

Economic Principles of Wildland Fire Management Policy¹

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Abstract

Evolving wildfire management policies are aimed at more comprehensive treatments of current wildland fire management problems. Key policies are identified that affect wildfire and fuels management. Policies are discussed in the context of institutional factors such as interagency cooperation and the growing number of regulations and laws. Key economic principles, such as the Coase Theorem, are developed in the context of contemporary policies and institutions. Economic principles of specific management situations are discussed, including smoke emissions, the wildland-urban interface, suppression policies, and the use of prescribed fire. Policy formation as it applies to a dynamic society with implications for emerging issues in the new millennium are also addressed.

Introduction

Over the past several decades, the forest fire suppression policy has altered natural fire regimes in many fire dependent ecosystems, resulting in ecological change and increased probabilities of wildfire activity (Donaghue and Johnson 1975, Mutch 1994) as well as social and political concern. It is widely acknowledged that in the absence of wildfire, vegetative changes have resulted in fuel loads that far exceed historic levels and pose serious threat to forest and cultural resources if ignited (Arno and Brown 1991). In addition, continuing urbanization is contributing to increased fire danger in the wildland-urban interface, further complicating fire management and adding to the already limited physical and financial resources.

Although there has been a shift toward reintroducing fire to reduce fuel loads and to restore natural ecosystem processes, fire managers must also consider social pressure to protect lives and natural and cultural resources. Primary concerns include public safety, risk, inconvenience from smoke, reduced air quality, decreased esthetics, and fiscal responsibility. The Federal Wildland Fire Policy of 1995 addresses several key areas of fire management and recognizes the need for activities based on science and sound ecological and economic principles (USDI / USDA 1995). Although fire policy and economic theory are often at odds, economic principles are important to evaluate the effectiveness of such Federal policy. Given fire management objectives and widespread concern regarding wildfire, it is important to policy-makers, land managers, and the public to assess wildland fire policy from an economic perspective.

This paper provides a discussion of economic principles pertaining to the Federal Wildland Fire Policy of 1995. We begin by reviewing issues among the five topic areas. Within each topic area we discuss key fire management policies and the economic implications of such policies. Finally, we discuss policy formation and emerging issues that will be important to fire managers, the public, and policy makers in the next millennium.

Federal Wildland Fire Policy 1995

The Federal Wildland Fire Policy was revised in 1995 in response to changing social and ecological factors to emphasize the need to incorporate fire into land management actions rather than the traditional approach of total fire suppression.

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The stated purpose of the 1995 Federal Wildland Fire Policy is to reduce the threat of catastrophic wildland fire through proactive goals and actions. The document outlines 13 broad wildland fire policies that pertain to 5 topic areas (USDI /USDA 1995). We will focus on the five topic areas and discuss key fire policies that shape fire management. The five topic areas include the role of wildland fire in resource management, use of wildland fire, preparedness and suppression, wildland urban interface protection, and coordinated program management.

The Role of Wildland Fire in Resource Management

Decades of successful fire suppression has significantly altered landscapes in many fire-dependent ecosystems resulting in increased fuel loads and altered fuel arrangements, as well as changes in vegetative structure and composition. Given such changes, wildfires are more likely to ignite, burn with greater intensity, and spread more rapidly causing a greater level of financial and ecological damage than in the past. The past suppression policy has also resulted in mean fire intervals that far exceed natural levels, exchanging past and current damage for increased future damage. The forest fire policy recognizes that fire is an integral part of some ecosystems and that it will be necessary, where feasible, to reintroduce fire and reduce mean fire intervals. The 1995 policy states that fire will be integrated as an essential ecosystem process through planning, the use of prescribed fire, and education (USDI/USDA 1995). All areas with burnable vegetation will be required to formulate fire management plans and fire prescriptions in the case of both human and natural ignitions.

Although the ecological role of fire is important, reintroducing fire is a contentious issue that must be addressed both socially and economically. First, although fire is a necessary and integral part of the ecosystem, public acceptance may prove difficult to achieve and significantly add to the cost of fire management. Society has been deeply ingrained over the past several decades with the idea that wildfires are not desirable and should be extinguished at all costs. The USDA Forest Service's successful Smokey the Bear campaign is testament to this fact. Further, smoke emissions and reduced esthetics as a result of charred trees add to social unacceptability of reintroducing fire into the ecosystem.

The success of the fire policy will strongly depend on education and public acceptance. Although prescribed fire often negatively impacts esthetics, results from catastrophic wildfires may be longer lasting and less desirable. To effectively obtain public acceptance, the long-run costs and benefits of both wild and prescribed fires should be identified and evaluated so the public can be made aware of trade-offs. Manfredo and others (1990) provide evidence that education is an effective tool in achieving social support for controversial Federal policies. They conducted a survey to determine the public's state of cognition regarding prescribed fire policies. Although they found the public to be polarized in their support of various fire policies, they suggest that education and knowledge tend to increase the support for prescribed burning programs. They conclude that social and economic support is critical and necessary before such programs can be successfully implemented.

Although there is biological and ecological support for reintroducing fire, there are economic issues to be considered. Fire managers need to quantify the physical relationships between fire management activities and long-term ecological changes. Also, it will be necessary to evaluate the long-term economic effects of such relationships, including expected changes in expenditures, resource and property damage, and an assessment of market and non-market benefits. With respect to physical effects, tools to evaluate the frequency and intensity of prescribed fire programs required to affect long-term fuel reductions, changes in vegetative composition, and effects on suppression needs, should be further developed. If current fire programming is temporally and geographically

insufficient, it may not generate substantive ecosystem changes necessary for effective long-term fuel reduction and hazard abatement.

There is very little economic research on the effects of reintroducing fire, which may be a result of the scarcity and inconsistency of data. Economic studies have typically focused on estimating cost per acre (González-Cabán and McKetta 1986, Jackson and others 1988, Rideout and Omi 1995, Wood 1988) or fire management efficiency (Bratten 1982, González-Cabán and others 1986, Mills and Bratten 1982, Mills and Bratten 1988). Given that the fire suppression policy resulted in ecosystem changes that occurred over several decades, the policy to reintroduce fire will likely take several decades to reverse such changes.

Use of Fire

The use of prescribed burning to achieve management objectives is becoming more prevalent and is recognized as ecologically beneficial for fire-dependent ecosystems. There has been much research to support prescribed burning as a management tool to reduce hazardous fuels and to restore ecosystem functions (Arno and Brown 1991, Donaghue and Johnson 1975, Omi 1989, Williams and others 1993). To effectively use prescribed fire as a means to achieve such objectives, it is appropriate, in addition to obtaining social acceptance, to evaluate trade-offs and to determine whether treatments are cost-effective over the long term. Similarly, it will be important to determine the temporal and geographical scope necessary to be effective.

The cost of prescribed burning is influenced by biophysical, economic and social factors, such as burn characteristics, number of acres burned, potential damage from escape, and related social costs (Cleaves and Brodie 1990), all of which are important for planning and decision making. Increasingly, however, laws and regulations are adding to the cost of prescribed burning (Cleaves and Haines 1995). Specifically, such increases are attributed to increased regulation and permit requirements, increasing liability risk and insurance costs, and finally, opportunity costs where the agency chooses to forgo prescribed burning in favor of other fuels management techniques. Such actions may lead to a decline in the number of acres burned that may precipitate a greater threat of wildfire in the future, and consequently, higher levels of damage and social costs.

Given that costs are increasing, it will become increasingly difficult to burn an effective number of acres over time. For prescribed burning to effectively reduce hazards associated with wildfires, it has been suggested that the number of acres burned annually should be increased tenfold (Bell and others 1995). Not only will this increase the total cost of burning, it will likely increase emissions and public opposition. Smoke is an important issue with respect to the use of prescribed fire. Although the public often rejects prescribed burning because of smoke emissions and perceived risk, prescribed burning may be a cheaper alternative than increased smoke levels resulting from catastrophic wildfires. Similarly, prescribed fires will reduce the risk of catastrophic wildfire, thereby reducing the risk to society over the long term. For Federal policy to be effective, managers will have to evaluate the future costs of trade-offs between prescribed and wildfire, and the effectiveness of suppression versus presuppression, both socially and financially, and work closely with constituents to achieve the necessary support.

Finally, cooperation between agencies is recognized as being crucial to achieving long-term objectives. Fire management is conducted within administrative boundaries often without regard for ecosystem needs and landscape patterns. To achieve results on the ground, agencies will have to consider ecosystem boundaries rather than administrative boundaries. According to the Coase theorem (Coase 1960), to efficiently use prescribed fire, managers across agencies could collaborate to achieve the least cost solution and obtain economies of scale. Similarly, through cooperative agreements, prescribed

burns planned at the landscape level may also provide the required necessary geographical scope to be effective.

Preparedness and Suppression

Because of the successful suppression policy of the past, Federal agencies' abilities to plan and suppress fires have been negatively impacted---firefighter safety has been compromised and resources are increasingly overextended (USDI/USDA 1995). Three closely related policies designed to address these issues will be important for effective wildfire management: planning and values to be protected, protection priorities, and adequate protection capabilities. First, given the goal to suppress fires at minimum total cost, values to be protected will be a key component in determining strategies for large-fire suppression. Values will include human life, and relative values of property and natural/ cultural resources. From an economic perspective, the value of human life can be measured and is not infinite, contrary to the prevailing social belief. Likewise, the value of natural resources can also be measured where markets exist and estimates of prices are obtainable. However, measuring non-market values presents a problem. Existence, option, bequest, and intrinsic values represent intangible benefits that are difficult and sometimes impossible to measure. Methods to estimate such values are well developed in the scientific literature yet are not easily obtainable (Loomis 1993). Such values will likely be associated with cultural resources and ecosystem function and will likely present significant problems when trying to quantify and include them in management plans.

The beneficial effects of fire are recognized theoretically as well as within the policy, yet in the past these have not consistently been considered as part of the calculus in determining the net costs and damages resulting from wildfires. The current policy suggests that to be consistent with overall policy objectives such benefits should be included. Although this component is an important element to effective resource allocation, benefits from wildfires are also typically difficult to estimate, particularly long-term ecological benefits. To date there is a lack of research that quantifies the benefits from both wildland and prescribed fires. Furthermore, the economic values of such ecological effects are equally difficult to estimate without the production function relationships mentioned previously. Without such information, inclusion of both beneficial effects and non-market values will be impossible, necessitating further economic research to effectively implement this policy.

The second policy relating to preparedness and suppression prioritizes the values to be protected. Human life remains the first priority, while values relating to property and cultural/ natural resources are considered equally as a second priority. Criteria to evaluate resources include environmental, commodity, social, economic, political, public health and other values (USDI / USDA 1995). However, many such values are difficult to quantify. Without such estimates, it will be impossible to establish priorities. Furthermore, objectives may be diametrically opposed in some instances. For example, political priorities often focus on providing outcomes for small groups of constituents regardless of cost efficiency, whereas economic objectives focus on achieving efficient solutions for society as a whole. Similarly, there may be conflict between commodity and environmental values that leads to conflict in establishing protection priorities. Before priorities can be established, it will be necessary to establish a framework that can be used to evaluate the priorities for the criteria in addition to the values to be protected. Again, this will require further economic research in the area of non-market valuation, particularly with respect to cultural resources and resources that do not provide market-based products.

Finally, preparedness and suppression pertains to resource availability and positioning, including employee expertise and availability. To better achieve suppression effectiveness, fire management plans will focus on maintaining

sufficient fire suppression and support requirements and pay particular attention to the proximity of resources. However, criteria to evaluate "sufficiency" is not listed and may be difficult to quantify particularly in the event of changing ecosystem functions as a result of fire reintroduction. Because funds are becoming increasingly limited, achieving efficiency is important. However, a broader approach should be taken when evaluating suppression needs and capabilities. Currently, the budget for emergency fire fighting funds (FFF) comes from an unlimited source (USDI/USDA 1993), whereas the budget for annual programming is limited. The unlimited suppression funding increases total fire management costs and creates disincentives to invest in fire management activities such as prescribed burning. To promote efficiency, research should examine the effects of presuppression activities in reducing future suppression costs. Without budget restructuring, unlimited funding will continue to increase total fire management costs while investments in prescribed burning remain significantly under-funded.

Wildland-Urban Interface Protection

The number of people living in and near National Forests is increasing. This area, known as the wildland-urban interface has been growing significantly over the past decade and is becoming one of the most controversial areas for fire managers to administer (Cortner and others 1990b). Increased fuels and fire hazard have increased the need for fire protection and have greatly added to fire management costs in addition to compromising the safety of firefighters.

Although private land does not fall under a Federal protection mandate, many residents feel that it is the Federal agencies' responsibility to provide fire management resources. Furthermore, residents are often not fully cognitive of the risk in such areas, and therefore, do not take appropriate steps to reduce hazards (Beebe and Omi 1993). They note that the media can greatly influence public perception regarding wildfire and prescribed fire. In some cases, media coverage conveys the importance of fire management in areas of risk, but in others, such coverage leads to widespread opposition of policies that use prescribed fire to reduce the risk of future catastrophic fire. They also support the notion that education and public participation are key factors in implementing successful prescribed fire programs. Where the public is informed and plays an active part in the decision making process, the use of prescribed fire may be more readily accepted, thereby reducing social and managerial costs.

Federal monies are available through the Federal Emergency Management Agency (FEMA), as well as private insurance, which reduces individual responsibility for fire management protection and risk reduction. If the cost of fire protection and hazard reduction is not borne by the resident, there is no incentive to take action individually, further increasing the pressure for Federal protection. Furthermore, without a full assessment of risk and hazard, individuals living in the urban interface cannot make informed decisions.

Another complicating factor regarding the wildland urban interface results from the lack of a clear definition with respect to the Federal role in protection. Although Federal policy does not include protection and management of private lands, the public often expects protection and generally opposes the withdrawal of forces from the wildland urban interface (USDI/USDA 1995). Currently, Federal agencies are limited to providing emergency assistance, training, and cooperation in prevention efforts. However, expectations that the Federal government will provide such services often results in social pressure, over-extension of fire fighting forces, and inefficiency. Furthermore, fire protection is inequitable from a societal perspective because tax dollars are used to protect select individuals who choose to live in the wildland urban interface. Solutions to achieve more efficient fire protection on Federal lands and to alleviate the social burden include billing individuals for suppression expenses and other fire

management services such as prescribed burning and fuels reduction. Similarly, insurance rates could be adjusted to capture the true cost of fire management resulting in a user pay system.

Coordinated Program Management

The organizational climate within Federal agencies has not been conducive to effective fire management in the past. Several criticisms include the lack of consistency in evaluating accountability, program efficiency, organization, legal and policy analysis, responsibilities and liabilities, as well as data management and weather support (USDI/USDA 1995). Policies to address such issues will focus on improving accountability and agency support as well as more emphasis on improving efficiency, particularly with respect to large fire suppression efforts. Finally, more importance will be given to implementing uniform policies within each Federal agency to provide employee support and increase responsibility at the administrative levels.

Although such improvements are important and will greatly enhance organizational efficiency, the policy overlooks an important issue. Risk is an inherent factor for both wildland and prescribed fire and has the potential to adversely affect economic viability as well as social acceptability and potential agency support. Risk refers to the probability of escape resulting in financial and ecological loss and the possibility that objectives will not be achieved. Alternative management scenarios generate different degrees of risk and ultimately a different set of economic outcomes (Cleaves and Brodie 1990).

Fire managers frequently have the discretion to make decisions based on their own expert judgment with respect to fire management and the extent of the risks undertaken. Typically, individual managers demonstrate higher levels of risk aversion than do agencies, primarily because individual managers are held responsible for problems that may occur, often resulting in higher operational costs. Blattenberger and others (1994) found that regardless of the approach to objectively include estimates of risk in fire management models, decisions are ultimately weighted by the decision maker, and acted upon according to individual levels of risk aversion. Similarly, Cortner and others (1990a) found that safety and resources at risk are two of the greatest influences on fire decisions, followed by public opinion, agency policy versus local and regional directives, reliability of information, and ability to maintain judgmental discretion.

Although research objectively identifies risk by using probability theory and other analytical procedures, more work is needed to fully integrate economic aspects of fire management to systematically achieve optimal management strategies. To manage effectively, risk should be objectively characterized and institutionalized such that managers conform to an agency-wide decision making framework. This will necessitate framework development including an objective assessment of values at risk and the degree of risk involved with a range of fire management scenarios.

Finally, the policy states that decision making capabilities and data support will be improved. Currently, decision support systems and computer models are used to estimate fire behavior and effects for both wild and prescribed fire. Behavior models include BEHAVE (Andrews 1986), RXWINDOW (Andrews and Bradshaw 1990), and FARSITE (Finney 1996). Similarly, computer systems have been developed to schedule fire use (Bradshaw and Fischer 1981) and to evaluate fire management prescriptions (Bevins and Fischer 1983, Reinhardt 1991). Models designed for stand-level analysis of fire behavior and effects include NEXUS (Scott and Reinhardt 1998), FOFEM (Reinhardt and others 1997), and the fuel and fire extension to the forest vegetation simulator, FFE-FVS (Hardy and Reinhardt 1998). Although such models are important at the stand level, they are not currently formulated to evaluate long-term economic effects of fire management programs. Economic research to evaluate efficiency will be

essential to implement effective fire management plans. Finally, it will be important to achieve consistency across agencies to develop databases that will uniformly support management decisions.

Discussion

The Federal Wildland Fire Policy of 1995 focuses primarily on reintroducing fire into the ecosystem to minimize hazard and the threat of catastrophic wildland fires. Policies are designed to promote reintroduction of fire and enhance agency cooperation and support. Although the policy addresses important economic issues with respect to efficiency and cost effectiveness, implementation of such policies could be problematic depending upon the degree to which community and public support is achieved. Although at an increased cost, social acceptance and education will play a crucial role in the future of fire management and will become increasingly important as populations residing in the wildland urban interface continue to grow. The public, often without regard for efficiency, typically ignores the risks resulting from increasing and unnatural fuel loads, not realizing the potential for damage and loss. Policy that focuses on education and information will likely be one of the key elements in achieving effective fire management in the future.

If fire management policies are to be effective over the long term, it may be necessary to increase total current expenditures and focus more on presuppression activities rather than suppression. Because fuel loads have reached unprecedented levels, fire management efforts will likely take several years to begin controlling the problem. To this effect, forested lands will require intensive management at a scale not seen before. Not only will this be expensive, it will likely be socially unacceptable because of increased emissions, reduced esthetics, and perceptions of risk. Economic research will be important to identify the value of such trade-offs and to compare costs and benefits over the long term.

Related to the effects of presuppression versus suppression, fire programming budgets will have to be revised to support fire management objectives. The unlimited emergency suppression funding has the potential to increase total fire management costs beyond what is optimal and creates a disincentive to invest in presuppression activities such as prescribed burning. Without a policy change in budgeting procedures, unlimited funding will continue to increase total fire management costs while annual budgets remain under-funded.

Fire management over the past century has been greatly influenced by prevailing management philosophies and social values of the times, both of which change in response to scientific advancement. As past fire policies and social beliefs are manifested in a continually changing ecosystem, new information will become available and can be effectively incorporated into the evolving fire management policy. Issues likely to become more important and further complicate fire management are the increasing danger and threat of catastrophic wildland fire, particularly as it affects the wildland-urban interface; the increasing need to burn more extensive areas of forested lands to effectively reduce such threats; increasing costs in relation to the greater number of acres burned; and increasing social and regulatory pressures. If policy makers can achieve a balance among these issues and gain social acceptance, they can begin to effectively address fire management problems through the next millennium.

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