Liability of Using Prescribed Fires on Forestlands and State Legislation Evolution

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Abstract

Escalating wildfires on forestlands in recent years have resulted in statutory changes in redefining the liability for landowners in using prescribed fires. This study summarized these reforms in recent years. While in some states there is still strict tort liability for damages from prescribed fires, eighteen states have reduced the liability burdens on landowners with simple negligence rules, and furthermore, four states with gross negligence rules. A multivariate ordered probit model across the fifty states was estimated to examine the factors that have influenced the retaining of certain liability rules in a state. Demand of prescribed fires from industrial and nonindustrial private forestland owners turned out to be the key driving force behind these statutory changes related to prescribed fires.

Keywords: burning law, liability, negligence, ordered probit, prescribed fires

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1. INTRODUCTION

The long-term suppression fire policy nationwide in past decades has resulted in high fuel accumulations on forestlands (Mutch 1994). This has been reflected in the increasingly severe fire seasons in recent years with more acres burned, increased number of catastrophic fires, problematic containment and suppression, and increased financial costs (National Interagency Fire Center 2004).

There are various ways of reducing fuel accumulation in forests. Especially, fire itself in the form of prescribed fire can be useful in reducing wildfire risk. Except fuel reduction, there are also other benefits associated with prescribed fires: vegetation control, wildlife habitat, site preparation, disease control, visibility for harvesting and recreational use, air quality, and water quality (McNabb 2001). Research also revealed that compared to other forest practices, prescribed fire often may be the least expensive or more effective management tool available (Dubois et al. 2003).

Recognizing the wide benefits associated with prescribed fires, landowners and public agencies have increased their use of prescribed fires in recent years. On the National Forests, acres treated by prescribed fire increased by 76% between 1985 and 1994, and average annual treatment reached 908,000 acres (Cleaves et al. 2000). From 1995 to 2000, annual acreage treated on federal wildland has further increased to 1,440,000 acres (National Interagency Fire Center 2005). On private forestlands, prescribed fires also have been widely used, especially in the south. A survey study by Haines and Busby (2001) revealed that more than 4.1 million acres per year of pine-type forests were burned between 1985 and 1994 in the south; approximately 88% of them were on private and state lands. Fuels managers were asked to estimate the annual area that should be burned to achieve their goals based on the mix of resource management purposes. The Forest Service burned about 63% of the fuels managers' self-described optimum targets, compared to 48% on private and state lands.

The demand and use of prescribed fires on forestlands have been increasingly subject to various constraints. One of the most cited is potential liability with escaped fires (Haines and Cleaves 1999; Haines and Busby 2001; Brenner and Wade 2003). For instance, an escaped prescribed fire during the summer of 2000 from the Bandelier National Monument burned into the Los Alamos Canyon, forced 18,000 people to be evacuated, and destroyed 250 homes (Hesseln 2001). Escaped fires may damage neighboring properties and persons and smoke released from fires also may cause accidents on roads. For many private landowners, the possibility of getting sued and potential litigation costs have been their immediate concern in considering prescribed fires.

Given the demand for prescribed fires from land management community and the concern of liability, state legislators have responded by revising state liability laws in recent years. In this regard, the State of Florida has been leading these statutory reforms. In 1990, Florida passed the Prescribed Burning Act, nationally recognized as landmark legislation in protecting a landowner's right to use fire as a management tool. Under the Act, a landowner or burner is not civilly liable for damages unless simple negligence in using prescribed fire is found. Furthermore, in the wake of the disastrous 1998 fire season in Florida, the Florida legislature modified its previous law so that a landowner or burner cannot be found civilly liable unless a court demonstrates that the burner was "grossly negligent." According to many legal minds, that is a dramatic change and reduction of liability burden on landowners in using prescribed fires (Brenner and Wade 2003). Following Florida's reform, many other states have changed their laws related to prescribed burning.

This wave of statutory reforms at state legislatures about the liability in using prescribed fires has received limited coverage in the literature so far. Brenner and Wade (1992; 2003) conducted excellent reviews on these changes in Florida. Haines and Busby (2001) and Haines and Cleaves (1999) covered regulatory and voluntary programs for prescribed fire in the Southern states. Yoder et al. (2003) focused on developing a theoretical economic model of the incentive and welfare effects of prescribed burning, while the characteristics of prescribed fire liability laws were examined for some states within the context of the model. There is also a large related body of literature that examines fire risk and management (e.g., Stanton 1995; Eshee 1997; Hesseln 2000; Prestemon et al. 2002).

Given the need of a comprehensive examination of state statutory changes related to prescribed fires study in recent years, the objective of this study is two-fold. First, a complete review of legislative reforms in each state concerning with the liability of using prescribed fires will be conducted. This will cover the most recent legislation in Michigan in 2005. It also will cover some earlier reform, but largely neglected in the literature, such as the gross negligence rule in Nevada. Second, a quantitative analysis will be performed to examine why states have retained different liability rules in regulating prescribed fires. Interest group theory of government and economic theory of legislatures (Benson and Engen 1988) will be used to explain the type of burning law retained in a state. A multivariate ordered probit model will be estimated to assess the influences of various factors on the choices by state legislatures.

The rest of the paper is organized as follows. A review of state statutory regulations across states will be conducted first. The trend of these changes over time also is briefly summarized. In the third section, theoretical and empirical models will be presented in analyzing the trends. Then an ordered probit analysis of these trends will be conducted to evaluate the determinants of different negligent rules. Empirical results are presented and conclusions will follow.

2. TORT LAW AND STATE BURNING ACT

Prescribed (or controlled) burning involves the use of fire as a tool to reduce fuel accumulation, destroy competing undergrowth, prepare sites for reforestation, and enhance the perpetuation and restoration of many plant and animal communities. Nevertheless, these benefits do not come without costs. Fire is inherently dangerous and may impose risk upon others. Our society has developed regulations that prescribe standards of behavior to limit these risks, and if there is any damage from fire, these regulations may be used to assign liability (Cooter and Ulen 2000; Eshee et al. 2003).

The liability issue related to prescribe fires falls into the category of tort law. A tort is a civil wrong which is the result of some types of socially unreasonable and unacceptable behavior. In the case of prescribed fires, tort law provides the remedy to solve disputes between victims (i.e., plaintiff) and landowners (i.e., burner, injurer, or defendant). There are various tort rules and they can be divided into intentional torts, strict liability torts, and negligence torts (simple or gross). Many intentional torts such as arson are also crimes. A person who commits such an act may be sued for damages under tort law by the victim and also prosecuted under criminal law by the state. Intentional torts are so much like crimes that they are not discussed here. Instead, this review focuses on three tort rules (i.e., strict liability, simple negligence, and gross negligence), and these related burning laws currently retained in each state.

Strict liability

Strict liability or absolute liability is liability without fault. It holds a defendant liable for actions even if the defendant is entirely unintentional and nonnegligent. Under strict liability, should the activity cause any injury, the person who engaged in the activity will always be held liable regardless of precautionary measures. Three areas of strict liability have been defined by the law: ultra-hazardous activities, animals, and product liability (Eshee et al. 2003).

Forest fires have traditionally been perceived as dangerous activities. In some states, there are still heavy liability burdens on landowners or his agents who employ prescribed fires. For example, in Minnesota, a person is guilty of a misdemeanor if the person has a burning permit and fails to keep the permitted fire contained within the area described on the burning permit, or if the person fails to keep the fire restricted to the materials specifically listed on the burning permit (Minn. Stat. §88.195). In Hawaii, setting fires or causing them to be set or allowing them to escape shall be prima facie evidence of wilfulness, malice, or negligence (HRS §185-7).

Other states with similar statutory languages are Delaware, Pennsylvania, Rhode Island, and Wisconsin (Table 1). These regulations and statutes clearly express the high possibility of liability assignment on landowners if there is any damage from escaped fires. For the purpose of this study, these codes are interpreted as strict liability tort rules, or very close to strict liability rules because of the heavy liability burdens imposed on landowners.

Simple negligence

A rule of negligence requires the plaintiff to prove harm, causation, and breach of a duty (i.e., fault). Unlike a rule of strict liability, a negligence rule permits the defense that the accident occurred in spite of the fact that the defendants satisfied all the applicable standards of care. As a result, a negligence rule may allow the defendant to reduce or even avoid the liability. Negligence rules also can be further divided into simple negligence and gross negligence. Simple negligence, also referred as negligence, is carelessness or the lack of the exercise of due care toward others or their property. The standard for measuring whether or not a person is simply negligent is the reasonable prudent person.

Table 1 Summary of state prescribed burning laws

Strict liability ($Y = 0$)	Uncertain liability ($Y = 1$)	Simple negligence ($Y = 2$)	Gross negligence ($Y = 3$)
Delaware	Arizona	Alabama	Florida
Hawaii	Colorado	Alaska	Georgia
Minnesota	Connecticut	Arkansas	Michigan
Pennsylvania	Idaho	California	Nevada
Rhode Island	Illinois	Kentucky	
Wisconsin	Indiana	Louisiana	
	Iowa	Maryland	
	Kansas	Mississippi	
	Maine	New Hampshire	
	Massachusetts	New Jersey	
	Missouri	New York	
	Montana	North Carolina	
	Nebraska	Oklahoma	
	New Mexico	Oregon	
	North Dakota	South Carolina	
	Ohio	Texas	
	South Dakota	Virginia	
	Tennessee	Washington	
	Utah		
	Vermont		
	West Virginia		
	Wyoming		
N = 6	N = 22	N = 18	N = 4

Source: The online database of the Lexis-Nexis Academic Universe was searched by using the following keywords: forest and fire, controlled fire, prescribed fire, burning, liability, and negligence.

In 1990, Florida passed the Prescribed Burning Act, nationally recognized as landmark legislation in order to limit liability of trained professionals utilizing fire under appropriate circumstances. It recognizes that prescribed burning is a right of landowners and a management tool that are beneficial to public safety and the environment. The Act was designed to eliminate the presumption of fire as inherently dangerous and change the standard of liability to simple negligence and reasonable care. The Act states that no property owner or agent conducting a prescribe burning in accordance with the Act will be liable for damage caused by fire or smoke unless (simple) negligence is proven (Brenner and Wade 1992).

Following Florida's pioneer legislation in 1990, many states adopted similar prescribed burning laws and have clear tort rules of simple negligence. These states include Alabama (Ala. §9-13-270; 1995), Louisiana (La. R.S. 3:17; 1993), Mississippi (Miss. Code Ann. §49-19-301; 1992), North Carolina (N.C. Gen. Stat. §113-60.40; 1999), Oklahoma (2 Okl. St. §16-28; year not clear), South Carolina (S.C. Code Ann. §48-34-10; 1994), Texas (Tex. Nat. Res. Code §153.081; 1999), and Virginia (Va. Code Ann. §10.1-1150; 1998). There are some other states that do not have such legislation but contain similar languages and liability rules. They are also classified as states with simple negligence rules as listed in Table 1. In total, there are 18 states with simple negligence rules.

Gross negligence

Gross negligence is the lack of even slight care and the intentional failure of a defendant to carry out a duty toward others or their property in a reckless disregard of the consequences of his activity. Compared to simple negligence, gross negligence just needs a slight diligence and entails a much smaller amount of carefulness and circumspection. The standard of care for gross negligence is much lower than that for simple negligence. Thus it dramatically reduces the burden on defendant (i.e., landowner or burner in the case of prescribed fires in this study).

In 1999, Florida modified its simple negligence rule contained in the 1990 Prescribed Burning Act into a gross negligence rule (Brenner and Wade 2003). At present, in the State of Florida, a property owner or his agent is not liable for damage or injury caused by the fire or resulting smoke unless gross negligence is proven (Fla. Stat. §590.125; 1999). Similarly, Georgia adopted simple negligence rule in 1992 and gross negligence rule in 2000 (O.C.G.A. §12-6-148). Michigan adopted simple negligence rule in 1995 and gross negligence rule in 2005 (MCLS §324.51501).

Contrary to the common belief, Florida is not the first state that has gross negligence rule for prescribed fires, even though its reform may have been the most widely recognized in the literature. In 1993, Nevada actually adopted a similar gross negligence rule (NRS §527.126). According to the rule, the State of Nevada, an agency of this state or any political subdivision or local government, or any officer or employee, is not liable for any damage or injury to property or persons, including death, which is caused by a controlled fire that is authorized pursuant to the section of §527.126, unless the fire was conducted in a grossly negligent manner. Currently, Nevada has 10.2 million acres of forestlands, and 94% of them are public (Smith et al. 2004). Other state legislatures in the region with similar forestland ownership did not follow its step in giving government immunity in using prescribed fires. Thus, the differences in forestland ownership and demand of prescribed fires in the west and the south may partially explain why gross negligence tort rules have been more received in the south in recent years.

Activity levels and regulations

Different tort rules influence the behavior of parties in different ways. In the case of prescribed fire, the three tort rules examined above (i.e., strict liability, simple negligence, and gross negligence) may have different effects on the amount of activities engaged by landowners. Economic theory reveals that if bilateral precaution is possible (which is true for prescribed fires in most cases), no tort rule is efficient in achieving efficient levels of activity (Cooter and Ulen 2000). Strict liability rule assigns all liability to burner and can depress burning activities to a very low level. Simple negligence rule may result in more activities. Gross negligence rule may encourage prescribed fire activities to a level too high to society. Therefore, In order to have an efficient level of prescribed activities, an additional control variable may be needed from outside tort liability rules.

State legislators apparently recognized that and have incorporated it into the statutory reforms for prescribed burning. Along with prescribed burning acts, detailed regulations specifying precaution measures have usually been passed together. These regulations increase the cost of precautions but make the legal standard much clearer and reduce the associated liability uncertainties on landowners. For example, in 1999 Mississippi adopted the “Mississippi Prescribed Burning Act.” (Miss. Code Ann. §49-19-301, et. seq.). Prescribed burning conducted under the provisions of the Act must: (a) be supervised by at least one certified prescribed burning managers; (b) be conducted pursuant to a written prescription notarized prior to the burning; (c) be permitted by the Mississippi Forestry Commission; and (d) be considered in the public interest not constituting a public or private nuisance when conducted pursuant to state air pollution statutes and rules.

In summary, across the fifty states, there exist wide differences in the liability tort rules for damages resulted from prescribed fires. There are still six states that have strict liability rules or similar and tend to hold landowners or burners liable for damages regardless of precautionary measures. Since the 1990s, statutory reforms across the states have gradually moved toward a negligence tort rule as the demand from the land management community of using prescribed fires continues to increase. At present, eighteen states have simple negligence rule and four states have gross negligence rules. Nevertheless, twenty-two states still do not have specific statutes about prescribed fires and its liability. Common laws usually are followed to assign liability. Because of the uncertainty, the liability burden for landowners in these states is usually between strict liability rule and simple negligence (Table 1). Overall, the evolution of state burning liability rules and the distribution across states present a good empirical setting to examine what factors have influenced the retaining of current state liability laws.

3. ANALYTICAL FRAMEWORK

A categorical examination was conducted on the retaining of state burning laws across the fifty states. Such an analysis was based on the notion that because legislation was not passed in a vacuum, the atmosphere within which these laws were passed should have a significant impact on their content. Based on the work of Benson and Engen (1988), interest group theory of government (demand-side) and economic theory of legislatures (supply-side) were used to explain the type of burning laws that has been retained within each state. These theories together treat the legislative process as a “market for laws.”

The interest group theory of government is based upon the assumption that all legislation has the intended goal of benefiting some particular groups, and that the benefits will flow to well organized and politically powerful interest groups from relatively less powerful groups or unorganized individuals. On the supply side of the “market,” a state legislature is characterized as a firm that “produces” laws. A legislature’s production of laws is not costless. There are institutional constraints which limit the supply of the legislative output.

Due to the absence of data on the price of law, structural supply and demand equations are rarely estimated. Rather, as Mehmood and Zhang (2002) explained, the following general reduced form equation is estimated.

(1) $Y = f(D, S; \beta, \varepsilon)$

Y is a categorical dependant variable of burning law in a state as shown in Table 1 (Y = 0, 1, 2, 3). The choice of burning law in a state is hypothesized to be determined by demand side variables (D), and state legislature features (S). β is the coefficients to be estimated and ε is the error term.

Because the dependent variable in the model is categorical in nature, the use of an ordered probit model is appropriate. It assumes an underlying continuum in the categorical dependent variable but does not assume uniform increments between categories. The ordered probit model adopted here has come into fairly wide use as a framework for analyzing such categorical legislative decisions. The model can be built around a latent regression in the same manner as a binomial model (Greene 2003; Quantitative Micro Software 2005):

(2) $Y^* = X\beta + \varepsilon$.

where X is the independent variables. As usual, Y^* is unobserved and what is observed is

$$
\begin{aligned}
Y &= 0 \text{ if } Y^* \leq \mu_1 \\
&= 1 \text{ if } \mu_1 \leq Y^* \leq \mu_2 \\
&= 2 \text{ if } \mu_2 \leq Y^* \leq \mu_3 \\
&= 3 \text{ if } \mu_3 \leq Y^* .
\end{aligned}
\tag{3}
$$

The μ's are unknown parameters to be estimated with β. A separate constant term is not separately identifiable from above limit points (μ's). The probability associated with each category can be expressed as:

$$
\begin{aligned}
&\text{Prob}(Y = 0) = \Phi(\mu_1 - X\beta) \\
&\text{Prob}(Y = 1) = \Phi(\mu_2 - X\beta) - \Phi(\mu_1 - X\beta) \\
&\text{Prob}(Y = 2) = \Phi(\mu_3 - X\beta) - \Phi(\mu_2 - X\beta) \\
&\text{Prob}(Y = 3) = 1 - \Phi(\mu_3 - X\beta).
\end{aligned}
\tag{4}
$$

By definition, the sum of all probabilities is one. The log-likelihood function and its derivative can be obtained readily and optimization can be done by the usual means.

For all the probabilities, the marginal effects of changes in the regressors are:

$$
\begin{aligned}
&[\partial \text{Prob}(Y = 0)]/\partial X = -[\phi(\mu_1 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 1)]/\partial X = [\phi(\mu_1 - X\beta) - \phi(\mu_2 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 2)]/\partial X = [\phi(\mu_2 - X\beta) - \phi(\mu_3 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 3)]/\partial X = [\phi(\mu_3 - X\beta)]\beta.
\end{aligned}
\tag{5}
$$

Interpreting ordered probit coefficients is not as straightforward as for ordinary least squares coefficients. In general, when X changes, only the direction of the change in the probability of falling in the endpoint rankings (i.e., Y = 0 or Y = 3 in this study) are unambiguous. Prob(Y = 0) changes in the opposite direction of the sign of β and Prob(Y = 3) changes in the same direction as the sign of β. The effect on the probability of falling in any of the middle rankings (i.e., Y = 1 or Y = 2) depends on the two densities and therefore it is ambiguous. The sum of marginal effects of all four categories is zero.

4. VARIABLES, HYPOTHESES AND DATA

The variables adopted, definitions, data sources, and descriptive statistics were summarized in Table 2. The design was cross-sectional, with state-level data collected primarily from the mid-1990s to current. The dependent variable (*Y*) was a categorical variable representing the variation in liability burdens of state burning laws. Y was equal to zero if a state has a statute with strict liability or similar for prescribed fires. Y was equal to one if a state has no statute or is not specific about the liability. Y was equal to two if a state has a simple negligence rule. Y was equal to three if a state has a gross negligence rule.

Along the division of interest group theory of government (demand-side) and economic theory of legislatures (supply-side), the independent variables were organized into three groups. The first group was used to represent the demand of state liability law from special interest groups. *FYNFS* was the area of the National Forests in a state. *FYIND* was the area owned by industrial forest landowners in a state. *FYNIP* was nonindustrial private forestland areas in a state. The mean of *FYNFS*, *FYIND*, and *FYNIP* was 3.0, 1.3, 7.3 million acres, respectively. In addition, *AGEN* was the number of permanent personnel in state forestry programs. Interest groups represented by these four variables are most interested in using prescribed fires and concerned with the potential liability. They definitely prefer less burdensome liability rules. State agencies also may support that because light liability rules usually come with more regulations such as obtaining permits from state forestry agencies, which in turn increases agencies' authority. Therefore, forestland acreages and the size of state forestry agencies were supposed to be positively related to the possibility of retaining state burning laws with light liability to landowners (i.e., $Y = 3$).

The second group was demographic characteristics, which was more related to general constituent interests in a state. *POPRUR* was the rural population in a state. Prescribed fires may put in danger properties of these people in the rural areas. However, many people in the rural areas may also own forestlands and demand light liability rules as landowners. So the effect of *POPRUR* was uncertain. *EDU* was the population 25 years old with advanced degrees in a state. *INC* was per capita income in a state. People with better education and higher income were perceived to be more supportive of using prescribed fires as a land management tool. So larger values of *EDU* and *INC* were expected to increase the likelihood of retaining gross negligence rule (i.e., $Y = 3$).

Table 2 Variables definitions, data sources, and descriptive statistics

Variable	Definition (source)	Mean	Mini	Maxi
Y	Categorical dependent variable (*Y* = 0, 1, 2, or 3) (a)	1.4	0.0	3.0
FYNFS	National Forests area in a state (million acres) (b)	3.0	0.0	18.5
FYIND	Industrial forestland area in a state (million acres) (b)	1.3	0.0	7.4
FYNIP	Nonindustrial private forestland area in a state (million acres) (b)	7.3	0.3	35.9
AGEN	Permanent forestry program personnel in a state (c)	312.8	23.0	3735.0
POPRUR	Rural population in a state (million) (d)	1.2	0.1	3.6
EDU	Population 25 years old with advanced degrees in a state (million) (d)	0.3	0.0	2.0
INC	Per capita income in a state ($ thousand) (d)	20.8	15.9	28.8
DAY	The maximum length of legislative sessions in calendar days in a state (e)	166.3	42.0	350.0
BIANN	A dummy variable equal to one for states with annual legislative sessions, zero with biannual (or less) (e)	0.3	0.0	1.0
SEAT	The total number of legislative seats (Senate plus House) in the legislative body in a state (e)	147.6	49.0	424.0
BICAM	The level of bicameralism in a state, defined as the size of the Senate divided by the size of the House (e)	2.9	0.0	16.7
COMIT	The total number of standing committees in a state (e)	34.6	10.0	69.0
RATIO	The total number of standing committees in a state divided by the number of legislators (e)	4.9	1.2	18.6

Data sources:
(a) Lexis-Nexis Academic Universe (see Table 1);
(b) Smith et al. (2004);
(c) The 2002 State Forestry Statistics Report by the National Association of State Foresters (http://www.stateforesters.org);
(d) 2000 Census of Population and Housing (http://factfinder.census.gov);
(e) The Council of State Governments (2004).

The third group was the characteristics of state legislatives, which represented legislative constraints discussed by Crain (1979) and Benson and Engen (1988). *DAY* was the maximum length of each state's legislative sessions in calendar days. *BIANN* was a dummy variable equal to one for states with annual legislative sessions, zero with biannual sessions or others. *SEAT* was the total number of legislative seats (Senate plus House) in each state's legislative body. As the number of decision-makers in the legislature or the length of legislative sessions increase, the transaction costs of achieving a majority rise. This constrains the legislature's ability to cater to interest groups. However, an increase in the size of the legislature or the session length increases the opportunities for potential gains from labor specialization by legislators and from lobbying by interest groups. These competing impacts result in uncertain signs for the coefficients.

BICAM was the level of bicameralism in each state, defined as the size of the Senate divided by the size of the House. Similarity between the two houses may affect production costs and the degree of meeting constituent interests (Benson and Engen 1988). *COMIT* was the total number of standing committees in each state. *RATIO* was the total number of standing committees in each state divided by the number of legislators. More standing committees and smaller groups may facilitate labor specialization and better respond to the demand from interest groups. However, as the number of committees increases, adequacy of resources may become a constraint. Overall, theories do not provide any prior expectations for these variables.

All the fifty states were included in the dataset. The status of liability rules in each state was determined by searching the online database of the Lexis-Nexis Academic Universe. Data for forestland areas by ownership were collected from Smith et al. (2004). Personnel employed by state forestry programs were from the 2002 State Forestry Statistics Report by the National Association of State Foresters (http://www.stateforesters.org). Demographic data for rural population, education, and income were from the 2000 Census of Population and Housing (http://factfinder.census.gov). The legislature characteristics were compiled from the Council of State Governments (2004).

5. EMPIRICAL FINDINGS

A multivariate ordered probit regression model was estimated to examine these factors that have affected the retaining of certain liability rules about prescribed fires in a state. Three models were estimated. Fist, considering the importance of forestland ownership and demand of prescribed fires in land management community, a regression was estimated with the three forestland variables only. Then a full model was estimated with all the explanatory variables included. Finally, a reduced model was estimated with three insignificant variables excluded using the Wald test (Quantitative Micro Software 2005). In the reduced model, two variables (*FYNFS* and *SEAT*) became significant at the 10% level or better. For all other variables, the results have been quite stable. The reduced model was selected for all of the following analyses. For these significant variables in the reduced model, marginal effects evaluated at the mean of explanatory variables were reported in Table 4.

Empirical results reported in Table 3 revealed several interesting findings. First of all, the size of forestlands by ownership in a state appeared as the key factor in determining what kind of state burning law a state would adopt. For both industrial and non-industrial private forestland acreages, the coefficients were positive and highly significant. The possibility of adopting gross negligence rule ($Y = 3$) was positively related to the size of private forestlands in a state, while that for strict negligence rule ($Y = 0$) was on the contrary. For the middle rankings, it depends on the size of forestlands in a state. At the sample mean, simple negligence rule was preferred by private landowners while uncertain liability rule was not. Furthermore, between industrial and non-industrial private forestlands, the effect of the former was at least ten times larger, as revealed by the marginal effects in Table 4. For example, the marginal effect of adopting simple negligence ($Y = 2$) was 0.149 for *FYIND* while only 0.015 for *FYNIP*. This indicated that industrial landowners might have more influences over the legislators than NIPF landowners.

Table 3 Results of the ordered probit regression

Variables	Model 1		Model 2		Model 3	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
FYNFS	0.00	-0.21	-0.04	-1.06	-0.04	-1.62*
FYIND	0.25	2.02**	0.44	3.44***	0.45	4.00***
FYNIP	0.05	2.15**	0.04	2.14**	0.05	2.28**
AGEN			0.00	0.31		
POPRUR			0.11	0.31		
EDU			1.32	1.63*	1.48	2.52***
INC			0.04	0.59	0.03	0.52
DAY			0.00	-0.84	0.00	-0.76
BIANN			-0.54	-0.78	-0.51	-0.78
SEAT			0.01	0.90	0.01	1.95**
BICAM			0.05	0.32		
COMIT			-0.07	-2.42**	-0.07	-2.67***
RATIO			-0.29	-1.95**	-0.30	-2.25**
Log likelihood (L)	-52.42		-46.19		-46.30	
Restricted L	-59.28		-59.28		-59.28	
LR statistic	13.71		26.18		25.96	
LR index (Pseudo R^2)	0.12		0.22		0.22	

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

The size of the National Forests in a state showed a negative coefficient and became significant at the 10% level in the reduced model. This is contrary to general expectation because there has been increasing use of prescribed fires on the National Forests (Cleaves et al. 2000) and reducing liability burdens on burners should be to their interests. A further examination of Table 1 revealed that currently most states that have adopted simple or gross negligence rules are in the south and east, but not in the west. Southern states have numerous private forestland owners and their demand for reducing the liability burden apparently has been much stronger and more persistent. In contrast, it turned out that large acreage of the National Forests in the west has not prompted much demand for reducing burners' liability. Nevada adopted gross negligence liability rule in 1993 but this immunity on governmental burning activities did not attract any follower in the west where public forestland ownership dominates. The negative sign and weak effect for *FYNFS* was consistent with these facts.

Among the demographic characteristics, EDU had significantly positive effect. This implied that the higher education level in a state, the larger the possibility of a state's legislature passing light liability tort rule. *POPRUR*, *INC*, and *AGEN* did not show any significant effect.

Of the six variables representing state legislatives, *SEAT*, *COMIT*, and *RATIO* were significant. The possibility for adopting light liability rules in a state was higher when there were more state legislative seats, less committees in the legislative body, and fewer committees per legislator.

Table 4 Marginal effects of standardized changes

	$Y = 0$	$Y = 1$	$Y = 2$	$Y = 3$
FYNFS	0.005	0.012	-0.014	-0.003
FYIND	-0.052	-0.126	0.149	0.029
FYNIP	-0.005	-0.013	0.015	0.003
EDU	-0.169	-0.413	0.488	0.094
SEAT	-0.001	-0.003	0.004	0.001
COMIT	0.008	0.020	-0.024	-0.005
RATIO	0.034	0.084	-0.099	-0.019

Complementary to the marginal effects at the variable means as reported in Table 4, a more comprehensive observation of the effects can be attained by showing the probability over the whole range of an explanatory variable. In Figure 1, the effect of varying the nonindustrial forestland areas in a state (i.e., *FYNIP*) on the probability of a state adopting one of the four categories of state burning laws was demonstrated, holding all other variables at their means. The graph was drawn by using the coefficients from the reduced model (i.e., Model 3 in Table 3). Each point on the graph represented the probability that a state would impose one of the four categories of state burning laws, given a specific proportion of nonindustrial private forestlands. The slope of a curve was the marginal effect of *FYNIP*.

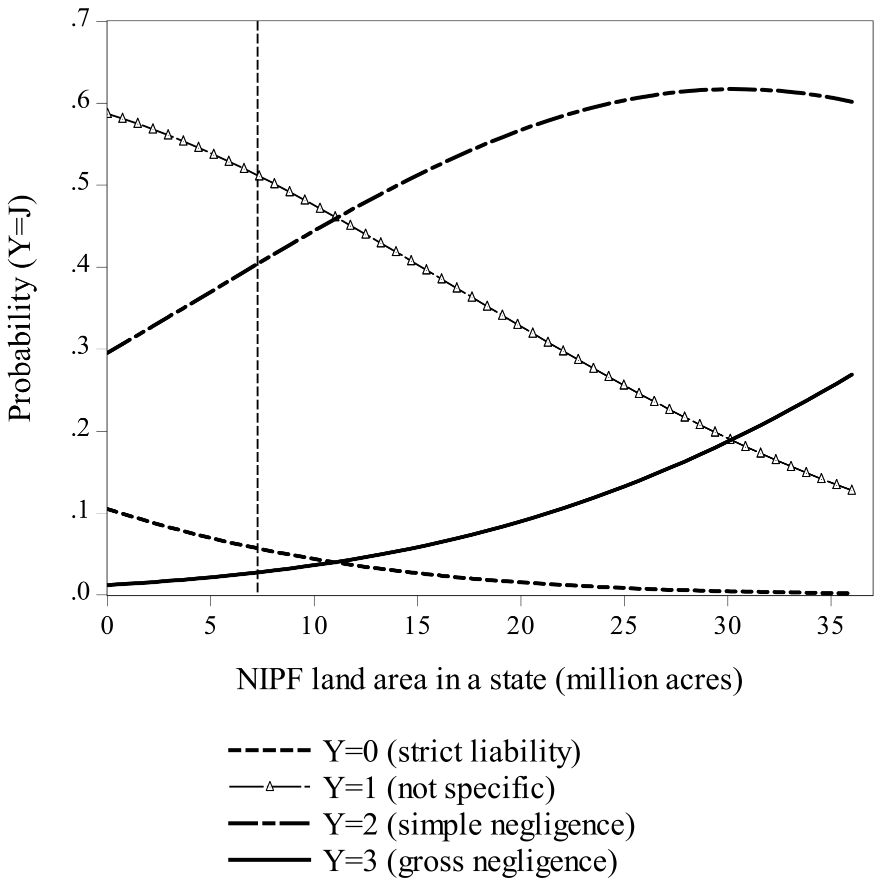
The Figure revealed several results. First, at the mean of *FYNIP* (i.e., 7.3 million acres and the dashed line in Figure 1), the slopes of the curves were these marginal effects for *FYNIP* as reported in Table 4. Second, over the most of the range of *FYNIP*, the curves for strict liability and gross negligence (i.e., $Y = 0$ and 3) were below the other two (i.e., $Y = 1$ and 2); in other words, the former had lower probabilities than the latter. This was consistent with the current status of state burning laws that most states have either simple or uncertain negligence rules. Third, the curvature revealed the signs and range of marginal effects. An upward trend of the curves indicated a positive relation (i.e., positive marginal effect) between *FYNIP* and the probability for falling in that category of *Y*, while a downward trend indicated a negative relation. For an ordered probit model, the signs of regression coefficients are consistent with these relations with the choices at end. For strict liability ($Y = 0$), the curvature was monotonically decreasing so the higher of *FYNIP* in a state, the lower the probability of strict liability tort rule in a state. For gross negligence ($Y = 3$), the relation was on the contrary. For $Y = 2$ or 3, the effects changes with the variation of *FYNIP*. This was especially apparent with simple negligence rule. Finally, when the size of nonindustrial private forestlands in a state was larger than 11 million acres, the probability of simple negligence became higher than that for uncertain tort rules, and the probability of gross negligence rule became higher than that for strict liability.

6. CONCLUSIONS

This study focused on liability burdens when landowners use prescribed fires as a management tool on forestlands. The evolution of state burning laws in recent decades has been reviewed and classified by several liability categories. A multivariate ordered probit analysis was conducted to examine the factors that might have influenced legislators' choices.

The review revealed that state statutory reforms about prescribed fires in recent years have gradually moved from heavy liability burdens on landowners toward a negligence tort rule.

Figure 1 Effects of NIPF land area on the variation of liability burdens of state burning laws



Note: The position of vertical dash line is the mean of NIPF land areas.

Currently, six states still have strict liability rules. Twenty-two states have no statutes or are not specific about liability. Eighteen states have either adopted simple negligence rules by passing Prescribed Burning Act or clearly indicate that in the regulations. Four states even passed laws to explicitly recognize gross negligence tort rule to reduce the potential liability on landowners.

These changes and evolution may reflect the demand from the land management community of using prescribed fires as a management tool. In recent several decades, wildland fires have become more severe and the demand of using prescribed fires in reducing fuel accumulations has been high. The State of Florida has been leading the changes in the south following several catastrophic fires in the state. Overall, demand of prescribed fires has driven the statutory changes in related tort laws.

The quantitative analysis through ordered probit model confirmed these impressions. Private forestlands acreages have appeared as the key factors in affecting the possibility for a state to adopt different liability rules. Larger private forestland ownership was associated with higher possibility of adopting simple and gross negligence rules. Industrial private forest landowners were even more influential, compared to nonindustrial private forestland owners. In addition, several factors charactering state legislatures also showed significant effects. States with large legislative body and few committees tended to allow light liability burdens on landowners.

Given the continued attention to forest fires, this study raised vital questions regarding the future of statutory law reforms related to prescribed fires. Future studies are needed to examine how these statutes have been interpreted in the courts. In addition, whether these statutes have encouraged the use of prescribed fires in actual forestry management and practices in recent years is a question that merits further observation and analysis.

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