Journal of Forestry, 2020, 385–402
doi:10.1093/jofore/fvaa017
Research Article - fire & fuels management
Received January 13, 2020; Accepted March 16, 2020
Advance Access publication April 27, 2020

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Research Article - fire & fuels management

Regulation and Practice of Forest-Management Fires on Private Lands in the Southeast United States: Legal Open Burns versus Certified Prescribed Burns

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Abstract

Forest-management burns have been widely acknowledged as a useful land-management tool in the United States. Nevertheless, fire is inherently risky and may lead to severe damages or create smoke that affects public health. Past research has not explored the difference in policy and practice between open burns, which meet minimum legal criteria, and certified prescribed burns, which follow a higher standard of care. This study seeks to understand the distinction between legal open burns and certified prescribed burns, and, furthermore, to identify trends by type of burn in the Southeast United States. To that end, we compared statutes, regulations, incentives, and notifications of fire as a forest-management tool among nine states in the US Southeast. We found no steady time trends in number or area of burns among the states for the past decade. A nontrivial proportion of legal open burns, which tend to be smaller burns, are noncertified burns, meaning they meet minimum legal requirements, but not the higher standard required for certified prescribed burns.

Keywords: burn notifications, certified prescribed fire, open burning, statutes, regulations, policy

Over the past few decades, fire ("burning") has emerged as an important management tool on forestland in the United States to reduce fuel load, improve wildlife habitat, or control vegetative competition (Ryan et al. 2013). These benefits must be balanced with the fact that burning is an inherently risky tool, including the possibility that individual burns can potentially escape from their intended boundaries, leading to property damages or bodily injuries, or create smoke that affects public health or impairs visibility in sensitive areas (Hauenstein and Siegel 1981, Yoder 2004). Thus, the practice of forest-management burning at times has been contentious.

The southeastern United States has been a leader in the use of burning for forestland management (Haines and Cleaves 1999). The decision to use burning as a means of forest management can be influenced by several categories of factors, including socioeconomics, demographics, and public perceptions; biology, ecology, and topography; and public policy including statutes, regulations, and other incentives. Public policy regarding the use of burning in the Southeast continues to change, and debates remain active on how to balance net benefits with inherent risks (Yoder et al. 2003, Sun and Tolver 2012).

Management and Policy Implications

Open burning laws are defined as those that have criminal penalties for noncompliance, and certified prescribed burning laws are those which limit civil liability. We compared legal open burns and certified prescribed burns for forest management in policy and practice in nine southeastern states. Statutes and regulations for certified prescribed burns were in general enacted in the 1990s to 2010s, much later than for open burns, creating a bifurcated system of law and policy. As more states enacted certified prescribed burn laws over time, the policy landscape became somewhat more uniform in that all states have lower minimum standards for (noncertified) open burns and higher levels of requirements related to planning and preparation for certified prescribed burns. Still, individual states are found to vary widely in both regulation and practice of using open burns and certified prescribed burns on private lands. Although each state has a unique natural environment, resources, social factors, and legal contexts, meaning that complete uniformity is not realistic, the variation between states, and in some cases within states, can be a barrier to broader application of burning.

"Open burning" is the unenclosed combustion of materials in an ambient environment, which includes burning for land management, land clearing, recreation, and other intentional or unintentional fires (Lemieux et al. 2004, Estrellan and Iino 2010). "Prescribed burning" is a subset of open burning, undertaken under specific environmental conditions and following additional precautionary and preparatory rules (Piatek and McGill 2010). These prescribed burns may be certified by a state agency, which confers limits on the liability of the burner (Yoder et al. 2003).

Thus, in states that use a system of certification for burning, burns for forest management can be classified into two types: (1) certified prescribed burns and (2) noncertified open burns. Many states in the US South have developed such a bifurcated system of burn policy as statutes and regulations were changed and new laws adopted over time. In the 19th and early 20th centuries, many states adopted "open burn" statutes and regulations that created criminal and civil liability for burners who do not follow a defined minimum standard of care such as giving prior notification to the state forestry agency or having someone present on site to monitor the burn until it is fully extinguished (Siegel 1985). All burners are required to comply with statutes and regulations for legal open burning; otherwise, they may be subject to criminal prosecution, leading to potential incarceration or fines. For the purposes of this research, we define "open burn" statutes and regulations as those that establish criminal penalties for noncompliant burners.

In the late 20th and early 21st centuries, as the potential benefits of controlled burns for forest management became more widely accepted, states adopted "certified prescribed burn" statutes and regulations that incentivize careful use of burning that meets a higher standard of care, such as contracting a certified burn manager and having a burn plan ("prescription") (Sun 2007, Yoder 2008). Compliance with these higher-level requirements can limit burners' potential civil liability, and states may provide additional incentives to encourage landowners to use prescribed burning, including monetary incentives and subsidized training. "Certified prescribed burns" must also meet the legal requirements of open burns, so they are a subset of open burns, but statutes and regulations focusing specifically on certified prescribed burns provide limits on civil liability and do not ascribe criminal penalties. Burns that meet the minimum open burn legal requirements but not the higher certified prescribed burn requirements are "noncertified open burns."

Several previous studies have reviewed and categorized statutes and regulations related to the use of burning in the US South, showing variability in the level of strictness (Haines and Cleaves 1999, Sun and Tolver 2012); however, these categorizations often combined open burn and certified prescribed burn requirements. A few studies have assessed the trend of administrative law reforms for burning in the US South in recent years, which have shown an overall trend of increasing precaution measures before burning and reducing tort liability for certified prescribed burning (Yoder et al. 2003, Yoder 2004). Other research has examined civil liability standards for prescribed burns (Yoder et al. 2003, Sun 2006) and the impact on rates of burning (Wonkka et al. 2015). However, past studies have not taken an in-depth look at the legal bifurcation of open burns and certified prescribed burns.

The objective of this study is to understand and delineate clearly the distinction between legal noncertified open burns and certified prescribed burns for forest management in policy and practice, and furthermore to identify trends of using open and certified prescribed burns in the Southeast United States. To that end, we

compared statutes, regulations, incentives, and notifications of burning as a forest-management tool among the nine states in the US Southeast.

Materials and Methods

Nine states in the US Southeast are the focus of this study: Alabama (AL), Florida (FL), Georgia (GA), Kentucky (KY), Mississippi (MS), North Carolina (NC), South Carolina (SC), Tennessee (TN), and Virginia (VA) (Figure 1). These states were selected because they are geographically and culturally proximate, and they have abundant forest resources and similar legal and ownership patterns (Melvin 2012). This region includes both the southeastern coastal and southern Appalachian regions; although burning has been more frequently used in the pine forests that are common in the more coastal areas, greater understanding of fire-dependent ecosystems and recent wildfires in the southern Appalachians, due in part to a history of fire exclusion, has raised awareness of the potential benefits of burning.

Statutes and Regulations

To better compare and examine the statutes and regulations in the nine states, we used a multiple-stage policy matrix based on the past work of Haines and Cleaves (1999) and Sun and Tolver (2012). Sun and Tolver (2012) divided the burn-management process into planning and implementation stages, with several policy choices in each. The planning stage entails preparatory steps that must be taken well in advance of the burn, and before seeking authorization for the burn, if applicable. For example, certified prescribed burn managers must receive training, and a burn plan (which might include, e.g., smoke management and emergency treatment plans) must be written. The implementation stage entails activities that must be undertaken immediately before, during, and after

Figure 1. Nine southeastern states comprising the study region.

the burn. For example, before conducting a burn, a gap in combustible material on the ground (fire line) should be established to contain the burn, and certain equipment should be available on site. During the burn, the burner should continually check weather conditions and air quality. After burning, it may be necessary to evaluate accomplishment of objectives. Building on this matrix, we added incentives, which include assistance and liability. Incentives also include penalties for compliance and noncompliance with burning rules. Liability standards for prescribed burning are divided into three categories: strict liability, simple negligence, and gross negligence (Sun 2006).[1] In sum, a total of 13 potential requirements for the planning stage, 20 for the implementation, and seven incentive policies were identified, as summarized in Table 1.

Data collection began by conducting a review of statutes and regulations for open and certified prescribed burns in each state, according to categories in Table 1. Relevant statutes and regulations were identified first by reviewing state-prescribed burning association and forestry agency websites for links to laws, and second, by searching current online statute and regulation databases for the terms "open burn," "prescribed burn," and "prescribed fire." Afterward, we contacted state forestry agency fire chiefs or designees in each of the nine states, requesting a validation of the review of statutes and regulations we provided for their state. All states except one (Alabama) verified the analysis and provided minor corrections.

We used online legal databases to sketch the legal history of open and certified prescribed burn statutes and regulations, with the goal of understanding regional trends in enacting laws over time. We identified the year each statute or regulation was first enacted. Although these laws may be revised over time, or other previous laws may have been repealed, the outcomes are a reasonable indicator of regional legislative trends.

Certified Burn Managers

All states have a required process, such as training or experience, to certify burn managers who could be employed to conduct certified prescribed burns. It is possible to envisage that the level of requirements could impact the number of burners going through the certification process, or that the number of certified burners in the state could impact the number of burns. We asked state fire chiefs or designees to provide us with the current total number of certified burners in each state.

There are differences in provisions among the nine states that make it difficult to compare the data directly. For example, some states do not currently have a recertification or continuing education requirement for certified prescribed burn managers. Therefore, a person who became certified many years ago would still be on the list of certified burners, even if he or she is no longer active (or in some cases may have even passed away).

Burn Notifications

In the states where all open burns are required to give advance notifications to or solicit authorization from the state forestry agency, we requested current and historical information about all notifications. The information requested covers the date of burn, county, planned area of the burn, purpose of burn, whether or not the burn was authorized (if applicable), and whether the burn had met the standards of a certified prescribed burn in that state. Descriptive statistics were used to explore the operational characteristics of open burns in the states. To identify potential time trends, we regressed the number of notifications (or area) on the year, using an alpha level of 0.05 to test for statistical significance.

The states of Kentucky, Tennessee, Mississippi, and Virginia had no statewide database with burn notification or authorization information. Each of the five remaining states (Alabama, Georgia, South Carolina, North Carolina, and Florida) provided data, with varying levels of completeness. Florida and South Carolina provided relatively complete information on the variables described above. Alabama and Georgia included data on most variables but did not include information related to if the burn was a "certified prescribed burn." In the case of Alabama, the state tracked whether or not the data were input through the online system (certified prescribed burners only), state agency employee (certified prescribed burners only), or a phone call (any open burner). Thus, it was possible to infer a "lower bound" on the number of certified prescribed burns by summing the online and employee entries, although this surely misses some certified prescribed burners who used the phone-based notification system. North Carolina does not have a statewide digital database of all open burn notifications, as records may be kept on paper in individual counties, but does require only certified prescribed burners to log information into a statewide online smoke-management tool.

For states with databases that identify burn purposes, we filtered the data only to include forest-management

Table 1. Description of the categories of major burn statutes, regulations, and incentive structures in the states, adapted from Haines and Cleaves (1999) and Sun and Tolver (2012).

Potential requirement or policy		Description
A. Planning stage		
Certification		
P01	Certified burner	The state manages a program to certify prescribed burn managers
P02	Training	Require training to become a certified burn manager
P03	Experience	Require actual burning experience to become a certified burn manager
P04	Recertification	Specify recertification procedures for burners
P05	Decertification	Specify procedures for decertification or revocation
P06	Insurance	Require purchase of liability insurance for burn manager
Prescription		
P07	Burn plan-prepared	Require a written burn plan ("prescription") to be prepared
P08	Burn plan-notarized	Require the burn plan to be notarized or witnessed prior to burn
P09	Burn plan-approved	Require the burn plan to be approved by an agency
P10	Burn plan-minimum	Require minimum items for the burn plan
P11	Burn plan-smoke	Require a smoke management plan in the burn plan
P12	Burn plan-weather	Require weather conditions stated in the burn plan
P13	Burn plan-urgent	Require emergency treatment plan in the burn plan
B. Implementation stage		
Preburn preparation		
M01a	Fire line-present	Require area around the burn to be cleared of flammable material
M01b	Fire line-inspect	Inspect fire control lines by agency
M02a	Equipment-available	Require certain equipment to be available at burn site
M02b	Equipment-inspect	Inspect equipment preparation by agency
Smoke preparation		
M14	Screening	Fire is screened to check potential air quality or visibility issues because of smoke
M15	Set-back	Set-back requirements from roads and highways
M16	Windrow	Windrow restrictions as to size, number, or soil content
M17	Starter fuels	Certain starter fuels prohibited
Burn execution		
M03a	Notification-neighbors	Require notification of adjacent landowners prior to burn
M03b	Notification-agency	Require notification of state agency prior to burn
M03c	Notification-responders	Require notification of local fire department
M03d	Permit/authorization	Require burn permit (written or verbal authorization) prior to burning [Agency has the authority to deny permit]
M04	Time	Specify burning seasons, hours, or bans
M05a	Site-attend	Require presence on site from ignition until a burn is fully extinguished
M05b	Site-cert. burner	Require a certified prescribed burn manager on site
M06	Site-burn plan	Require a written burn plan on site at all times
M07	Site-agency	Inspect and supervise burning on site by agency
Postburn evaluation		
M08	Evaluation-now	Require evaluation on burn immediately by the burner
M09	Evaluation-postfire	Require evaluation during first postfire season by the burner
M10	Evaluation-agency	Perform postburn evaluation by the agency
C. Incentives		
Assistance		
I01	Assistance-financial	Financial assistance available from state (Y or N)
I02	Assistance-technical	Technical assistance available from state free or below cost (Y or N)
Liability		
I03a	Criminal class	Criminal class and level for noncompliance with minimum fire requirements
I03b	Max imprisonment	Maximum imprisonment (months) associated with the criminal level in I03a, for the first offense
I03c	Max fine	Maximum fine (US$) associated with the criminal level in I03a, for the first offense
I04a	Liability-Supp. cost	Civil liability for the cost of suppression of escaped fire
I04d	Liability-Damages	Civil liability for the cost of damages under compliance with prescribed fire requirements

burns, rather than agricultural, residential, or construction clearing burns. Each state uses a different burn purpose categorization structure, but five key categories of forest-management burns were identified: hazard reduction, competition control, site preparation, wildlife habitat, and disease control. We used forest area by state from Oswalt et al. (2018) to control for the differences in forested acreage among the nine states, expressing the burn notification area as a percentage of total forested area.

Results

Statutes and Regulations

To compare legal and regulatory requirements for open burns and certified prescribed burns in each of the nine states, we provide an overview of statutes and administrative codes in each state, validated by state agency designees (Tables 2 and 3). The state-by-state analysis groups provisions into planning stage, implementation stage, and incentives. Two states have variable policy requirements within the state, based on either separate geographic regions within the state (North Carolina) or different seasons within the year (Tennessee). Therefore, for the nine states, 11 distinct legal/regulatory regimes for open burns and certified prescribed burns are included.

Table 2 illuminates the fact that, across all states, open burn requirements only apply at the implementation stage, whereas certified prescribed burn requirements apply at both the planning and implementation stages. Apart from this fact, the requirements for both types of burns vary significantly by state. All states classify violations of open burn laws as misdemeanors, but the level or degree of misdemeanor, and potential punishments, are variable by state. For liability from damages caused by fire or smoke, most states follow a simple negligence standard, although some follow a gross negligence standard. We highlight some key findings from individual states in the following section, based on our analysis and Tables 2 and 3.

State Summaries

Alabama. Alabama has a simple negligence standard regarding damages from burns, and a relatively large number of requirements for burning. Open burn requirements to control the spread of fire focus on establishing a fire line, having appropriate equipment available, and having someone on site until the burn is extinguished. Moreover, Alabama requires open burners to notify adjacent landowners and state agency prior to burn, and receive authorization from the agency. With regard to smoke, the open burn should be screened for potential air quality issues, and certain starter fuels are prohibited. Certified prescribed burns require participation and presence of a trained, certified burn manager on site, as well as a burn plan with several required elements.

Florida. In 1990, Florida was the first state to enact a prescribed burn law and in 1999 revised the law including modifying its simple negligence standard into a gross negligence standard. Florida currently has the most requirements for open burns and certified prescribed burns among the nine states. Florida requires open burners to notify the state agency and receive authorization to burn, as well as to have a fire line and equipment present, adhere to time-of-day restrictions, and have someone on site until the burn is extinguished, in order to control the burn's spread. Open burners also must prepare by screening for smoke issues, adhering to set-backs from public paved roads, and limiting burning of windrows. Certified prescribed burns require a trained and experienced certified burn manager present on site, and a burn plan with several required elements present on site.

Georgia. Relative to other states, Georgia has the fewest number of legal requirements for open and certified prescribed burns. On the other hand, the potential time of imprisonment for violating the open burn laws (12 months) is the highest among the nine states and potential fines (US$1,000) the second highest. Georgia does require open burners to notify the state agency and receive authorization to burn, so it is still possible for the agency to withhold authorization in cases where burning could pose a danger. Open burning also must follow time-of-day restrictions in certain counties and seasons. Georgia does not separately classify burns themselves as either certified or noncertified; however, the state does certify burn managers. Thus, although "certified prescribed burns" do not technically exist in Georgia, we consider an open burn that is managed by a certified burn manager to be similar to certified prescribed burns in other states. Georgia followed Florida's lead in implementing a simple negligence standard in 1992 and a gross negligence standard in 2000.

Kentucky. Kentucky passed its first certified prescribed burn law most recently of any of the nine states, in 2016, and implemented a simple negligence standard. Even though Kentucky has an intermediate

Table 2. Current (2018) statutes and regulations related to planning and implementation stage open burns and certified prescribed burns in the southeastern United States.

		No. of states		State or substate region										
		O*	O + P*	AL	FL	GA	KY	MS	NC-A†	NC-B†	SC	TN-A‡	TN-B‡	VA
No. of requirements	O*			8	9	3	3	5	6	2	9	7	5	4
	O+P*			17	20	6	16	11	16	14	18	15	15	17
A.Planning stage§														
P01	Certified burner	0	10	P	P		P	P	P	P	P	P	P	P
P02	Training	0	11	P	P	P	P	P	P	P	P	P	P	P
P03	Experience	0	7		P	P	P		P	P	P			P
P04	Recertification	0	4	P	P							P	P	
P05	Decertification	0	3		P		P							P
P07	Burn plan-prepared	0	10	P	P		P	P	P	P	P	P	P	P
P08	Burn plan-notarized	0	2	P				P						
P09	Burn plan-approved	0	1											P
P10	Burn plan-minimum	0	7	P	P		P		P	P	P			P
P11	Burn plan-smoke	0	7	P	P		P		P	P	P			P
P12	Burn plan-weather	0	7	P	P		P		P	P	P			P
P13	Burn plan-urgent	0	3				P					P	P	
B.Implementation stage§														
M01a	Fire line-present	7	7	O	O		O				O	O	O	O
M02a	Equipment-available	3	7	O	O						O			
M14	Screening	6	9	O	O			O	O	O	O	P	P	P
M15	Set-back	3	3		O			O			O			
M16	Windrow	3	3		O				O		O			
M17	Starter fuels	6	6	O				O	O		O	O	O	
M03a	Notification-neighbors	4	7	O			P		P	P		O	O	O
M03b	Notification-agency	7	11	O	O	O	P	O	O	P	O	O	P	P
M03c	Notification-responders	0	1				P							
M03d	Permit/authorization	7	9	O	O	O		O	O	P	O	O	P	
M04	Time	8	8		O	O	O		O	O		O	O	O
M05a	Site-attend	7	9	O	O	P	O	P	P	P	O	O	O	O
M05b	Site-cert burner	0	10	P	P		P	P	P	P	P	P	P	P
M06	Site-burn plan	0	7		P				P	P	P	P	P	P

*O = open burn requirement; P = certified prescribed burn requirement only; O + P = total requirements for certified prescribed burning since certified prescribed burns must also meet the open burn requirements. Blank cell = no such requirement in state statute or regulation.

†North Carolina-A and North Carolina-B represent different policies regarding separate geographic regions within North Carolina: NC-A is 19 counties in the eastern part of the state designated as "high-hazard" counties, whereas NC-B is the remaining 81 counties.

‡Tennessee-A and Tennessee-B represent different policies in Tennessee for different times of the year: TN-A is in effect from October 15 to May 15, whereas TN-B is in effect from May 16 to October 14 each year.

§Requirements P06, M01b, M02b, and M07-M10 from Table 1 are not presented in this table for brevity, as no states had any related requirements.

number of requirements related to certified prescribed burns, for open burns there are only three requirements—having a fire line, time-of-day restrictions (from February 15 to April 30 and from October 1 to December 15 each year), and someone on site until the burn is extinguished. There are no requirements in Kentucky for open burns related to smoke. Since 2016, Kentucky has had new regulations for certified prescribed burn, certified burn managers' training and experience, burn plans, and notification, many of which were being put into practice for the first time in 2018–19.

Table 3. Current (2018) statutes and regulations related to incentives for open burns and certified prescribed burns in the southeastern United States.

		State								
		AL	FL	GA	KY	MS	NC	SC	TN	VA
C.Incentives										
I01	Assistance-financial			Y		Y	Y	Y		
I02	Assistance-technical	*	Y	Y			Y	Y	Y	Y
I03a	Criminal class[†]	m-B	m-2	m	[‡]	m	m-3	m	m-B/C	m-3/4
I03b	Max imprisonment (mos)	6	2	12	6	3	0.33	1	6	0
I03c	Max. fine (US$)	3000	500	1000	500	500	200	200	500	500
I04a	Liability-Supp. cost[§]	simp	none	simp	simp	gross	simp	none	simp	simp
I04d	Liability-Damages[§]	simp	gross	gross	simp	simp	simp	[¶]	simp	simp

Note: "Y" = yes, state offers this type of assistance to landowners; blank cell = no, state does not offer this type of assistance.
* We were unable to determine whether Alabama offers below-cost technical assistance.
[†]"m" = misdemeanor, followed by the class/level of offense.
[‡]Kentucky did not specify if the violation was a felony or misdemeanor, but the penalty levels were consistent with what would generally be considered a misdemeanor in most states.
[§]"simp" = simple negligence; "gross" = gross negligence.
[¶]South Carolina applies gross negligence to smoke-related damages and simple negligence to other types of potential damages.

Mississippi. In 1999, Mississippi adopted its first certified prescribed burning law, which includes the second-fewest number of total requirements for certified prescribed burns of the nine states, and simple negligence standard for damages. Open burners must notify and receive authorization from the state agency, but no other requirements related to control of the spread of fire. With regard to smoke, open burns do have to be screened, be set-back from airports and air-strips, and follow starter fuel restrictions. Certified prescribed burns must have a trained, certified burn manager on site, and a burn plan prepared, but the contents of the burn plan are not regulated.

North Carolina. North Carolina has a simple negligence standard for damages, but variable requirements for burns based on separate geographic regions—19 counties are designated as "high-hazard" counties (NC-A in Table 2). Nonhigh-hazard counties in North Carolina (NC-B) have the fewest open burn requirements of any of the nine states, only screening for smoke issues and adhering to time-of-day restrictions. Compared to nonhigh-hazard counties, high-hazard counties have additional state agency notification and authorization requirements, as well as windrow and starter fuel restrictions for open burns. State agency notification and authorization are required for certified prescribed burns in all counties, as well as neighbor notification and trained and experienced certified burn manager and burn plan on site, and the burn plan has minimum standards. North Carolina has among the lowest potential punishments among the nine states for the first offense violating open burn laws, with maximum imprisonment of 10 days and maximum fine of US$200.

South Carolina. South Carolina has the most requirements related to open burns and second-most for certified prescribed burns. South Carolina has a gross negligence standard for smoke-related damages and a simple negligence standard for other damages. The requirements for open and certified prescribed burns in South Carolina are relatively similar to those in Florida. South Carolina requires open burners to notify the state agency and receive authorization to burn, as well as to have a fire line and equipment present and someone on site until the burn is extinguished, in order to control the fire's spread. Open burners also must prepare by screening for smoke issues, adhering to setbacks from public roads and residential, commercial, and industrial sites, restricting starter fuel, and limiting burning of windrows. Certified prescribed burns require a trained and experienced certified burn manager present on site, and a burn plan, with several required elements, present on site.

Tennessee. Tennessee enacted its prescribed burn laws relatively recently (2012) and adopted a simple negligence standard. Tennessee has variable policy requirements by season. The stricter rules for open burns are in effect from October 15 to May 15

(TN-A in Table 2), whereas more relaxed rules are in effect from May 16 to October 14 each year (TN-B). During the season with stricter rules, open burns must notify and receive authorization to burn from the state agency, which only applies to certified prescribed burn in the season with relaxed rules. Year-round open burn requirements include presence of a fire line, time-of-day restrictions, starter fuel restrictions, and notification of neighboring landowners. In addition to these rules, certified prescribed burns must have a trained, certified burn manager and burn plan on site, but the contents of the burn plan are not regulated.

Virginia. Virginia requires that open burners notify neighbors, follow time-of-day restrictions (from February 15 to April 30 of each year), establish a fire line, and have someone on site until the burn is extinguished. Certified prescribed burns must have a trained and experienced certified burn manager and preapproved burn plan that contains several elements on site. Virginia follows a simple negligence standard. Criminal penalty level for noncompliance with open burn laws include no imprisonment for the first offense.

Open Burns

Open burn requirements are those to which a burner must comply, or face criminal penalties (Tables 2 and 3). The most common requirements are limiting burning to specific seasons or times (8 of 11 states/regions), followed by constructing a fire line (7), notifying or receiving a permit from the state agency (7), and remaining on site until the burn is totally extinguished (7). Some state/region open burn policies require checking or screening for potential air quality or visibility issues (6) or prohibit certain starter fuels that might cause air-quality issues (6).

As shown in Table 2, the states with the most requirements for open burns are Florida and South Carolina (9 requirements each), followed by Alabama (8) and Tennessee-A (7). The state with the fewest legal requirements is North Carolina-B (2), followed by Georgia (3) and Kentucky (3). The three states with fewest requirements have one requirement in common, burning season or time requirements.

Certified Prescribed Burns

The most common requirement for certified prescribed burns is the training of a burn manager to become certified to conduct a prescribed burn (11 of 11 states/regions). Three requirements for prescribed burning are listed in the policy of 10 out of 11 states/regions. i.e., having a certified burn manager, a written burn plan, and the presence of the certified burn manager on site until the burn is fully extinguished. Georgia is the one state that lacks all three of these requirements. Other common requirements are burn managers having past burning experience, and minimum requirements for the burn plan which include a smoke management plan (in seven states), and weather conditions (7), as well as having the burn plan on site (7). However, none of the states have requirements related to liability insurance for burn managers, inspection by agency of fire lines or equipment, agency burn supervision, or agency postburn evaluation.

In this study, open burn requirements are a minimum standard of laws that must be followed. In order to implement a certified prescribed burn, a burner must first meet the legal requirements for open burns (O), plus the certified prescribed burn requirements (P). Therefore, when comparing the level of requirements for certified prescribed burning in the nine states, we sum the number of requirements for both open burn and prescribed burn (O + P in Table 2). For example, Florida has the largest number of total requirements for certified prescribed burning (O + P = 20), followed by South Carolina (18), and Alabama and Virginia (17), and then Kentucky and North Carolina-A (16). Georgia has the fewest total requirements (6), followed by Mississippi (11) and North Carolina-B (14).

Comparisons of legal and regulatory requirements by type demonstrated that the requirements for open burns are fewer than the additional requirements for certified prescribed burns except for Georgia. Moreover, the number of requirements between open burns and certified prescribed burns differs greatly in Kentucky, North Carolina-A, North Carolina-B, Tennessee-B, and Virginia. For example, the number of the requirements in Kentucky for open burns is three requirements, but for certified prescribed burns, it is 13 additional requirements (16 total).

Liability and Incentives

Since the open burn requirements are a legal minimum, burners that do not comply with them would be subject to criminal penalties in each state (Table 3). These are categorized as different classes or degrees of misdemeanors, which vary in definition by state. Therefore, comparing across states is complex. For example, open burn violations in Alabama and Tennessee are class B or C misdemeanors, whereas in North Carolina and Virginia, they are class 3 or 4

misdemeanors. Maximum imprisonment for the first offense has a median of 3 months and ranged from no imprisonment in Virginia to 12 months in Georgia. Maximum fines for the first offense had a median of US$500 but vary from US$200 in North Carolina and South Carolina to US$3,000 in Alabama. It should be noted that some states do not define punishment levels for the first offense versus subsequent offenses and may allow judges more discretion in sentencing, which results in more difficulties for the comparison among the states.

In the case of liability for suppression costs associated with escaped burns, all the states except Florida and South Carolina follow a simple negligence standard. In Florida and South Carolina, burners do not bear liability for suppression costs of escaped burns. Regarding the liability for damages, all the states except Florida, Georgia, and South Carolina implement simple negligence. Florida and Georgia implement gross negligence for all types of damages. South Carolina implements gross negligence for smoke-related damages and simple negligence for other potential damages.

Although there are few provisions of laws on state assistance for burns, fire chiefs or designees in four out of nine states reported financial assistance, such as cost-sharing. Six out of nine states offer technical assistance for burners with free or below-cost prices, e.g., burn training and education, or technical assistance in burn-management planning (Table 3). For example, the state forestry agency in North Carolina can conduct a site visit, prepare a burn plan, go over the plan with the landowners/burn managers prior to the burn, and loan hand tools such as drip torches, fire rakes, and flappers.

Legal History

Table 4 presents the enactment years of current primary laws related to open and prescribed burns. The list is not all-encompassing, as each state has other statutes and regulations that are relevant; however, these are the primary and most directly relevant laws. Burn statutes and regulations in many states were codified into two kinds of systems: open and certified prescribed burn law. For example, in Alabama, the open burn statutes are codified primarily in the Code of Alabama (C.O.A.) §9-13-11 to 13 and regulations in Alabama Administrative Code (A.A.C.) §335-3-3-01, whereas the certified prescribed burn statutes are codified in C.O.A. §9-13-270 to 274 and regulations in A.A.C. §390-X-6.

The years of enactment were highly correlated with the type of burn. Table 4 shows that open burn statutes have generally been enacted much earlier than certified prescribed burn. The earliest open burn statutes were enacted in 1848 in Mississippi, with most from the 1950s through the 1980s. It is possible that some previous laws relevant to open burns were fully repealed and replaced or under previous codification systems (e.g., from older state constitutions), and thus they are not covered in Table 4. In contrast, prescribed burn statutes were implemented relatively later and largely concentrated from the 1990s to 2010s.

Table 4. Indicative list of primary laws governing open and prescribed burning and year enacted.

	Open burn		Certified prescribed burn	
	Primary law(s)	Year enacted	Primary law(s)	Year enacted
Alabama	C.O.A. §9-13-11 to 13; §9-13-140 to 142	1923, 1939, 1967	C.O.A. §9-13-270 to 274	1995
Florida	F.S. §590.125 [prev. F.S. §590.025]	1999 [1977]	F.S. §590.125 [prev. F.S. §590.026]	1999 [1990]
Georgia	O.C.G.A.§12-6-90	1956	O.C.G.A. §12-6-145 to 148	1992
Kentucky	K.R.S.§149.375 to 400	1964, 1966	K.R.S. §149.175	2016
Mississippi	M.C. §97-17-13	1848	M.C. § 49-19-303; 307	1992
North Carolina	N.C.G.S.§106–942 to 943	1981	N.C.G.S. §106–968	1999
South Carolina	S.C.C.L. §48-35-10	1962	S.C.C.L. §48-34-40	1994
Tennessee	T.C.A. §39-14-305 to 306	1989	T.C.A. §11-4-1001 to 1003	2012
Virginia	C.O.V. §10.1–1141 to 1142	1950	C.O.V. §10.1–1150	1998

Note: Florida enacted burning laws in 1977 for open burning (F.S. §590.025) and 1990 for certified prescribed burning (F.S. §590.026). These were repealed and replaced with a unified section on burning (F.S. §590.125) in 1999.

Florida was the main exception to this trend, as it is the only state examined that has a single comprehensive law detailing requirements for both noncertified open burns and certified prescribed burns in the same chapter and section. Statutes and regulations for open and prescribed burns were more closely linked in its current primary statute on all types of burning, which was enacted in 1999, upon the repeal of previous relevant statutes. Open burning laws are codified mainly in Florida Statute (F.S.) §590.125(2) and Florida Administrative Code (F.A.C.) §5I-2.004, and §5I-2.006(4), whereas the certified prescribed burn laws are codified in F.S. §590.125(3) and F.A.C. §5I-2.006(2). However, we do note that previous versions of Florida burning laws did follow the same trend as other states, as the now repealed F.S. §590.025 for open burning was enacted earlier in 1977, and the now repealed original F.S. §590.026 for certified prescribed burning was enacted later in 1990. The repeal and replacement changed the simple negligence liability rule from the 1990 law to a gross negligence standard in 1999 (Brenner and Wade 2003). Prescribed burning statutes and regulations in some other states have been revised one or more times in the period as well, but Florida is the only to fully repeal and replace open and prescribed burn laws in this time period.

Certified Burn Managers

Table 5 shows the total number of certified burn managers and the number per 10,000 acres of forestland area in each state. The most certified burn managers are in Georgia (3151), followed by South Carolina (1848) and Florida (1740). The highest number of certified burn managers per unit of forestland is South Carolina (1.4 per 10,000 acres), followed by Georgia (1.3) and Florida (1.0). However, as noted previously, states including Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Virginia do not require re-certification, so in those states, individuals could potentially be left on the list after they have become inactive. The numbers in those states could be overestimated. Mississippi was not able to provide the number of certified burners. At the time of data acquisition in late 2018, Kentucky had not yet implemented its training and certification program, and therefore Kentucky has no certified burn managers.

The requirements for becoming a certified burn manager (Table 2) may affect the number of people who become certified. Each state has different requirements to become a certified burn manager. For example, in Georgia, requirements for certified prescribed burn managers include three aspects: completion of a 2-day prescribed burn course, directing five prescribed burns, and 2 years of experience. In Kentucky, as of 2018, the certified burn manager program was still in draft, but the proposed requirements included both training and experience. Other states, such as Alabama, Mississippi, and Tennessee, do not require experience prior to becoming a certified burn manager. Further, the amount of training and/or experience tends to vary between states. Therefore, the number of certified prescribed burn managers in a state is influenced by a diversity of policies and can also potentially influence implementation of burning in the state.

Burn Notifications

Open Burn Notifications

In our region of interest, four states out of nine (Alabama, Florida, Georgia, and South Carolina) provided relatively complete data regarding open burn notifications (including both certified prescribed and noncertified burns). Alabama and Florida provided data from 2008 to 2017, Georgia from 2010 to 2017, and South Carolina from 2009 to 2017. Because of the lack of comprehensive digital database on open burns in North Carolina, we obtained some partial data from 2007 to 2017. These limited data in North Carolina show an increasing trend on the number of open burn notifications; however, this might be due simply to more people using the online notification system over time instead of alternatives such as phone or in-person. To avoid potential biases on our analysis,

Table 5. Certified burn managers by state: absolute number and per 10,000 acres of forest land.

	AL	FL	GA *	KY *	MS *	NC *	SC *	TN	VA *
Number of certified burn managers	1233	1740	3151	0	ND	682	1848	238	1207
Total forest land area (million acres)	23.1	17.3	24.6	12.4	19.4	18.8	12.9	13.9	16.0
Certified burn managers per 10,000 acres of forest land	0.5	1.0	1.3	0.0	ND	0.4	1.4	0.2	0.8

Note: ND = no data.

* These states do not require recertification, so certified burners could potentially remain on the list even after becoming inactive.

North Carolina data on open burns are not shown in our study.

During the period from 2008 to 2017, Georgia had the most notifications, averaging 23,875 legal open burn notifications per year, followed by Alabama (7,137), Florida (6,807), and South Carolina (5,611). Among these four states, the annual number of burns in Florida, Georgia, and South Carolina held relatively stable during the period of time, without a statistically significant time trend. However, Alabama shows a statistically significant increase of 248 burns per year in the number of open burns ($P = .03$, $R^2 = .46$).

Open burns (including noncertified and certified prescribed) for forestry-related purposes were notified and authorized (where required) in these four states for a total of 34.3 million acres over the entire period for which we had data in each state. Florida has the largest average annual area of burn notifications, at 1.44 million acres per year, compared to 1.06 million acres per year in Georgia, 0.76 million acres per year in Alabama, and 0.42 million acres per year in South Carolina, or an average of 3.7 million acres per year for the entire four-state subregion. The larger area but lower number of burns indicated that Florida has significantly larger burns than Georgia. We found no statistically significant time trends for open burn notification area among these states during the period.

States with a larger forest area might have more burns. To better compare the open burn area in each of the four states, we chose to normalize the burn area by dividing by the total forest area to compare open burn area as a percentage of total forested area in each state (Figure 2). Florida averaged the highest percentage of burn notification area, at 8.4 percent of forested area annually, followed by Georgia at 4.3 percent, then Alabama and South Carolina both at 3.3 percent.

Certified Prescribed Burns by State

Alabama, Florida, North Carolina, and South Carolina are the only states that have data on the number of certified prescribed burn notifications. Despite not having a complete digital open burn notification database, North Carolina requires certified prescribed burners to fill in some information by an online smoke management tool. Neither Georgia nor Alabama specifically tracks certified prescribed burn notifications in their database; however, we inferred a lower bound on the number in Alabama because all Internet and agency employee notifications must be certified prescribed burns, whereas phone notifications may or may not be.

We compared the annual prescribed burn area as a percentage of the total forested area in each state (Figure 3). Florida averaged 7.0 percent annually and had a bigger average area of certified prescribed burns as a percentage of the total forested area than South Carolina (2.3 percent) and North Carolina (0.4 percent). The lower bound on Alabama was 0.8 percent, which indicates more certified prescribed burns than North Carolina, but impossible to draw conclusions relative to South Carolina. Since the total open burns (of which prescribed burns are a part) in Alabama was still less than the area of prescribed burns in Florida, we can also conclude that prescribed burns in Alabama were less than in Florida, as a percentage of forested

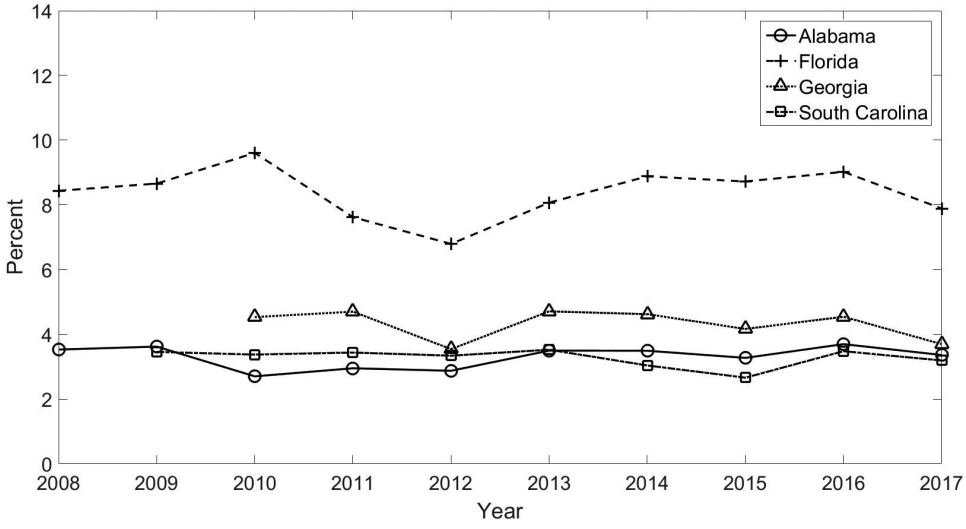

Figure 2. Legal open burn (certified and noncertified) area per year as a percentage of the total forested area in a state.

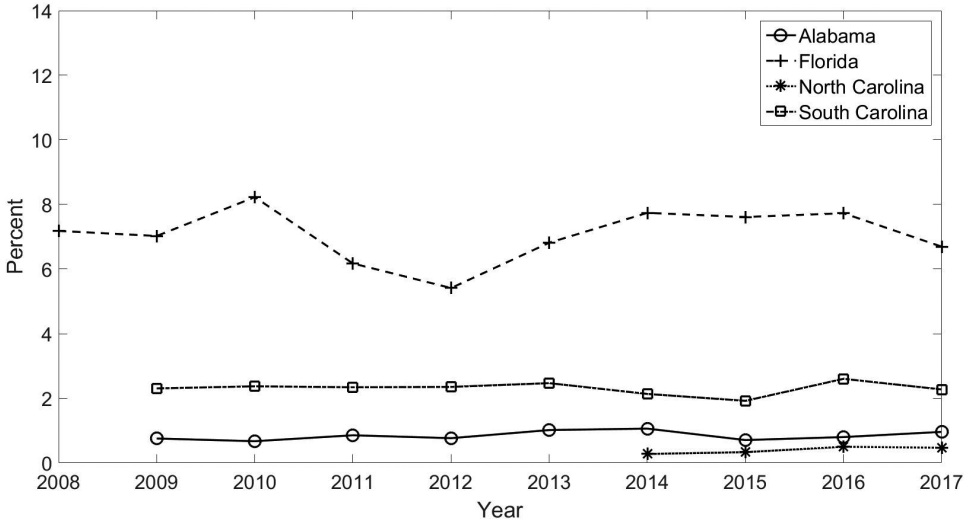

Figure 3. Certified prescribed burn area per year as a percentage of the total forested area in a state. Data for Alabama certified prescribed burns should be viewed as a lower bound, since they were based on the number of notifications by Internet or agency employees. Phone notifications may or may not be certified prescribed burns.

area. None of the states had a statistically significant time trend.

In our region of interest, Florida and South Carolina gathered data on the number of noncertified and certified prescribed burn notifications, so it is possible to estimate the percentage of all open burns that are certified prescribed burns. Florida had a higher percentage of certified prescribed burn notifications by area, at 84.3 percent of the area of open burn notifications, followed by South Carolina at 70.4 percent. In terms of numbers of burn notifications, in Florida 44,810 (65.8 percent) of 68,073 open burns were certified prescribed burns, and in South Carolina 23,405 (46.3 percent) of 50,503 open burns were certified prescribed burns during the period 2008–17. This indicates that certified prescribed burns tend to be larger than noncertified open burns in both states.

Burn Notifications by Category

Figure 4 presents the area of burns by state by purpose—hazard reduction, competition control, site preparation, wildlife habit, and disease control—and also shows the proportion that are certified prescribed. Hazard reduction burns are the most common reason for implementing burns, comprising 57.5 percent of burn notifications by area. Competition control was the next most common, at 24.1 percent of burn notifications by area. Wildlife habitat comprised 12.9 percent by area, and site preparation was 5.5 percent by area. Disease control was a minor category with less than 0.1 percent by area (Alabama and Georgia do not have a disease control category).

Florida and South Carolina are the states with reliable data on certified prescribed burn notifications. Hazard reduction burns were the most common type of certified prescribed burn at 55.7 percent by area, followed by competition control at 29.2 percent, wildlife habitat at 12.4 percent, site preparation at 2.7 percent, and disease control at 0.1 percent.

Discussion

Comparison with Past Research

In analyzing the legal environment, the intentional use of burning for forest management is divided into two types in this study: (noncertified) open and certified prescribed burns. In contrast, previous studies (e.g., Haines and Cleaves 1999, Sun and Tolver 2012) lumped them together, without any explicit differentiation. Our analyses reveal that the legal environment for these types of burns is different in the planning and implementation stages and incentives. Thus, these findings will be able to help landowners and burn managers understand the policies and regulations more accurately. Furthermore, we identified new prescribed burning laws in two states (Kentucky and Tennessee) since the publication of Sun and Tolver (2012), as well as some other minor modifications in regulations in other states.

Our results show an annual average of 3.7 million acres per year burned via open or certified prescribed

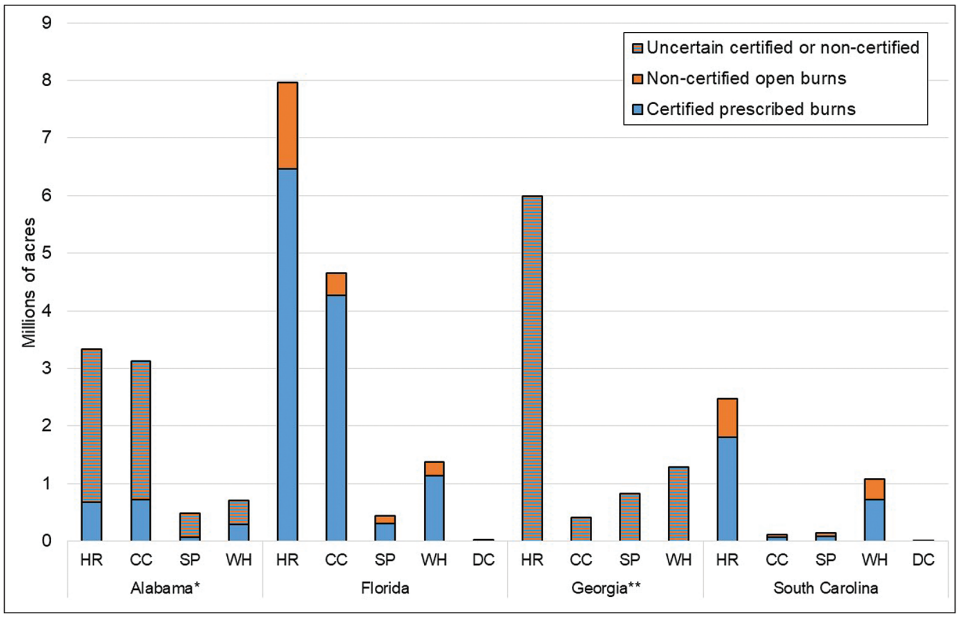

Figure 4. Total area of burn notifications, 2008–17 for Florida and Alabama, 2010–17 for Georgia, and 2009–17 for South Carolina, presented as either certified prescribed or noncertified open burns, and categorized by purpose by state: hazard reduction (HR), competition control (CC), site preparation (SP), wildlife habitat (WH), and disease control (DC). *Data for Alabama certified prescribed burns should be viewed as a lower bound, since it was based on the number of notifications by Internet or agency employees. Phone notifications (shown here as "uncertain certified or noncertified") may or may not be certified prescribed burns. Alabama does not include disease control as a possible category. **Georgia does not track certified prescribed burns, so it was impossible to quantify them as a proportion of all open burns. Georgia includes records with multiple objective categories, which led to possible double (triple, and quadruple) counting. To adjust, acres of fires in multiple categories were divided by the total number of categories (out of 4) in which they were categorized. Georgia does not include disease control as a possible category.

burns for a subregion of four states (Alabama, Florida, Georgia, and South Carolina). For comparison, Melvin (2012, 2015, 2018) surveyed state forestry agencies and estimated 5.8 million acres burned in 2017, 6.2 million acres in 2014, and 6.5 million acres in 2011 across 13 states in the Southeast region. Although this suggests our results may be a moderate overestimation compared to Melvin's estimate, Melvin (2012, 2015, 2018) does not state whether or not those data include noncertified open burns. Furthermore, it is reasonable that the four states for which we have direct data comprise the majority of burns in the Southeast, since they are the four states comprising the majority of existing longleaf pine area. Therefore, our estimates of annual burn area and number are consistent with past research. On the other hand, Melvin's (2012, 2015, 2018) estimates are suggestive of a decline in annual burn area over time from 2011 to 2017, a result that our data do not corroborate.

Heterogeneity of Burn Policies

As every state is unique in natural resources, social factors, and regulatory structure, effective burning policy and implementation often are built on local context-specific priorities (Toledo et al. 2013). Moreover, different levels of liability rules influence perceptions and the behavior of burners in different ways. Although complete uniformity is not realistic, the variability in legal requirements and incentive structures between states, and in some cases within states, can be a barrier to broader application of burning. For example, burn managers practicing in one state may not be able to practice a few miles away, across state borders.

Florida was the first state to embark on statutory reform related to certified prescribed burning in 1990, and its Prescribed Burning Act has been regarded as landmark legislation in the field (Wonkka et al. 2015). Other states have subsequently adopted similar certified prescribed burning laws, making the region somewhat more uniform, yet many great differences still exist in the planning stage, implementation stage, and incentives among the states (Tables 2 and 3). For example, since 1999, Florida implemented a gross negligence standard, which limits liability only to those whose lack of care demonstrates a reckless disregard for the safety or lives of others. Most states in the

region use a simple negligence standard (Sun 2006). Among the certified prescribed burning requirements, one common requirement was training to become a certified prescribed burn manager.

More specific requirements on using certified prescribed burning may indicate more precaution measures, increasing the cost of implementation, but reducing uncertainties and risks (Yoder et al. 2003, Sun 2006). Therefore, this will be a tradeoff under a local context-specific environment for each of the states.

Burn Rules and Regulations on Public Land

Federal agencies manage about 17 million acres of land in the nine southeastern states, including significant areas of forest land. These include the National Forests (about 9 million acres), National Parks (3.7 million acres), bases and other lands managed by the Department of Defense (2.3 million acres), and National Wildlife Refuges (1.8 million acres) (CRS 2020). Federal agencies are not legally required to comply with state laws regarding use of burning on these federal lands. However, Forest Service policies dictate that its employees not use burning unless it meets conditions that would be lawful on nonfederal lands; therefore, by policy (though not by law), the same rules apply on National Forests as on private or state and local government lands. Above and beyond the state regulations, National Forests, as well as National Parks and National Wildlife Refuges, form part of the National Wildfire Coordinating Group and therefore subscribe to the much more detailed procedures and guidelines laid out in the Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG 2017). Furthermore, the National Forest System and individual National Forest Regions have their own policies and procedures for burns (USFS 2017).

Burn Notification Trends over Time

There are few significant time trends in the implementation of open burns and certified prescribed burns from 2008 to 2017. Although there was one statistically significant trend detected, it did not seem particularly meaningful and could just be from random variation. Implementation of burns can be influenced by policy factors, as well as other incentives, socioeconomic forces, and climatic and environmental factors. The fact that there were no consistent, meaningful time trends among the states suggests relatively stable legal and environmental conditions for burning over the past decade in the states for which we had data.

Potential Influences of Burn Policy on Burn Implementation

In Florida, because of the ecology of native flora and fauna requiring periodic fires, the public recognized certified prescribed burning is a significant management tool to maintain public safety and biodiversity (Brenner and Wade 2003). Although many states followed Florida's legislation on prescribed burning since 1990, no two states have exactly the same regulations on the use of burning. Georgia followed Florida's legislation in adopting a gross negligence standard for certified prescribed burns in 2000 (Wonkka et al. 2015). Nevertheless, Georgia did not enact a large number of planning or implementation stage regulations on burns (Wonkka et al. 2015). For example, in Florida, to become a certified prescribed burn manager, an individual must complete the required training and conduct a successful certification burn; a burn plan must be completed prior to any ignition, and a paper copy must be on site and available for inspection. However, in Georgia, there are no planning stage burn requirements, other than certified burn managers needing training and/or experience.

Interestingly, Georgia had more burn notifications, but a smaller total area burned than Florida. Since this research does not control for potential confounding factors, we cannot ascribe these particular differences in burning to differences in statute and regulation, but these differences are seemingly consistent with past research. Yoder et al. (2003) suggested that certified prescribed burning would be affected by both liability and the cost of implementing legal and regulatory requirements. Wonkka et al. (2015) compared adjacent counties in different states, controlling for certain confounding factors, and found that differences in liability had an impact on burn number and area, but legal and regulatory requirements did not.

Through the summer of 2018, Kentucky did not yet have training or an established process for certifying burn managers. Prior to 2016, there were only limited regulations on burns in Kentucky, which were specified burn hours and the authority to establish burning bans (Sun and Tolver 2012).

Technical and Financial Assistance

From an economic perspective, financial assistance for landowners and burn managers may play an important role in the use of burning (Schultz et al. 2018). Costs related to the use of open burning include burn plan, fire line building, mop-up activities, and so on.

There are also indirect costs associated with the risk of escaped burns or smoke (Yoder et al. 2003). If the landowner's net benefit does not exceed the cost and risk, he/she is not likely to implement a burn (Yoder et al. 2003). Financial assistance may help compensate for some costs, and statutes and regulations can partially mitigate liability and risk.

Burning not only is beneficial to landowners but also may generate positive spillover effects for the local community and wider society, including lower risk of wildfire locally, increased habitat for wildlife, and enhanced biodiversity (Hesseln 2000). Since these benefits are in the public domain, individual landowners may not have the sufficient incentive to conduct the socially optimal number of burns without financial and technical assistance. Furthermore, the social and ecological benefits of burning generally take a long time to manifest, so long-term and persistent financial assistance would help landowners to accomplish open burning management objectives.

Our research generated some information about the extent and types of financial and technical assistance available. Future research is needed to help understand the qualitative and quantitative differences in assistance across and within states, and how those differences affect burning, in conjunction with legal/regulatory, socioeconomic, and biophysical factors.

Conclusions

This study analyzed the regulation and practice of "open burning" and "certified prescribed burning" in the southeastern United States. The primary contribution was to differentiate between (noncertified) open and certified prescribed burns in terms of public policy and practice. To better summarize the statutes and regulations in each state, we used multiple-stage policy matrices and conducted a legal review of open and prescribed burns, validated by state forestry agency Fire Chief or designees. We found that even though these states may have adopted open and prescribed burn laws around the same time and for similar reasons, many differences indeed exist in the planning and implementation stages. Moreover, many states tended to reduce liability after burning and increase precaution measures before burning (Yoder et al. 2003).

To understand the implementation of open and certified prescribed burns, we requested information from the state forestry agency about all notifications or permits in recent years. We compared number and area of burns by state and over time. There are few significant time trends in the implementation of open burns and certified prescribed burns from 2008 to 2017. In Florida 66 percent and in South Carolina 46 percent of open burn notifications qualified as certified prescribed burns, indicating that not all burners choose to take the extra steps necessary to qualify as certified prescribed burns. Potentially part of the story is that noncertified burns tend to be smaller and may be perceived as less risky by burners. In addition, both liability and cost of achieving the certified prescribed burn requirements may play a role (Yoder et al. 2003), and further research is needed to quantify these effects.

Our findings open interesting new areas of research. Delving deeper into case law in each state can clarify differences and similarities in interpretation of law, state by state, particularly with regard to negligence standards. Also of interest is to track the outcomes of open versus certified prescribed burn, to see, e.g., if one type is more likely to produce negative incidents such as escaped burns or smoke emergencies. Another future area to explore is how awareness of burning as a forest-management tool and interrelated factors such as perceptions of risk and potential for wildfire to cause damage change with climate change and expanded wildland–urban interface, and how this affects adoption of laws and regulations, and implementation of burns over time. In particular, it will be of research interest to track experiences in states like Tennessee and Kentucky, which only relatively recently enacted prescribed burn laws and are not within the southern pine ecoregion, but have substantial hardwood forests that are potentially vulnerable to wildfire, as the 2016 fall fire season demonstrated.

The findings from this study can inform policymakers and land managers in multiple ways. First, this work updates past research that compared state statutes and regulations regarding burning, including Haines and Cleaves (1999) and Sun and Tolver (2012). Since the publication of Sun and Tolver (2012), new relevant laws have been passed in Tennessee (2012) and Kentucky (2016), making the region somewhat more consistent in the law surrounding certified prescribed burns versus noncertified open burns. This update allows decisionmakers to better understand areas of consistency and divergence between states and therefore to comprehend future policy options. Second, past work on burn policy has focused on "prescribed burning" statutes and regulations in the US South, and this is the first research to clearly distinguish between certified prescribed burns and noncertified open burns in the forestry context. Our research showed that a large number of open burns are not certified prescribed

burns in South Carolina and Florida, meaning they do not meet all the requirements for limiting the potential liability. This is likely to be true in other states as well. Therefore, land managers and policymakers can better understand the potential tradeoffs between the two different legal standards.

Acknowledgments

The authors would like to thank Drs Natasha James and Carissa Wonkka for their valuable comments on a draft of this manuscript.

Disclaimer

The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or US Government determination or policy.

Financial Disclosure

This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Endnotes

1. Generally speaking, strict liability is liability regardless of fault. Simple negligence requires the plaintiff to prove harm, causation, and breach of a duty. Gross negligence requires the plaintiff to prove the lack of even slight care. Interpretations can vary from state to state.

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