To Burn or Not to Burn: Ecological Restoration, Liability Concerns, and the Role of Prescribed Burning Associations

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Fire suppression in ecosystems that have evolved in the presence of fire, together with the occurrence of other natural and anthropogenic processes, has resulted in the conversion of many grasslands and savannas to woodlands. From an ecological perspective, eliminating fire in areas that evolved with fire inhibits natural processes that limit woody plant expansion and, consequently, promotes ecosystem degradation. From an economic perspective, brush encroachment associated with fire suppression has led to reduced livestock carrying capacity and destruction of property by catastrophic fires that occur when accumulated fuel loads ignite under hot dry conditions. By contrast, research results suggest many ecological and economic benefits to using prescribed fire.[1,2] This leaves social constraints as the primary hurdle to applying periodic fire on the landscape.[3] Prescribed fire has not been adopted widely as a management and/or restoration tool primarily because of perceived safety and legal concerns.[4,5] In this paper we discuss the benefits and risks of using prescribed fire and how prescribed burn associations have mitigated these risks, resulting in an increase of prescribed fire application, including extreme restoration burns that are ignited under wildfire-like conditions.

The Benefits and Risks of Burning

Removing invasive woody vegetation reduces competition for water, sunlight, and nutrient resources needed by herbaceous species used by livestock and wildlife. Application of prescribed fire in fire-adapted systems often increases forage yield by stimulating understory vegetation and reducing competition for these necessary resources[6,7] (Fig. 1). Reduction of invasive woody cover and increased forage yields not only lead to an increase in carrying capacity for livestock and wildlife, but may also enhance wildlife-related income and generate higher ranch values by maintaining open viewsheds.

Methods for managing invasive woody plants can be classified as mechanical, chemical, biological, and prescribed fire.[8] Mechanical methods include bulldozers, tractors, and roller choppers, and chemical methods involve the application of herbicides that defoliate or kill targeted invasive plants. The use of innovative mechanical and chemical technologies has resulted in positive brush control outcomes,[8] but these methods can be cost prohibitive.[9] Biological methods usually include introduction of species that target and impact the brush species of concern, but in many cases introduced species can have unintended consequences.[10] The primary advantage of mechanical, chemical, and biological brush management methods is that they can be applied under a wide range of environmental conditions whereas prescribed fire requires a minimum fuel load to carry flames and specific weather conditions for safe and effective application.

Research has found that prescribed fire is an economically feasible brush control method and in most cases more effective than chemical or mechanical brush control treatments.[9,11] An economic advantage of fire is the low cost of implementation. Accordingly, some researchers have concluded that fire should be used as the preferred brush management option whenever possible and other treatment types should be used only when fire is not feasible (e.g., proximity to roads or urban areas or insufficient fine fuel).[1] However, many landowners will not apply prescribed fire on their land because of their concerns about the risks and liabilities[4] associated with fire ignition or the need to defer grazing to accumulate sufficient fine fuel to carry fire and then burn valuable forage. Factors that must be taken into consideration when assessing risks due to prescribed fire are the biological risks of lighting a fire, the risk of fire spreading to adjacent properties, and smoke hazards on nearby roads and/or populated areas.

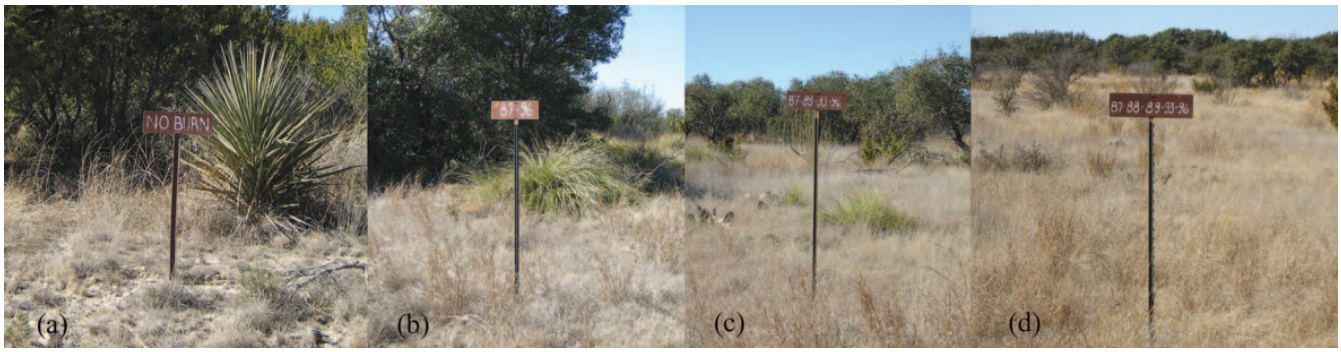

Figure 1. A visual comparison of adjacent experimental burn plots on the Texas AgriLife Research Station at Sonora, Texas. From left to right (**a**) has not been burned, (**b**) has been burned twice since 1987, (**c**) has been burned four times since 1987, and (**d**) has been burned five times since 1987.

Overcoming Resistance to the Use of Fire to Restore Rangeland Ecosystem Processes

Reintroducing prescribed fires will by itself not necessarily restore brush-invaded rangelands back to their historic grassland or open savanna states. In areas where elevated brush density has substantially suppressed the accumulation of fine fuels, the use of high-intensity or so-called extreme prescribed fire may be necessary to consume trees and reduce brush cover. Major drawbacks associated with this type of fire are the risks of igniting fire under conditions that fall outside historical guidelines for applying prescribed fire. Prescribed fires can be applied safely under such conditions provided proper preparations have been made and the necessary equipment as well as experienced personnel are in place.[5] However, few landowners have the capacity to bring together all of these resources. Although several government programs can help landowners implement prescribed burns, federal agencies are rarely willing to endorse the application of fire under such extreme conditions due to human safety and legal liability concerns. Therefore, implementing extreme restoration burns can be a daunting task. The Certified Prescribed Burn Manager program administered by the Texas Department of Agriculture offers the opportunity for individuals to become certified to provide contract-burning services on private land. If landowners hire a certified burn manager to conduct a fire on their property, the burn manager assumes the landowner's liability up to $1 million.

Another approach to overcoming impediments to the application of prescribed fire has been the establishment of prescribed burn associations (PBAs) in several states. PBAs consist of members who work together to promote the safe and effective use of prescribed fire at a landscape scale. They accomplish this by providing fire safety training, opportunities to participate in prescribed burning, pooled fire management equipment, and labor through member participation.[5,12] PBAs have also obtained prescribed burn liability insurance policies; for example, the Edwards Plateau Prescribed Burning Association recently used part of its membership fees to purchase a $2 million policy to cover the association, its members, officers and directors, and the burn boss. Together these efforts have reduced the liability of applying fire, reduced the costs of managing brush, and facilitated the restoration of the ecological integrity of many fire-adapted rangeland ecosystems.[12] The safety record of these PBAs has allowed them to establish sufficient authority to modify regulations regarding the use of prescribed fire; in some Texas counties this has even enabled PBAs to ignite prescribed fires under extreme conditions when government-mandated burn bans are in effect.

Landowner Perspectives

We conducted a landowner survey in three eco-regions of Texas to compare the attitudes and perceptions of PBA members and nonmembers toward the use of fire as a rangeland management and restoration tool. Our study included the Rolling Plains, Edwards Plateau, and South Texas Plains, which lie along a north-south transect within the Southern Plains that extends from Oklahoma through Texas into Mexico. Vegetatively all three eco-regions have various concentrations of honey mesquite (*Prosopis glandulosa*) and prickly pear (*Opuntia* sp.), and the Edwards Plateau is dominated by Ashe juniper (*Juniperus asheii*). For our study, we selected clusters of four counties in each of three eco-regions, including Stephens, Sutton, Throckmorton, and Young in the Rolling Plains, McMullen, Menard, Schleicher, and Shackleford on the Edwards Plateau, and Bee, Duval, Kimble, and Live Oak in the South Texas Plains. We obtained 2008 open-access county tax records and PBA membership lists to randomly selected in each county 100 landowners with 50 or more acres of land. We surveyed all landowners in each selected county who were a member of a PBA, including the North Central, Edwards Plateau and Hill Country, and Coastal Bend Prescribed Burn Associations in our northern, central, and southern study areas, respectively. We did not subsample PBA members because the number of members in each county was fewer than 100; the surveyed group nevertheless represents a sample of all members of PBAs in Texas. We had a higher sampling density but lower sample size of PBA members

Table 1. Summary of landowner responses to opinion toward the practical use of prescribed fire

Respondent characteristics	PBA members (n=121)*,†	Nonmembers (n=399)*,†	Diff.‡
Prescribed burning is easier to implement than other methods for controlling woody plant encroachment	5.53 (1.59)	4.98 (1.54)	0.55
Prescribed burning is more effective than other methods for controlling woody plant encroachment	5.58 (1.46)	4.73 (1.58)	0.85
Prescribed burning is less costly than other methods for controlling woody plant encroachment	6.34 (1.03)	5.43 (1.29)	0.91
In favor of prescribed burning in general (includes four response items)	6.68 (0.50)	5.55 (1.53)	1.12
In favor of extreme prescribed fires in particular (includes four response items)	5.60 (1.31)	4.55 (1.45)	1.05

*Index values based on aggregated responses to the survey items using a seven-point response scale from 1=strongly disagree and 7=strongly agree.
†Values represent means and standard deviation (in parentheses).
‡Significant at alpha=0.05.

than nonmembers (PBA member sample = 190, nonmember sample size = 997, which excluded selected landowners who could not be reached).

We conducted a mail survey during the summer of 2008 that included five mailings (presurvey information letter, cover letter with survey questionnaire, reminder card, replacement questionnaire, and final reminder card).[13] From the 1,187 survey participants, we received 585 useable responses (129 PBA members and 456 nonmembers), representing an overall response rate of 49% (11% PBA members and 38% nonmembers).

To compare the attitudes and experience of PBA member and nonmember landowners with respect to the use of prescribed fire we used a seven-point scale to obtain response data, where 7 represented strong agreement, 4 represented a neutral opinion, and 1 represented strong disagreement with statements or questions to which survey participants were asked to respond. To facilitate the PBA member/nonmember comparisons we developed two latent indices that combined the seven-point response data from multiple variables. The first index represented the degree to which survey respondents favored prescribed burning in general; we created this index using response data from the following four statements:

1. I consider the use of prescribed burning to be a beneficial tool for restoring rangelands;
2. I agree in principle with the idea of using prescribed burning on my land when needed;
3. I am in favor of applying prescribed burning on my land occasionally; and
4. I am in favor of applying prescribed burning on my land whenever it is needed and there is sufficient fuel to burn.

The second index provided a measure of agreement or disagreement with the use of extreme restoration burns; we created this index using the response data for the following four statements:

1. I am in favor of applying prescribed burning on hot days (up to 100ºF) when there is a lot of fuel and little wind;
2. I am in favor of burning using warm season prescribed burns as a land restoration tool;
3. I would be willing to apply warm season prescribed burns on my land if it was shown it benefited my land; and
4. Based on my knowledge and experience, warm season prescribed burns are favorable for my land.

We used the statistical software SPSS ver. 17[i] to conduct data analyses. These included the derivation of descriptive statistics for individual data variables, while response data from PBA members and nonmembers (including index scores) were compared using independent sample t tests for normally distributed data, Mann–Whitney tests for nonnormally distributed data, and χ^2 tests for bivariate variables.

Our study found that, in general, the survey respondents were experienced landowners who have time to manage their land but have financial constraints that limit their

[i] SPSS, Inc., Chicago, Illinois, http://www-01.ibm.com/software/analytics/spss/.

Table 2. Concerns of prescribed burn association members and nonmembers over lack of knowledge and/or experience about fire safety and lack of labor and/or equipment needed to safely implement a prescribed burn

Respondent characteristics	PBA members (n=124)*	Nonmembers (n=403)*	Diff.†
I am concerned about using prescribed burning because I lack knowledge and/or experience about fire safety.	2.63 (1.91)	4.45 (2.04)	1.82
I am concerned about using prescribed burning because of lack of labor and/or equipment needed.	3.15 (2.16)	4.98 (1.90)	1.83

*Values based on response values to single-survey questions using a seven-point response scale from 1=strongly disagree and 7=strongly agree; values represent means and standard deviation (in parentheses).
†Significant at alpha=0.05.

capacity to implement land improvements. Given such fiscal constraints, landowners often depend on public cost-sharing programs to enable them to clear invasive woody plants on rangelands[14,15] (but this is likely to become an increasingly inaccessible option as state and federal budgets for such support programs shrink), or they avoid investing in land improvements altogether. Although deferring treatment of invasive woody plants may not be immediately economically deleterious, the costs of inaction become increasingly prohibitive as brush proliferates and the carrying capacity for economically valuable livestock and even wildlife declines. Therefore, it is imperative to identify and promote the least cost and most effective method for managing the ongoing invasion of woody plants. From an economic perspective, the use of extreme fire was estimated to be the only feasible rangeland restoration option (i.e., positive return on investment) compared to mechanical and chemical treatments in all three of our study areas.[9]

In our survey we found that the respondents generally agreed with the finding of fire being economically superior. On average they indicated that prescribed burning was easier to implement, more effective, and less costly than other brush control measures (Table 1). Respondents generally considered prescribed fire to be an acceptable tool for managing invasive brush (i.e., response value>4) with PBA members having a significantly more positive attitude toward its use than nonmembers. In addition, the respondents were positive although somewhat more cautious about the use of extreme fire as a rangeland restoration tool (i.e., response values>4 but lower than those for the use of prescribed fire in general), but again PBA members had a significantly more positive attitude (Table 1).

Although many of our survey respondents favored using prescribed burns, only 33% had actually applied fire on their land. In general, the 67% of survey respondents who had not used prescribed fire on their land indicated that the main reasons were lack of knowledge about the safe application of prescribed fires, lack of labor and/or fire management equipment, and liability associated with the ignition of fires. In general, PBA member respondents were not concerned (response values<4) about using prescribed burns due to lack of knowledge, experience, equipment, and labor, but nonmember respondents were quite concerned about these issues (response values>4; Table 2). These statistically significant differences are, at least in part, due to the fact that PBA members received fire safety training, share PBA fire management equipment, and, as a condition of membership, are required to assist with three burns on other properties before being able to obtain assistance with the application of a prescribed fire on their land.

When asked about the best season to perform prescribed fires, only 34% of the respondents preferred applying prescribed fires in dry, warm months when the potential risks for loss of control over prescribed fire may be higher than during wetter cooler periods. We found that the attitudes toward the use of fire in general and extreme fire in particular correlated with the survey respondents' risk perceptions. For example, although 88% of the respondents felt that the risks of prescribed burning were low, those with negative attitudes toward prescribed burns were more likely than expected to perceive the risks of applying fire to be high.[ii] Very positive attitudes towards the use of prescribed fire (79%) were strongly associated with low risk-perception levels, but as risk perceptions about using fire increased, attitudinal differences between survey respondents regarding the use of prescribed fire declined (48% positive attitude, 52% negative attitude).

In comparing PBA member and nonmember perceptions about the riskiness of using prescribed fire, our survey found that 49% of nonmember respondents with a positive attitude towards prescribed fire considered burning to be a high-risk action, whereas none of the PBA members with a positive attitudes considered the ignition of fire to be highly risky. This clearly illustrates the potential for PBAs to reduce concerns over risk and legal liability of applying prescribed fires on private rangelands. PBAs help reduce physical risks by enhancing training, access to shared fire management equipment, and labor on burn days. Most importantly, by building and strengthening landowner networks, trust, and reciprocation, PBAs can change attitudes toward prescribed

[ii] x^2=28.74, df=1, P<0.01.

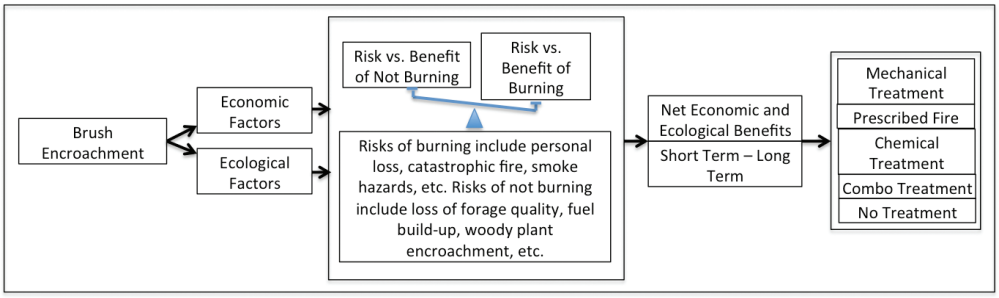

Figure 2. Conceptual model of the decision making process used to determine the application of the brush treatment that will yield the highest economic and ecological effects in the short term and long term.

burning and enhance the social acceptability of prescribed burning as a management practice.

Prescribed Burning and PBAs in Range Management

Because episodic fire is a natural element of ecosystems in the Southern Plains, and the periodic use of prescribed fire, including occasional extreme burns, is economically superior to other brush control treatments, the primary obstacle to the application of fire by land managers appears to be their perceptions that deliberately igniting fire is risky due legal liability. If woody-plant–invaded rangelands characterized by private landownership are to be restored to open grasslands and savannas, the broad-scale reintroduction of periodic extreme fires appears to a necessary first step. To accomplish this objective, promoting the establishment and support of PBAs appears to be a critical approach to increasing landowner willingness and ability to apply prescribed fires.

To demonstrate this, we present a conceptual model of a landowner's decision-making process when selecting brush reduction treatments (Fig. 2). When making decisions about brush management, landowners need to consider the effectiveness of alternative treatments and the frequency of treatment reapplication. They also need to determine both the short-term and the cumulative economic and ecological consequences of the treatments. Long-term land degradation incurs a hefty restoration price tag that landowners generally cannot afford to pay. Based on the objectives that have been set out for a particular piece of land, the risk of burning versus the risks of not burning need to be taken into account. PBAs can reduce the risks of burning for a landowner, effectively tipping the scale to promote more burning. By maintaining ecological processes with which rangeland ecosystems have evolved, such as periodic fire, conservation-minded land managers may not only more effectively sustain income streams from grazing livestock, but they may also increasingly be able to capitalize on additional income-earning opportunities. Through their land management, such ranchers may more effectively maintain or increase the delivery of what are generally considered free ecosystem goods and services for which society is increasingly willing to pay.

Fires are a natural occurrence in many rangeland ecosystems and cannot be avoided indefinitely. As the 2011 fire season in Texas has once again amply demonstrated, under hot dry weather conditions that follow periods of fuel load accumulation, herbaceous and woody vegetation will eventually burn often as uncontrolled wildfires that cause substantial infrastructural damage and loss of human life. Effective brush treatments need to be considered to reduce fuel loads to acceptable safety standards and to maintain ecosystem integrity. Prescribed fire has several clear rangeland restoration and conservation benefits, and, despite risk and liability concerns, burning is an economically and ecologically feasible land management practice that has been recommended as a superior woody plant treatment option.[1,2,9] However, depending on the property, the type of ownership, and time-specific conditions, prescribed fire may not always be the best brush management choice. Nevertheless, by carefully weighing ecological, economic, and legal benefits and risks of alternative treatment options, it may be possible to use judiciously timed prescribed fire to restore rangeland ecosystems at the landscape scale in areas where brush invasion has become a severe problem. By reducing the equipment and labor costs as well as risk and legal liability concerns of applying prescribed fire on private land, PBAs have proven to be a valuable tool for encouraging landowners to apply fire across the landscape to reduce woody plants. At the end of the day, in rangelands it is generally not a question if they will burn but when will they burn and how much control over the fire land managers can exert when they do burn.

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