CHAPTER 8

DESIGNING ECONOMIC IMPACT ASSESSMENTS FOR USFS WILDFIRE PROGRAMS

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1. INTRODUCTION

As often happens in the wake of a series of extreme fire seasons, such as those in 2000, 2002 and 2003, federal wildfire policy is being scrutinized and recommendations regarding changes both large and small are prevalent (Stephens and Ruth 2005, Busenberg 2004, Dellasalla et al. 2004, Dombeck et al. 2004). It is common practice for increases in acres burned and in suppression costs to be cited as evidence that existing policy is a failure and that changes must be made. For example, Busenberg (2004) argues that "the wildfire crisis in America was created by a longstanding policy failure" which "greatly increased the risk of wildfire damages."(p. 145). However, there is scant empirical evidence regarding the magnitude of total economic damages (much less, the benefits) resulting from wildfire, and empirical evidence that would permit an overall evaluation of wildfire programs is limited.

Stephens and Ruth (2005) make suggestions for reducing the trend in wildfire acres burned, which begs the question of whether the objective of federal wildfire policy is to minimize acres burned, economic impacts, or some other measure. Although the 2001 Federal Fire Policy has as its primary tenets the protection of life, property and resources, it does this through 9 guiding principles, 28 findings, 17 policy statements and 19 implementation actions (United States Interagency Federal Wildland Fire Policy Review Working Group 2001). Thus, despite a clear statement about protecting life, property and resources, the firefighting agencies are often faced with determining priorities in the face of multiple guiding statements that may imply contradictory objectives. One interpretation of this policy could be an objective of minimizing acres burned, although this results in treating all acres as equal in value, whether they are endangered species habitat, wildland-urban interface, or some other designation.

In the past, prior to the current epoch of increasing fuel loads and the expansion of the wildland urban interface into fire-prone areas, and with easier success in suppression, a goal of minimizing acres burned may have been synonymous with minimizing damages. Over the last 100 years, however, changes in suppression

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success in conjunction with increases in the values at risk have likely led to a divergence between economic damages and acres burned. Certainly, it is apparent that at least the largest and most well known fires are damaging (Kent et al. 2004, Butry et al. 2001, Franke 2000), but data are insufficient to identify trends in local, regional, or national impacts.

An analysis of the costs and losses associated with any natural disaster will be influenced by the inclusiveness and scope of the cost and loss categories used to conduct an assessment. In particular, an economic assessment will be sensitive to the spatial scale (geographic area to be assessed), temporal scale (time span used to assess impacts), and sectoral scale (economic sectors included). Further, programmatic scale issues derive from differences in evaluating the costs and losses of an *event* as compared to the costs and losses of a *program*. Finally, economic costs of individual wildfire events and wildfire programs are important not only because of the magnitude of the costs and losses, but also because these events and programs will have distributional consequences, influencing who gains and who loses from each event and program (chapter 9 of this book). This chapter discusses design of economic impact assessments for natural disasters, describes a feasible design for wildfire programs, and suggests immediate improvements to data collection that could enhance the ability of the U.S. Forest Service to evaluate trade offs for private property owners and public land managers.

2. ECONOMIC IMPACT ASSESSMENTS OF NATURAL DISASTERS

2.1 Defining Economic Impacts: Costs, Losses, Benefits, and Damages

Over the last decade, evaluations of empirical methods to assess the costs of disasters have been conducted by three organizations: (1) the Bureau of Transport Economics of Australia (BTE) (2001), (2) the Economic Commission on Latin America and the Caribbean (1999) (ECLAC), and (3) the National Research Council (NRC) (1999). Each of these evaluations promotes a slightly different method of tallying the costs, losses, impacts and damages of disasters, but the overall intent of the evaluations was to provide a consistent method for tallying disaster costs. We discuss the classifications of costs and losses recommended by these studies, noting where an evaluation of a wildfire program would be different from the evaluation of nationally or internationally designated disasters.

In the United States natural disasters are defined by either the insurance industry or by presidential proclamation. The Property Casualty Services unit of the Insurance Service Organization, an industry group, began collecting data on disasters, which they defined as an event with over $1million in insured losses, in 1949. The dollar limit increased several times to $5 million in 1983, and was most recently set at $25 million in 1997. The second determination, allowed under the Stafford Act (P.L-93-288) passed in 1988, is a presidential proclamation of disaster, which allows federal resources to be used for assistance and reimbursement of local, state, and uninsured damages and costs. Few wildfires, and no non-fire program activities, have been classified as disasters, and thus would not be tallied under a disaster evaluation program. However, although each event may be small, we still need to know cumulative impacts in order to address the trade-offs inherent in developing a wildfire program.

The terms costs, losses and damages are used in the BTE, ECLAC, and NRC evaluations of disaster costs similarly, and are consistent with the cost plus loss (least cost plus net value change) model traditionally used for assessing wildfire suppression (chapter 16 of this book). Economic impacts of a wildfire program will include both market (e.g., timber) and non-market (e.g., water quality and quantity) effects. One component of market effects is costs—expenditures made by agencies or individuals to directly influence the wildfire program or recover from a wildfire event. Costs include suppression expenditures, as well as disaster aid, rehabilitation expenditures and pre-fire treatments and activities.

Two types of damages, direct and indirect, are identified in the 3 listed reports, which can be either monetized (also referred to as losses) or nonmonetized (e.g., intangible losses). Direct damages are the physical assets destroyed by a catastrophic event and are typically measured in monetary terms. Indirect damages are the subsequent, or downstream, effects of the disaster on the rest of the economy. These downstream effects include losses in production and gains due to reconstruction and rehabilitation.

Damages to environmental assets may be of more importance in evaluating wildfires than in evaluating other natural disasters such as earthquakes or tsunamis. These can include damages to soil, water, cultural resources and wildlife habitat. Suppression efforts themselves have also been identified as a source of environmental damage (Backer et al. 2004) as have timber salvage activities (McIver and Starr 2001). The three studies disagree regarding whether losses to environmental assets are considered direct losses (loss of capital) or indirect losses (loss subsequent to the event).

In addition, while all three studies refer to intangible losses, and the potential significance of these losses, they acknowledge that there are no methods for computing either the values or quantities of these losses. These intangible losses include loss of memorabilia, sense of trauma or fear, and loss of sense of place. Indirect damages are also difficult to quantify, and there is some evidence that these downstream damages may be less important for wildfires because wildfires rarely destroy major economic infrastructures in the manner of disasters such as earthquakes and floods (NRC 1999). There are also potential positive impacts from wildfire that are rarely quantified, even though these effects are one reason that the behavioral model is now referred to as cost plus net value change rather than cost plus loss.

2.2 Scale

The disaster cost plus loss tallies such as those suggested by the NRC, BTE and ECLAC are specifically designed to address individual events, not a land management program which happens to include events that may end up classified as disasters. In the case of wildfire and other forest disturbances, damages and benefits will accrue from both the events themselves and from the mitigation and rehabilitation efforts, and will accrue each year, whether activities and events occur or not. Thus, tallies such as those recommended by NRC, BTE and ECLAC do not adequately address a program such as that used by federal agencies for all wildfire activities. Expanding these tallies so that data are recorded for all events in a program (including prevention, presuppression, suppression, and recovery and rehabilitation) would require substantial, and unavailable, investment by the land management agencies. Yet, without addressing programs as a whole, the usefulness of these tallies will be limited to addressing single questions rather than overall program goals. Agencies conducting tallies of detailed costs and losses for individual fire events will need to determine if the agency and public would be better served by a broader assessment of the economic impacts of a program, or if they will continue to place energy and funding to tallying details of only a select few events.

Program evaluation is complicated by the fact that it requires calculating the interactions and trade-offs between the various activities of the program. For example, the impacts of a wildfire on life and health are undeniably negative. This does not lead to the conclusion that wildfires are to be avoided, unless, of course, the consequences and costs of avoiding wildfires are also assessed. Evaluating the impacts of the wildfire *program* on life and health, however, will require assessing the health impacts of prescribed fire (which may be different than wildfire), mechanical fuel treatments (logging is still a dangerous occupation), and wildfire impacts under different suppression scenarios (e.g., full suppression, wildland-urban interface only, increased use of wildland fire use fires).

The geographic, temporal and sectoral scales of an assessment will affect the total measured outcome. It is possible that effects of a natural disaster may be close to zero if the measured part of the economy is large enough (NRC 1999). Similarly, impacts will differ if the geographic area of the analysis is small or if the time span of the analysis is short. If the area of impact is the nation or state, the effect of any single wildfire event or even the total program will be dwarfed by the size of the economy. Geographic trade-offs will occur in nearly all market sectors, where timber prices may influence adjacent markets, and tourism may be redirected to adjacent recreation areas, resulting in gains in areas otherwise unaffected by the wildfire. In this case, for a large geographic area, the only losses that may result are from additional costs incurred to travel to the new location.

If only the immediate effects of a wildfire program are measured, the assessment might easily exclude potential benefits from a fire or treatment (such as improved ecosystem health). Likewise, certain damages (such as later flooding or water quality degradation) might be omitted from a short-term assessment. Thus, a time scale appropriate for the type of each activity or event must be used to correctly evaluate overall impacts. The sectors to include in the analysis will also influence the outcome, especially as there are often gains in one sector or part of the market even as there are losses in another sector.

2.3 Distributional Impacts

Although tallies of costs and losses are important for current and future economic analyses, an optimally designed economic assessment would also include information that would allow the distributional impacts of wildfire program costs and benefits to be evaluated (Holmes et al. 2007). Due to the complex interactions of weather conditions, fuel loads, and topography that affect wildfire management decisions, it is unlikely that fire suppression decisions fully reflect the consequences of a fire event from the perspective of households with various income, age, ethnic, or racial characteristics. If some socio-economic groups are more likely to reside or work in locations with a high fire risk, then they would be more vulnerable to potential losses from a fire event. Likewise, if some groups have a lesser ability to recover economic losses from a catastrophic fire, either because they are uninsured or have a lesser ability to receive disaster assistance, they would have greater vulnerability to long-term economic losses.

Most research evaluating the linkages between demographic characteristics and the severity of impacts from natural disasters has been conducted in the context of low-income countries (Morduch 1994). Within the United States, Bolin and Bolton (1986) evaluated the role of race, religion, and ethnicity on the ability of households to recover from natural disasters in four different case studies. They concluded that poor families and large families have the greatest difficulty acquiring aid and recovering from a natural disaster. They note that, because members of ethnic minorities, particularly Hispanics and blacks, are more likely to belong to such families, these ethnic groups are more vulnerable to natural disasters. This conclusion is echoed in the sociological review conducted by Fothergill and Peek (2004) who found that, within the United States, the poor are more vulnerable to losses from natural catastrophes because of their location decisions, poorer quality housing, less frequent purchase of insurance, and lesser ability to travel the bureaucratic pathways necessary to claim disaster assistance.

We are unaware of any studies that have specifically evaluated the relation between demographic groupings and the economic impacts of wildfire related damages. However, rapid population growth in fire-prone regions of the wildland urban interface, combined with the structure of the local economies in these areas, suggest that such studies may be warranted. Johnson and Beale (1994) reported that, during the 1990s, the fastest growing counties in the United States were non-metropolitan counties that were destinations for retirement-age migrants or were outdoor recreation centers. Because service industry jobs in the outdoor recreation and tourism sector generally provide lower levels of income than other sectors of the economy, the impact of income inequality on the ability to recover from wildfire damages may be an emerging issue in some fire prone communities.

A second distributional concern is that the provision of disaster relief by the federal government creates what economists call a "moral hazard". By offering financial assistance to insured and uninsured households and businesses in the wake of a natural disaster, disaster relief lowers the recovery costs faced by people who voluntarily choose to locate in high hazard areas. This moral hazard creates an economic incentive to locate in hazard prone areas (Shughart II 2006). Further, it has been argued that both presidential and congressional politics affect the rate of disaster declaration and allocation of recovery expenditures (Garrett and Sobel 2003). These findings raise questions as to whether federal disaster recovery funds are reaching the people in greatest need of assistance.

3. FEASIBLE ECONOMIC IMPACT ASSESSMENT FOR WILDFIRE PROGRAMS

Without adequate information, landowners and land managers can not make the best decisions. Risk analyses, optimization models, and program assessments of varying degrees of detail have the potential to provide better information for both land management agencies and for homeowners, reducing economic losses associated with both property owner response to wildfire risk (often presumed to be inadequate) and land management agency response, variously assumed to be excessive (if one is paying the bills) or inadequate (if one's home was destroyed by wildfire).

A complete model of an economically optimal wildfire program maximizes net social welfare summed across all participants and over time. Such a model would include values for all market and non-market products, services and attributes; incorporate ecological tradeoffs between wildfire, prescribed fire, fuel treatments, logging and grazing; recognize how suppression influences fires and affects forests; and incorporate climate and weather linkages to fire, suppression and forest regrowth. Developing data sufficient for this type of model across all ownership types, temporal and spatial scales, and wildfire programs is overwhelming and likely prevents realistic optimization in the near future.

It is feasible, however, to develop assessments of economic impacts (including damage estimates) that address policy issues, even if the data are not sufficient to develop a fully specified cost+loss model. These assessments can help land management agencies determine the appropriate level of suppression as compared to fuel treatments, prevention, prescribed fire and other land management. Further, they can help landowners determine the appropriate level of insurance and averting behavior. In section 4 we suggest an immediate economic impact assessment that could be implemented within the current data structure with few changes. In the remainder of this section we describe a more fully-specified feasible economic impact assessment.

Four analyses of large, recent wildfires are used to illustrate the fire-only components of a feasible economic impact assessment, and to illustrate where additional research might be needed before components are suitable for inclusion. These wildfires are Florida 1998, Hayman 2002, California 2003 (selected fires), and Northern Rockies 2000. Table 8.1 summarizes the values derived from these assessments. The tallies are inconsistent due to the fact that different attributes were significantly affected in each of the fires and different methods were used to estimate the various impacts. This table shows the total economic impact and the percentage of the valued total that was attributable to each loss category. These totals and percentages, combined with our understanding of the time involved in evaluating some of these losses, contributed to the feasible assessment design.

Certain losses caused by wildfire, such as those from watershed impacts, tourism and recreation impacts, health impacts, and the damage and destruction of insured property need additional research to ensure consistent and reliable estimation of each impact's value. These damages and losses will take significant time to determine even after accepted methods are developed. However, delaying development

Table 8.1. Economic impact assessments of four recent wildfires.

	1998 Florida		2000 Northern Rockies		2002 Hayman Colorado		2003 Old, Grand Prix and Padua	
Damages								
Size of fire(s) (acres)	500,000		3,104,000		138,000		161,175	
Structures destroyed #								
Residential	340		135		132		1,130	
Commercial	33		5		1		11	
Outbuildings			325		466		60	
Human losses								
Deaths #			4		5		6	
Injuries #			14		3			
Costs + Losses	mm$	% of total	mm$	% of total	mm$	% of total	mm$	% of total
Loss of structures and contents	12	2%			39	25%	576	50%
Loss of timber	480	64%			0.036	0%		
Suppression costs	100	13%	378	100%	43	28%	61	5%
Disaster relief costs	22	3%			6	4%	45	4%
Watershed costs and losses					66	43%	478	41%
Health costs	0.52	0%						
Tourism costs	138	18%						
Total costs plus losses	753		378		154		1,160	

of an assessment program until these issues are resolved could postpone an evaluation of damages and trends from wildfire programs for many years.

Note that many of the entries in table 8.1 are left blank. These values or numbers were not found in the studies we used. This blank entry could represent a 0, or perhaps it was not possible to estimate this value, or the value may have been estimated by others and thus not included in the economic analysis. This illustrates the difficulty in deriving total wildfire impacts, let alone total wildfire program impacts, by using estimates from the few fires that were deemed worthy of additional analysis. These elements are discussed further below.

3.1 Impacts Included in the Feasible Design

3.1.1 Agency expenditures (all activities including suppression)

Although there is substantial discussion and importance placed on suppression expenditures (chapters 13, 15, 16, and 17 of this book, for example) these expenditures averaged only 21 percent of the total cost-plus-loss for the 4 assessed fires (table 8.1). They are, however, of critical importance to the agencies faced with limited budgets and increased pressure to reduce costs. Accurate tallies of these expenditures, both for suppression and other wildfire programs, are also critical for determining trade offs between different activities such as prescribed fire and wildfire, or mechanical treatments and prescribed fire. While there are significant issues associated with this data it is relatively easy to collect, consistent and reliable.

3.1.2 Natural resource impacts (excluding timber, all activities)

Damages from suppression and from activities such as prescribed fire and fuel treatments are necessary for evaluation of wildfire programs, and some estimate of these losses and benefits may be attainable. These tallies, however, could always be presented in physical terms, with values in dollar terms provided where available. The development of valuation estimates for natural resource damages is difficult and time consuming, and is unlikely to be available for all wildfire program activities, but could be presented where available. None of the four studies presented in table 8.1 show these impacts.

3.1.3 Timber (all activities)

Earlier versions of the USFS Wildfire reports (FS 5100-9) included an estimate of timber value destroyed. Timber values destroyed and damaged could be included for areas where commercial timber harvest is still a viable economic activity. Butry et al. (2001) provide a welfare theoretic method for assessing these values in detail, but for most fires a simple estimate of volumes destroyed and volumes damaged but salvageable could be included. Timber comprised an average of 20 percent of all costs+losses recorded for the four sample fires, but variations from fire to fire are extreme. In addition, the methodology used varied depending on this level of importance. For example, for the Florida fires, the calculation included losses and gains to both consumers and producers in all sectors, while the Hayman estimate represents only the total loss to the USFS from timber sales (primarily firewood and Christmas tree sales). There was an additional estimate of total timber value destroyed on the Hayman of $34 million which appears to be based on projected volume destroyed times average price, but is not related to actual or projected timber harvested on the affected area.

3.1.4 Human life and injury (all activities)

Although human life and injury is number one on the list of federal fire policy objectives, the USFS makes a limited effort to tally the effects of wildfire, and especially the effects of a wildfire program including treatments, on human life and injury. OSHA maintains records by job category, but the detail needed to link these to presuppression, initial attack, wildfire, wildland use fire, or prescribed fire are not available. For the other program activities, it is similarly difficult to determine if fatalities and injuries result from traditional logging or fuels treatments. This information is crucial to developing reliable economic impacts, especially in view of the importance given to this objective in federal wildfire policy. Human fatalities and injuries are, however, generally available for large and damaging fires and these numbers are displayed in table 8.1 where available.

3.1.5 Threatened and evacuated structures (wildfire and escaped prescribed fire only)

Calculating the number of threatened and evacuated structures may be difficult, but is important for determining the negative effect of wildfires on communities, and for determining the positive effect of suppression on reducing damages. Knowledge of the potential size and damages of a fire without suppression is unattainable, but the threats to development will provide some information on these potential damages. Evacuations are ordered by neighborhood or street, and local governments may have accurate numbers of dwellings in a neighborhood. Commercial evacuations may also be available from local governments. The number of threatened structures is a core element of a post-fire assessment of values at risk. Currently, there is little guidance regarding what constitutes a 'threatened' structure. Evacuated structures can be classified as threatened, but additional research and discussion are needed to develop a more precise measure of 'threatened' areas, be they acres or structures.

3.1.6 Infrastructure destroyed or damaged (wildfire and escaped prescribed fire only)

Damages to major infrastructure, such as highways, communications facilities, recreational areas and electric power lines, could be recorded. These damages are usually less than structural damages, but could be critical to recovery and rehabilitation efforts. These could be recorded as dollar values whenever possible.

3.1.7 Structures destroyed or damaged (wildfire and escaped prescribed fire only)

Standards could be developed and used to determine whether a structure is destroyed or damaged, and levels of damage could also be included based on the percentage of total value destroyed. It is critical to make distinctions between types of structures, because the loss of an outbuilding is not likely as important as the loss of home or business. The preliminary and final reports for the 2000 Northern Rockies fires both report that 465 structures were damaged, but only the preliminary report provides the detail that 135 homes and 5 businesses were destroyed, the remainder were outbuildings (table 8.1). A protocol could be developed to clarify the use of terms representing the type of structures destroyed rather than continuing to refer to the all-encompassing 'structures lost' which can be misleading.

3.2 Impacts Requiring Additional Research

3.2.1 Watershed impacts (all activities)

One particular impact of wildfire is on municipal watersheds—leading to two distinct outcomes. First, is the change in the quality of water produced for municipal use from increased sediment, nutrients, and salts. Second is the change in the quantity of water, leading to flooding and mudslides. Municipal water managers must address both of these, and there may be substantial costs associated with both the quantity and quality changes resulting from the fire. As of yet, however, the data are not available to consistently estimate the costs of fire on watersheds.

Few assessments attempt to value watershed impacts of fire. Dunn (2005) included an estimate from the 2003 fires in the San Bernardino Mountains in Southern California. Estimates from the Santa Ana Watershed Project Authority, Natural Resources Conservation Service and others amounted to $478 million, nearly 8 times the estimate for suppression expenditures and 83 percent of the estimate for structural losses (table 8.1). Making programmatic decisions based on these impact estimates could lead to the conclusion that only slightly more of our suppression effort should be directed at structural protection than at watershed protection. However, including these damage and restoration estimates as stated is questionable due to the unknown methodologies and assumptions used in their construction. In addition, a full programmatic assessment would require estimates of the impacts on water quantity and quality from other program events, such as prescribed fire, mechanical treatments, and wildland fire use. We recommend that additional research on the costs and values of the impacts of the wildfire program on municipal watersheds be conducted before these estimates are included in wildfire program tallies of costs and benefits.

3.2.2 Tourism and recreation impacts (all activities)

Locally, wildfires and prescribed fires may have significant effects on immediate (fire-year) recreation and associated tourism expenditures. Documentation of declines in tourism expenditures (Butry et al. 2001), outfitter and guide trips (USDA Forest Service 2001), and national forest visits (Kent et al. 2003) indicates that for some market participants the effects could be significant. These effects, however, may be mitigated in the larger economy by the substitution of other recreation sites for the fire-affected sites (Kent et al. 2003). Medium-term (1-5 years) effects are also uncertain, with some studies suggesting losses and others finding increases subsequent to the fire season, presumably by curiosity-seekers (Franke 2000, chapter 10 of this book). In situations where fires dramatically alter ecosystem attributes, the dynamics of forest regeneration and recovery may continue to induce long-term (spanning decades) declines in visits to affected areas (chapter 10 of this book). Substitution patterns over space and time appear to be rather complex, suggesting the need for future research.

The issue of substitutability between recreation sites and activities can be seen in the varying results from the four fires evaluated in table 8.1. The large negative values from the Florida fires (Butry et al. 2001) assumed that all tourism was lost, and no substitutes were available. In contrast, Kent at al. (2003) assumed that substitutes were available and used, resulting in a much lower loss estimate. Direct effects (losses occurring from closures and/or destruction of property) could be separated from indirect effects (losses occurring later because of publicity or effects on the resource that attracted the tourism in the first place). We recommend that additional research be conducted on these issues regarding recreation and tourism impacts of a wildfire program before efforts are made to include these data in economic impact tallies.

3.2.3 Insurance values and losses (wildfire and escaped prescribed fire only)

Currently, tallies of total insured losses are available only for select wildfires, usually the largest and/or most damaging. The Insurance Service Organization (ISO) gathers data from all insurance companies, but this information is not available free of charge. In addition, the records do not always distinguish between wildfire and structural fire as the cause, unless the fire is considered a disaster (exceeding $25 million in losses). It may be possible to work with insurance organizations to develop reporting that would be useful to both the ISO and to the agency. Once insured losses are known, a simple conversion is usually used to derive total losses, including uninsured, deductibles and underinsured costs.

One additional issue remains with collecting and utilizing insurance losses for use in an assessment. Because the access to insurance differs across economic, social, and demographic strata, reliance on this aggregate level of values information alone may mask differential equity effects. While a complete tally of costs and benefits would measure the values at risk in order to compare these values with the costs of protecting these values, the inequities inherent in these value-based analyses must also be addressed. In some respects, the number of dwellings and commercial buildings destroyed, damaged and threatened may be equally appropriate as a measure of economic impact. Tallies of types of structures damaged/destroyed must always accompany any structural dollar loss totals.

3.2.4 Other health impacts (all activities)

At this time, data are not readily available for estimating total health impacts from wildfire programs. The Butry et al. (2001) analysis of the Florida wildfires included a monetized assessment of the costs of smoke from the wildfire. More recently, Rittmaster and others (2006) present a method for estimating the health impacts of elevated particulate matter associated with a wildfire in Alberta, Canada. They report that the economic impacts are substantial and only second to the impacts on timber. We recommend that additional research be conducted that would allow estimation of these impacts for all wildfire program activities.

4. IMMEDIATE USFS ECONOMIC IMPACT ASSESSMENT FOR WILDFIRE PROGRAMS

Within the USFS, and through other federal agencies, we have various systems to record data on fires, but these are primarily oriented toward tallying suppression efforts and suppression resources used, and to documenting the path and course of the fire itself. And many of these data are collected only for large fires (greater than 100 acres). In addition, while the databases often allow for entry of information on specific suppression activities or on threatened structures, these entries are not required. Prudent data entry personnel would not likely allocate time for optional entries, particularly when there is inadequate time for the required entries. Even so, this information on damages is necessary to understand trade-offs between the various wildfire program elements, over space, and through time. The USFS could begin acquiring the necessary information by requiring the collection of the following information:

1. Require that all wildfire program events (fuel reduction treatments and prescribed fire) be recorded, including all information possible, similar to the recording of wildfire events done currently including at least location, acres, costs, fuel model, and start and end dates. Additional fields to record the type of treatment could be added.
2. Require that firefighter and non-firefighter (including civilian) deaths and injuries be recorded for all wildfire program activities.
3. Require that evacuations and threatened, damaged and destroyed residential and commercial structures be recorded for wildfires and escaped prescribed

fires. Develop precise and understandable criteria for determining what constitutes a threatened, damaged or destroyed structure and how to measure evacuations.

4. Require corrected agency expenditures, accounting code and acres affected (for wildfires—acres burned by a predetermined classification of severity or intensity; for other activities—total acres only).

5. Require a list of affected communities, perhaps by zip code, name or census tract. Population, income and other demographic variables in destroyed, damaged and threatened areas can be determined subsequent to a fire provided the spatial extent of the affected areas is recorded.

We believe that a credible and useful immediate impact assessment for wildfire programs could be developed if these 5 suggestions are immediately implemented.

5. CONCLUSIONS AND SUGGESTED RESEARCH

Over the last 15 years, trends in wildfire acres burned and suppression costs have increased and have become increasingly volatile. While intuition, common sense and anecdotal evidence indicate that damages are also increasing, data are insufficient to develop trends for economic impacts and damages. Many post-fire reports and analyses have been produced, each addressing the issues important to that fire or season. These reports are produced by different groups or agencies, and there currently is no single location where data on economic impacts from wildfire are archived. Evaluations of damages are typically conducted when some unusual event occurs, such as an escaped prescribed fire (Cerro Grande in 2000), higher than average suppression costs (Biscuit 2002), large numbers of homes destroyed (California 1991, 1993, 2003), or widespread fire seasons (USFS Northern Region 2000, Yellowstone 1988, Florida 1998). Many other large fires, some equally damaging, have received little attention, and small fires, even if they result in loss of life or structures, receive no economic impact analyses at all. In addition, the other interrelated components of a wildfire program, including fuel treatments and prevention, are not recorded in the same manner. Thus, we have inconsistent data for the fires collected, inconsistency in the reporting, and inconsistency in data accessibility. And, while Emerson (1841) eschews "a foolish consistency" as the "hobgoblin of little minds", scientific analyses and decision making at both the property owner and governmental level wisely require consistent and available data.

While data on numbers of ignitions and acres burned are of crucial importance to land managers in preparing for upcoming fire seasons, without similar values for structural and other damages, neither private landowners nor public land managers will have the necessary information to develop optimal responses to the risk of wildfire damages. Accurate, well-defined entries for the number of destroyed, damaged and threatened structures will be an important step in developing an adequate economic impact summary for wildfires.

Developing data sufficient to model economic optimization across ownership types, over time and for overall wildfire programs requires data on wildfires as well as on other land management activities with direct links to wildfire occurrence and severity, including pre-suppression (initial attack), fuel treatments (both mechanical and prescribed fire), fire prevention programs, and changes in external hazards such as the wildland urban interface and climate. Costs that could be assessed include financial costs to agencies, businesses and individuals, and all losses to capital including buildings, other infrastructure, human life and injury, and ecosystems. Losses to ecosystems from suppression and the positive effects of wildfires and other program components would also be included. In addition, data on external influences, such as insurance, population and demographic variables would be needed to fully evaluate trends in economic impacts.

The cost, damage and benefit data for all wildfires would not be confined to large fires (>100 acres) or disasters (more than $25 million in damages). Cumulative impacts and damages from small fires could be considerable, and if a wildfire program is successful, less damaging individual fires may become the norm. Second, structures damaged, destroyed and threatened, as well as structures evacuated would be collected in conjunction with other existing fire records. Third, lives lost and serious injuries must be recorded for all fires. Fourth, acres burned by a predetermined classification by severity will assist in developing loss and damage estimates for non-market or non-quantified attributes. Fifth, other program elements would have the same degree of detail as included for wildfires, perhaps by using the fire records database to include prescribed fire and other fuel treatments data.

The USFS could implement a basic improvement to their data collection that would substantially improve our ability to assess economic impacts and damages from fires. This would begin the process of developing data necessary for understanding trends in damages and impacts. Without this information, we run the risk of making changes to a program that could be worse than continuing with existing programs.

Beyond these changes, additional research needs to be conducted before some costs and benefits of wildfire events can be included in numerical tallies. Suggestions for further research includes (1) evaluate losses to recreation and tourism resulting from wildfire programs, specifically addressing substitution, and considering the endemic nature of fire in ecosystems, (2) evaluate costs, damages and benefits to watersheds resulting from wildfire programs, (3) evaluate health and fatality impacts resulting from wildfire programs and (4) evaluate the effect of wildfire programs on insurance and distribution of wealth, and the effects of wealth and insurance on wildfire programs. For each of these, it is imperative that the analyses be conducted to include wildfire, fuel treatments and prescribed fire and that a multi-year approach be taken.

6. REFERENCES

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