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Liability, incentives, and prescribed fire for ecosystem management

Jonathan Yoder¹, David Engle², and Sam Fuhlendorf²

Prescribed fire is widely viewed as a useful but risky ecosystem management tool, and liability is a crucial issue for prescribed burning on private and public land. Basic liability rules motivate landowners to reduce risk when making choices about the use of fire. Liability therefore influences land use through incentives, and so has important consequences for the larger ecological landscape. Strict liability rules may lead to too little prescribed fire use, while negligence rules may, under certain circumstances, lead to too much. Although prescribed fire provides broad public benefits, such as reduction of wild-fire risk or enhanced ecosystem health, the application of liability rules by courts often discourages its use as a vegetation management option. Various approaches exist for improving the laws and regulations surrounding prescribed fire.

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Fire was critical for the development of many ecosystems throughout North America (Pyne 1982; Wright and Bailey 1982; Collins and Wallace 1990), and prescribed burning is widely viewed as a useful ecosystem management tool (Babbitt 1995; Pattison 1998). Some state and federal programs, such as the Environmental Quality Incentive Program of the US Department of Agriculture, encourage the use of prescribed burning and the Federal government recognizes its use as an integral element of wildland fire management, despite the fact that it is among the most risky activities of federal land management agencies (US Department of the Interior and US Department of Agriculture 1995). Legal liability as a result of property damage due to escaped fires remains an important concern for prescribed burning on private and public land (Haines *et al.* 2001). Although prescribed burning may be critical to restoration and conservation of many ecosystems, it is inherently risky, and its application is largely limited by social constraints. It is therefore important to understand the social incentives and barriers to adoption of prescribed fire (Figure 1). Knowledge of these constraints and incentives will facilitate the development of policies that promote the use of prescribed fire when appropriate and limit its use when it is inappropriate.

In a nutshell:

- Prescribed fire is critical to the conservation and restoration of ecosystems, but its use is largely limited by social constraints
- Liability rules affect incentives for prescribed fire use and precautions by both practitioners and neighboring landowners
- The relative effectiveness of different liability laws depends on who bears the costs and benefits of the activity and who has the capacity to reduce the risk
- The broad social benefits of prescribed fire are not likely to be fully considered in the practical application of liability law, thereby discouraging its use

From a lawyer's perspective, legal liability is "backward looking" in the sense that the facts of an accident are examined and blame is assigned based on an existing legal framework. From an economist's perspective, liability law is "forward looking" in that it affects the way people behave while undertaking risky activities. This article addresses the constraints for prescribed burning from the second perspective and examines how liability law affects incentives and precaution levels when prescribed burning is used. To flesh out the incentive effects of liability law, we examine the comparative advantages of two important liability rules, strict liability and negligence, under various situations. We then consider the efficacy of these liability rules for determining when prescribed fire provides public benefits in terms of improved ecosystem health or wildfire risk mitigation.

Some background about general liability rules and existing prescribed fire liability law may be useful here. Under a negligence rule, the owner of damaged property shoulders the loss unless a court finds the burner negligent. Under strict liability rules, defendants are liable for damage caused by an escaped prescribed fire, regardless of the precautions taken. Today, virtually all states have codified civil or criminal statutory law for prescribed burning (Yoder *et al.* 2003). Most state statutes impose negligence rules of some form on the prescribed burner, but four states impose strict liability. In the absence of statutory law, legal liability is based on common law, which is the history of legal precedents that has accumulated through previous judicial decisions. The common law for prescribed fire is generally based on negligence rather than strict liability (American Law Reports 1994).

A recent example of a negligence decision is *Schmierer et al. v Weishaar et al.* (2000). A field-clearing burn, started in Washington State in 1996, escaped and burned neighboring property, apparently because calm winds unexpectedly intensified and rekindled the fire after it was thought to be extinguished. In a pretrial summary judgment, the court decided that the increase in wind

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Figure 1. Fuel accumulation around structures at the wildland–urban interface generates questions about who is responsible for fuels management and wildfire risk. The structure of legal liability rules affects the incentives for both potential burners and their neighbors to mitigate wildfire risk.

was unforeseeable and found the defendant not negligent and not liable for damages. On appeal, the appellate court found, to the contrary, that the defendant should have foreseen the possibility of increased winds. The case was sent back to the lower court for trial, but was ultimately settled prior to that trial.

An interesting strict liability case is that of *Koos v Roth*, in Oregon (1982). Oregon statutes do not explicitly impose strict liability for escaped prescribed fire, so the common-law approach would usually be to apply a negligence rule. However, based on testimony from a local fire chief that as many as one out of eight field-burning fires escape in the country, the court found field burning to be an “ultra-hazardous activity”, and therefore subject to strict liability, because even reasonable and prudent precautions cannot reduce the risk of escape to acceptable levels. To the extent that this decision acts as precedent for subsequent cases, field-burning Oregonians expect to face strict liability and are required to pay damages if a neighbor’s property is harmed, regardless of their precautionary effort. In this way, existing liability law affects expectations about the distribution of risk among involved parties, and thereby alters incentives for performing risky activities.

■ The economics of precaution

Imagine a landowner considering the use of prescribed fire in an ecosystem restoration project, and a neighbor whose property will be damaged if the fire escapes. Assume, for simplicity, that the burner bears no responsibility for damage if a fire escapes, and the neighbor gains

no benefits from the prescribed fire. The risk of damage depends on the burner’s precautionary effort and the neighbor’s effort to reduce fire damage to his or her property. Examples of burner precaution include fire planning, fuel break construction, and employment of sufficient manpower and equipment. The neighbor may use fire resistant construction materials in buildings and create defensible space around structures.

The net benefits of the fire equal the gross benefits minus the sum of precaution costs and expected damage. Expected damage can be conceptualized in the statistical sense as the probability of escape times the potential damage (or more generally, the expected value given escape times the probability of escape). Based on a narrow definition of economic efficiency, precaution should be applied by one or both parties to maximize the net benefits of the prescribed fire, and the fire should be performed only if net benefits are positive

(by definition, the distribution of benefits among individuals does not matter for efficiency). Although this discussion will be in terms of US dollar values, these need not represent market values – they can represent a person’s willingness to pay for any perceived benefit, or a willingness to accept compensation for damage, regardless of whether a market actually exists.

Suppose the benefit to the burner equals \$100, the cost of taking precautions is \$30 for each landowner (if carried out), and the expected damage to the neighbor equals \$15 if both take precautions, \$75 if only one takes precautions, and \$150 if neither takes precautions. If both take precautions, the total net benefits equal $\$100 - \$15 - \$30 \times 2 = \25 (benefits minus expected damage minus precaution costs). If only one takes precautions, the net benefits are $\$100 - \$75 - \$30 = -\5 . If neither takes precautions, the net benefits are $\$100 - \$150 - \$0 = -\50 . In this example, the prescribed burn should be performed if, and only if, both landowners take precautions. Any other outcome is economically inefficient.

Now consider three legal settings: (1) the burner is not liable for damage, (2) the burner is always liable for damage (a strict liability rule), and (3) the burner is liable only if he makes insufficient effort to take precautions, from the court’s perspective (a negligence rule). In the first case, if the fire escapes and burns the neighbor’s property, the burner is not bound by law to pay for the damage. The burner gets the benefits from a fire, faces no damage costs at all, and therefore has no incentive to control the fire. He therefore gets \$100 in personal benefits, but bears no costs, so he would perform the burn. Now consider the neighbor’s incentives. The burner has

no incentive to contain the prescribed fire he sets, so the neighbor faces \$150 or \$75 worth of expected damage, depending on whether he himself chooses to take precautions. The precautions cost the neighbor \$30, but reduce expected damage by $\$150 - \$75 = \$75$, so he will choose to take precautions and incur total expected costs of $\$30 + \$75 = \$105$. This outcome is inefficient: the total net benefits are $-\$5$, but the burn is performed anyway. This case would provide an incentive to prescribed burning with minimal caution and illustrates why liability laws exist in the first place.

In the second legal setting, a strict liability rule requires the burner to reimburse all damage to the neighbor's property. Here, the neighbor bears no risk and therefore has no incentive to take precautions, and so the costs to the neighbor of the burner's prescribed fire is zero. If the burner chooses to carry out the prescribed burn, his expected costs will be $\$75 + \$30 = \$105$, if he takes precautions, or $\$150 - \$0 = \$150$ if he does not. Either way, the burner's benefit of \$100 does not cover his costs, so he will choose not to burn. So, strict liability rules are a barrier to the use of prescribed fires.

In the third case described above, under a negligence rule, the burner need not reimburse the neighbor for damage unless the court finds the burner negligent. Suppose that \$30 worth of effort satisfies the court's minimum standard of care. If the burner burns carelessly he will be found liable by the court and his net benefit will be, at most, $\$100 - \$75 = \$25$ (or $-\$50$ if the neighbor does not take precautions). If the burner takes precautions, his net benefits are $\$100 - \$30 = \$70$, because the negligence standard is met. This is his best alternative, so he burns, carefully. Suppose that the neighbor knows the benefits and the costs that the burner receives; he therefore knows that the burner will burn carefully. The neighbor therefore expects to bear the costs of damage if the fire escapes. Given the burner's incentive to take care, the neighbor's expected costs, if he also takes precautions, are $\$15 + \$30 = \$45$; without precautions they are \$75. The neighbor therefore also invests in precautions. Since both are exerting effort to prevent damages, we end up with an economically efficient result: the burner nets \$70, the neighbor expects to lose \$45, but the total benefit is \$25 – as large as is possible. Given these numbers, a negligence rule induces an efficient outcome because all participants choose to contribute to minimizing potential damage from escaped fires.

Negligence rules are not perfect, however. Suppose the burner's gross benefit was \$60 instead of \$100, so his net

Panel 1. A numerical example of the influence of liability on prescribed burning decisions

In each scenario, the burner receives US\$100 in benefits. Damage mitigation effort (precautions) exerted by either party costs \$30. Expected damage to the neighbor's property depends on precautionary effort, and total net benefit is equal to the benefits minus the sum of expected damage and precaution costs.

Scenario (#)	Precautionary costs			Expected damage	Total net benefit
	Benefit to burner	Burner	Neighbor		
Both take precautions (1)	\$100	\$30	\$30	\$15	\$25
Neither takes precautions (2)	\$100	0	0	\$150	-\$50
Burner takes precautions (3)	\$100	\$30	0	\$75	-\$5
Neighbor takes precautions (4)	\$100	0	\$30	\$75	-\$5

Based on a total net benefit criterion that accounts for the net benefits of both the burner and neighbor, the burn should be conducted under scenario 1, but not under scenarios 2, 3, or 4. However, the burner will choose to burn if his private net benefits are positive (regardless of the neighbor's costs). Furthermore, both burner and neighbor will take precautions only if their private gains outweigh their private costs. Consider the outcomes of three different legal settings:

Legal setting 1: no liability placed on the burner

- The burner chooses to burn but does not take precautions; gains \$100
- The neighbor takes precautions and bears expected damage costs; loses \$105
- Neighbor's losses outweigh burner's benefits; the burn is performed when it should not be, given the incentives for precautionary effort

Legal setting 2: strict liability (burner compensates for damage regardless of precautions taken)

- The neighbor's costs are zero; he has no incentive to take precautions
- The burner's expected costs of \$105 outweigh the benefits of \$100; he chooses not to burn

Legal setting 3: negligence rule requires a specified level of precaution by the burner

- The burner escapes liability (at least \$75) by taking precautions; his net benefit is \$70
- The neighbor bears the damage because the burner is not negligent; the neighbor takes precautions and faces total expected costs of \$45
- This result is efficient if the gross benefit to the burner is \$100; efficient levels of precaution are instituted and a burn is performed when it should be (total net benefits = \$25)
- If the gross benefit of the fire to the burner were \$60 instead of \$100, both parties take efficient levels of precaution, and the burner still burns; however, the burn is conducted when it should not be (total net benefits = $-\$15$).

benefit is $\$60 - \$30 = \$30$. The neighbor's costs are still \$45, so the overall net benefit is $\$30 - \$45 = -\$15$. In this case, precautionary effort is at the efficient level given a burn, but the burn is performed when it should not be. There is, in principle, a solution to this "overuse" problem. The court can add another dimension to the negligence rule: if sufficient precautions are taken and the total expected net benefit is positive, then the burner is

Table 1. State liability law for prescribed fire and spread of wildfire (Yoder et al. 2003; used by permission of RAE)

Liability or property rule	State*
Burner strictly liability	CT, ND, NH, OK
Burner presumed negligent if fire escapes	AK, GA, MD, OR, UT
Burner liable for damage if proven negligent	AL, AR, CA, DE, FL, LA, MS, ME, MI, NC, NJ, OR, TX, VA, WA, WI
Notification requirements [N]=neighbors, [A]=agency	AR[N,A], CO[A], LA[N], OK [N,A] NY[N], NC[N], TN[N], UT[A]
Permits or bans supported by statute	AL, AZ, CA, CO, CT, FL, GA, ID, IA, ME, MA, MN, MS, NE, NV, NH, NJ, NY, OR, RI, SD, UT, WV, VT, WA
Criminal penalties for leaving fire unattended or failure to extinguish and negligent escape	AL, AK, CA, MI, NJ, NM, NV, NC, OK, OR, SC, SD, TN, UT, WI, WY
No statutes addressing prescribed fire	HI, IL, IN, KS, MO, MT
Liable for negligently allowing uncontrolled spread of wildfire	AK, DE, MI, OH, OR, PA, SD, TN, TX, UT, VT, WA, WV
Uncontrolled fire is a nuisance: can be billed for public fire suppression costs.	CO, GA, ID, MS, NH, ME, MD, OK, OR, WA, WI
Regulations restricting excessive vegetative fuel loads	MN, MT, NM, WA

*Citations for supporting statutes are available from the authors.

not negligent. Otherwise, the burner is negligent. In legal jargon this cost-benefit standard is called a Learned Hand rule, named after the judge who first applied it in court. Addition of this second dimension to the Learned rule will induce efficient prescribed fire use in all cases, if applied perfectly. There are many complexities of liability-induced incentives relating to incomplete information, burden of proof, transaction costs, and other issues (Cooter 1991), but one characteristic of prescribed fire liability in particular has become more apparent and critical in recent years.

■ Liability, incentives, and public goods

From an economic perspective, liability rules are legal attempts to induce burners to consider all of the potential costs of their actions. Without these rules, burners would not bear the costs of damage done to the property of others. Economists call these types of risks or costs “externalities”, because the costs are external to the decision maker, and therefore external to the decision itself. When these costs are internalized through liability rules, people tend to be more

cautious in their actions, and are likely to perform fewer prescribed fires than otherwise.

On the benefits side of the problem, fire ecology and management research is showing that, in many environments, prescribed fire can provide landscape-scale benefits in terms of wildfire risk mitigation, improved wildlife habitat, and ecosystem health. To the extent that this is true, prescribed fire provides positive economic externalities (whether they are represented in markets or not). The burn can result in geographically broad benefits through wildfire risk reduction, habitat benefits, and other ecosystem services. In addition, escaped fire, even if it damages property and perhaps resources, reduces the risk of future wildfire and may provide future benefits that are very hard to quantify for the purposes of litigation. These benefits will probably not be incorporated into the courts’ damage calculations. More generally, non-market and future values provided by prescribed fire, and even escaped fire, are not likely to be included in a systematic way into the calculus of court decisions.

Consider the previous example, in which the gross benefits from the prescribed fire are \$60. This time, however, suppose that from wildfire risk reduction or some other ecosystem improvement, \$40 of this \$60 represents the net present value of prescribed fire to a large set of neighbors. It would again be efficient for the landowner to perform the prescribed fire, but because the burner gets only \$20 and the cost of the prescribed fire is \$30, the burn will not be carried out. This is a standard economic result relating to the provision of public goods. Goods that provide benefits beyond those that accrue to the decision-maker often may not be provided privately.

A reasonable question to ask at this point is, why can’t the Learned Hand rule be applied to account for these public benefits as well? Indeed, this would replace the problem; potential prescribed burners would expect all costs and benefits to weigh into the negligence ruling, and so would have an incentive to consider them when deciding if, when, and how to perform a burn. The problem is that these types of benefits are particularly diffuse or hard to quantify or both, and legal precepts and practicality generally dictate that courts limit their considerations only to those costs and benefits accrued by the parties to the particular lawsuit in question – the plaintiff and the defendant. If the beneficiaries of landscape-scale wildfire risk reduction or other ecosystem benefits are rarely involved in lawsuits related to prescribed fire damage, then these benefits are not likely to be considered by the court. The manager of an escaped fire might therefore be found negligent under a Learned Hand rule, even if he would not have been had the broader set of benefits been considered. Liability rules may not therefore be sufficient to induce precautionary behavior when diffuse public benefits are provided

by the risky activity. Below we consider current liability laws in light of the above discussion.

■ New developments in liability law

In addition to the common law emphasis on negligence, 22 states in the US impose negligence rules, whereas only four states have statutes that impose strict liability (Table 1). This suggests that policy makers recognize that potential victims of fire damage generally have some control over the extent of damage that might be sustained as a result of prescribed burning.

A new generation of prescribed fire statutes has been developing in the southeastern states, beginning with Florida in 1990 (Brenner and Wade 1992), ostensibly to address the public goods issues discussed above. The Florida statute (and now statutes in a number of other states) explicitly recognizes prescribed burning as a land management tool that provides public benefits, such as wildfire risk mitigation and other ecosystem benefits (Figure 2).

For state-certified prescribed fire professionals, the current statute provides an interesting combination of a lower negligence standard – a requirement of gross negligence – with a substantial set of regulations that work together to address the weaknesses of liability law discussed above. Gross negligence is generally defined as the failure to use even the slightest amount of care, thereby showing recklessness or willful disregard for the safety of others. In order to be eligible for the gross negligence standard the burner must satisfy a relatively detailed set of regulatory requirements. The Florida statute also modified the common law history regarding nuisance, in that prescribed fire conducted in accordance with the statute could not be terminated in response to nuisance complaints regarding smoke.

This statute is interesting for three reasons in particular. First, a lower negligence standard reduces the costs to burners in terms of lower required precautionary costs and perhaps expected damage, so that prescribed fire is more likely to be worth the risk for the burner. Secondly, the low liability standard is bolstered by regulation and oversight through a permit system, contingent on written prescriptions, sufficient firebreaks, equipment and personnel, and other factors. The regulatory requirements increase the cost of precautions, towards the amount that would be accrued under a simple negligence rule. However, to the extent that these precautions lead to safer fire



Figure 2. Prescribed burning has benefits that are difficult to quantify and may extend beyond property boundaries. Burning eastern red cedar, an invasive species affecting much of the Central and Southern Great Plains, may reduce both wildfire risk and the spread of the invasive species.

management, the expected liability costs to the burner will probably be much lower because of the smaller chance of being found negligent.

■ Conclusions

Liability is consistently listed as a major concern for land managers using prescribed fire, and is often cited as a reason for not using it. This concern stems from recognition that part of the cost of using prescribed fire is the potential for escape and subsequent damage to neighboring property – a cost placed on burners via liability law. The relative effectiveness of a liability rule depends in large part on the relative ability of burners and nearby landowners to mitigate the risk of damage. If the potential victims (neighbors) have the ability to reduce damage to their own property, but do not because the liability law does not encourage it, then prescribed burning will be excessively costly and will be used less than it perhaps should be. If prescribed fire provides public goods such as wildfire risk mitigation, wildlife habitat management benefits, and ecosystem restoration, liability law should rely on negligence rules – perhaps even weaker negligence rules such as gross negligence standards rather than strict liability rules, because these rules provide less of a disincentive to use prescribed fire as a fuels management tool.

The pyrophilic ecosystems of the southeast provide sharp focus for understanding the relationships between law, regulation, and incentives for prescribed fire use, and the relatively well-developed law in those states is a reflection of this. The problems of fire and ecosystem

management in the Great Plains and the Western states are different from the Southeast for many reasons, and wholesale adoption of those legal structures is probably not advisable. However, as the importance of fuel management and the role of fire is becoming better understood, the legal innovations of the southeastern states ought to be considered for other regions of the US.

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