (the study was restricted to six Texas counties), by addressing the issues of innovation adoption and effective outreach discussed above they do suggest interesting possibilities for the broader adoption of prescribed fire by landowners.

The results of our study corroborated all three hypotheses. First, the use of prescribed fire by respondents was indeed positively correlated with their property size, residence on the land, annual household income, proportion of income derived from the land, and positive perspectives about the effects and use of prescribed fire. Such landowner characteristics might be useful targeting criteria for outreach programs aimed at expanding the use of fire. Second, concerns over legal liability and lack of resources and assistance with burn plans were deterrents to using fire, while measures to address these factors would likely increase the frequency of fire application.

Perhaps most importantly, the third hypothesis that members of the EPPBA have more positive attitudes about the role of fire and are more willing to apply prescribed burns was corroborated by significantly higher response values from members than nonmembers to questions about the ecological effect and use of fire and by the higher frequency of fire use by members. Although many landowners likely became EPPBA members because they were predisposed to applying fire on their land, anecdotal information obtained during the focus-group meeting revealed that some members, including the EPPBA chairman, were previously opposed to using fire, joined the EPPBA to learn more about its effects and use, and became

advocates only after joining. Regardless, the rapid growth in membership (currently over 300), and the recent development of new associations in the Rolling Plains and South Texas Plains ecoregions of Texas, point to the catalytic effect of such associations with respect to the expanded interest in and use of prescribed fire by private landowners in Texas.

EPPBA members indicated that membership provides a broad range of benefits, including greater access to assistance with the development of burn plans, fire safety training, and fire management equipment and labor on burn days, all of which reduce liability associated with the ignition of prescribed fire. One reason for the dramatic success of the EPPBA in expanding the use of prescribed fire by landowners may be that it provides a learning environment and outreach activities that adhere to the adult learning framework of Toman et al. (2006). Specifically, the EPPBA addresses a well-defined issue—using prescribed fire to manage fuel loads and invasive woody plants. At the same time, it provides a high degree of learning autonomy for its members who are free to participate in burning activities when they have the time and inclination to do so, yet it encourages cooperation among members by requiring them to participate in prescribed fires on at least three other properties before their own land can be burned. Finally, it enhances trust among landowners through the provision of mutually beneficial, joint learning experiences about an issue of common interest. In addition, the EPPBA deals directly with factors that enhance innovation adoption. It effectively disseminates information through hands-on learning about the function and use of prescribed fire, which is an instantaneously visible and cost-effective tool for managing brush encroachment. At the same time the EPPBA deals with barriers to innovation adoption by ensuring freely available labor resources and potentially greater access to cost-sharing programs, by promoting positive peer influences, and by reducing legal liability. This latter characteristic is driven by the lower likelihood that neighboring EPPBA members will seek retribution for “damages” caused by a prescribed fire that spreads across their common property boundary because they are less likely than nonmembers to be fire averse.

In developing new prescribed burning associations, our study found that EPPBA members preferred a two-tiered structure with a regional association and local chapters over a three-tiered structure that includes formal state-level representation for all regional associations. Although the EPPBA membership is a narrow base upon which to determine the structure of future associations, the dramatic growth in EPPBA membership and the recent establishment of new prescribed burning associations in other Texas ecoregions suggests that the organizational structure of the EPPBA is efficient (Taylor 2005). Nevertheless, greater state-level representation, specifically with respect to liability concerns, would likely further facilitate their use of fire.

Finally, the lack of resources as a reason for landowners not applying prescribed fire needs to be addressed. Although prescribed burning associations like the EPPBA can reduce the problem of lack of labor, and can facilitate the development of prescribed burn plans when experienced members help less experienced members to prepare such plans, members may still require funds to prepare adequate fire breaks and perhaps

offset the loss of forage resources when prescribed fire is applied. To address this issue, publicly funded cost-sharing programs may be necessary. Our study suggests that a cost-sharing percentage of 50% under a short-term contract may be optimal for encouraging landowner participation in a program aimed at enhancing the adoption of prescribed fire by landowners.

IMPLICATIONS

The inclusion of prescribed fire as an integral element in management strategies is critical for many ecosystems where fire suppression has led to the buildup of dangerous fuel load levels or deleterious plant species composition shifts. The results of our study have several implications for increasing the effectiveness of efforts to promote the application of prescribed fire by private landowners. Specifically, their concerns about the legal liability they face when initiating a fire need to be squarely addressed. Almost no insurance companies currently offer policies to protect individual landowners, certified burn managers, or prescribed burning associations against liability for unintended damages associated with the ignition of prescribed fires. To offset this limitation and enhance the availability of affordable fire insurance, the Texas Prescribed Burning Board has proposed that the state legislature develop a fund to underwrite such insurance.

Perhaps most important for expanding the use of prescribed fire by private landowners is the development of burning associations. They provide fire safety and management training, and shared learning opportunities and expertise, and they enhance access to shared fire-management equipment and labor on burning days. Burning associations may also be better able than individuals to obtain the participation of local fire departments on burn days. Finally, increasing burning association membership could reduce the legal liability associated with igniting prescribed fires because members jointly participate in fire applications on their properties. In the future it may also be possible for burning associations with demonstrated expertise in the safe application of fire to obtain affordable insurance for its members. The two-tiered organizational structure of the EPPBA provides a successful model for establishing other landowner burning associations (Taylor 2005). The development of new regional burning associations could also facilitate the establishment of state-level representation for members and increase acceptance by state policy makers of prescribed fire as a critical land management tool for maintaining healthy rangeland ecosystems. The expansion of existing cost-sharing programs or the development of new ones to offset landowners' costs related to the preparation of fire breaks and lost forage resources may also increase the use of prescribed fire by landowners.

The results of our exploratory study provide several interesting possibilities. However, because our study was based on a limited sample of landowners in two ecoregions of Texas and members from one prescribed burning association, the findings need to be tested with a broader sample of landowners and members of newer prescribed burning associations in other ecoregions.

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