Wildland Fire Management Policy and Fire Management Economic Efficiency in the USDA Forest Service[1]

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Abstract: Wildfires are a significant social problem affecting millions of people worldwide and causing major economic impacts at all levels. The severe fire events of 1910 in Idaho and Montana galvanized a fire policy excluding fire from the ecosystem by the U.S. Department of Agriculture Forest Service. This policy was consolidated with the passage of the 10 a.m. fire suppression policy in 1935, which lasted all through the late 60s. Fire management policy changes in 1978, 1995, and 2001 introduced the use of prescribed burning and cost-benefit analysis into the fire management policy, and the concept that fire plays an important ecological role in the ecosystem. However, the fire problem remained unabated in part because the large hazardous fuel loads created by the fire exclusion policies of the past and tremendous influx of population in the wildland-urban interface. The 1978 policy change required the FS to conduct a cost-benefit analysis to justify its budget requests to Congress. The resulting National Fire Management Analysis System (NFMAS) used the Cost-plus-Net-Value Change (C+NVC) model to evaluate fire management programs economic efficiency. The model is now being challenged in its utility to measure fire management programs economic efficiency. The unwritten *social contract* between the Forest Service and the public has created the expectation on the public's part that it is the agency's responsibility to protect them regardless of the circumstances and costs. This expectation is taxing the capabilities and abilities of government agencies to respond to fire situations. One potential solution to this conundrum is to ask households to pay for the fire protection services provided so they face the true costs of their decisions to build in the wildland urban interface. For a national wildland fire policy to succeed we must avoid focusing on just one dimension of the fire problem and understand the social and financial investments necessary to redress 100 years of fire exclusion policies. It is time for a change in the existing *social contract* and for the public to take responsibility for their decisions to live in high fire danger prone areas.

Introduction

Wildland fires are a societal problem threatening many ecosystems, affecting millions worldwide and causing major economic impacts at local, regional, national and global scales. In the USA alone, for example, in the last decade wildland fires have affected more than 24 million hectares of wildlands at direct suppression costs of $9.642 billion (Table 1). These are significant numbers even for an economy as large as that of the USA. Worldwide the problem is not subsiding but rather worsening. Factors external to the control of managers such as global warming and resulting climatic conditions, changes in social and economic concerns and changes in fire management polices at the national level affect the dimension and capabilities of agencies to deal with the problem.

How did we get here? How can we explain the events that contributed to the situation in which we find ourselves today? I will use the situation in the USA as a

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means to explain where we are today and how we got here. Although I am focusing on the wildland fire management problems in the USA the analysis presented here has worldwide applicability. Because of USA leadership in the field many of the policies and the techniques and technologies developed in the USA often receive worldwide adaptation and application.

In the following sections I will present a short summary discussion of the progression through the 20th century of the USDA Forest Service (FS) fire management policy in response to society's view of the wildland fire problem. I will also discuss policy changes and their implications for fire management programs economic efficiency and how we have tried to measure economic efficiency through time.

Fire management policy sets the goals and objectives that federal agencies with wildland fire suppression responsibilities must follow to address the wildland fire threat to society. This policy consists of operational policies, procedures, and guidelines for managing wildland fire and fire aviation operations in the USA. Fire management policy is subject to revisions and changes as societal views of the wildland fire problem evolve. In the USA there have been several instances of changes in the federal fire management policy. As will be seen later there is a direct relationship between fire management policies and the current wildland fire problem in the USA.

The fire management policy also has implications for the economic dimension of the wildland fire problem. This is not only applicable when measuring direct fire management expenditures for prevention, detection, fuels treatments, and fire suppression, but also when trying to measure the economic efficiency of the investments on wildland fire management programs. *Economic efficiency* measures how well inputs are used to achieve outputs when all inputs and outputs are valued. This differs from *cost effectiveness*, which is often used to measure how well inputs in a production process produce a fixed set of outputs. This is not a trivial difference because *economic efficiency* measures the total contribution of the investment on society's welfare and not on an individual firm or government agency. All the benefits and costs resulting from a wildland fire management program must be measured. This makes for a more difficult task!

A fire management policy requiring complete fire exclusion from the ecosystem, as we will see was the case for most of the 20th century in the USA, would have tremendous impact not only at the ecosystem level, but at the economic level as well. Many ecosystems are known to be fire dependent. Fire is needed for these ecosystems to thrive and maintain their vigor and functionality. Excluding fire from those ecosystems could tax them to a point that may actually threaten their survivability. Total fire exclusion impacts negatively on agency's budget that is necessary to comply with such requirements. Looking at fire suppression alone, we can see that there has been an upward trend in suppression expenditures during the last 10 years (table 1). This increase in fire suppression expenditures may limit federal agencies ability to carry out their other land management mandates. As an example, during the past three years Forest Service research has seen a reduction in research dollars in part because research funding has been redirected to fire suppression operations. Increasing multiple demands on shrinking federal budgets reduces the ability of federal agencies with wildland fire responsibility to respond appropriately to the expanding wildland fire problem.

Fire Management Policy in the USDA Forest Service

The Formative years: 1905-1911

The origins of federal forest-fire management in the USA can be traced back to 1886 (Stephens and Ruth 2005). During this time the U.S. Army started patrolling the newly established National Parks. Later (1891), Congress approved legislation creating the forest reserves, which became our National Forests. With the transfer of federally owned forest from the US Department of the Interior to the US Department of Agriculture in 1905, the USDA Forest Service became responsible for managing the newly minted national forests. Under the guidance of its first *Chief*, Gifford Pinchot, the first national forest-fire policy was formulated. The establishment of the National Forests was a direct result of the active conservation movement of the times. As such the newly established agency and its *Chief* wanted to promote an efficient use of the natural resources under the agency's supervision through coordinated, centrally directed decisions made by forestry professionals (Busenberg 2004). As part of this strategy there was a de-facto establishment of a forest-fire policy to protect the natural resources from wildland fires. The early stage of this policy excluded fires from forests ecosystems and was aggressively pursued by the succeeding Forest Service chiefs.

Table 1-- Area affected and suppression expenditures for US Federal Agencies with fire protection responsibilities: 1997-2006

Year	Area Affected (Million Hectares)	Suppression Exp. (Current $ million)
2006	4.00	$1.501*
2005	3.52	0.876
2004	2.75	0.890
2003	1.99	1.326
2002	2.81	1.661
2001	1.45	0.918
2000	3.41	1.362
1999	2.29	0.523
1998	0.94	0.329
1997	1.33	0.256
Total	**24.49**	**$9.642**

* This year includes only FS expenditures

Along with its mandate to protect the National Forests, Congress approved legislation providing the Forest Service with an emergency funding mechanism to finance its fire protection program. This mechanism allowed the FS to spend money on fire suppression above budgeted funds for the purpose. The FS would then ask Congress to cover the shortfall. Fire suppression deficit spending was born! The FS now had a tool in place to finance aggressive wildfire suppression activities nationwide, even if the expenditures surpassed its available budgeted funds.

While the new agency gained a foothold on the financial front to sustain wildfire suppression activities and was aggressively pursuing a fire exclusion policy, the underlying debate on the role of fire and the proper use of fire in the management of the national forests continued unabated (Stephens and Ruth 2005, Busenberg 2004). However, all of this changed with the great fires of 1910. In that year, fires in northern Idaho and western Montana blackened more than 1.215 million hectares of prime timber land. Sadly, they also took at least 86 lives, and caused enormous economic losses to the timber industry as well as to the general population. It is estimated that around 10,000 firefighters participated in suppression activities during the year. The FS deficit spending limits were tested by over spending about $1.1 million (Busenberg 2004). This event by itself galvanized the FS wildfire suppression policy of total fire exclusion from the ecosystem. The policy was further entrenched with the passage of the Weeks Act of 1911 allowing the FS to acquire land on the headwaters of navigable rivers and to enter into cooperative arrangements with states (through matching funds grants) for fire protection in state and private lands. The era of fire suppression and exclusion of fire from the ecosystem had started in earnest. In hindsight we see the irony. By concentrating solely on fire exclusion rather than on a combination of fuels reductions and fire suppression, the policy itself was contributing to increasing the wildland fire problem on the lands being "protected."

The Consolidation Years: 1911-1968

Between 1911 and 1968 there was a consolidation of the fire exclusion policy in the FS as well as the other federal agencies with wildland fire responsibilities. Several Congressional acts as well as world events contributed to this consolidation process. As mentioned above, the Weeks Act and its extension by the Clarke-McNary Act of 1924 expanded the capabilities of the FS to provide cooperative fire protection on any timber producing lands in the states with which they were cooperating. The creation of the Civilian Conservation Corps (CCC) in 1935 was a major boost to the fire suppression program. These volunteers were used to build trails, roads, fuel breaks, and more importantly they were organized into large wildland firefighting crews (Pyne 1982).

This period saw a tremendous increase in FS fire suppression capabilities in part because of innovations developed by the agency's research branch, and because the surplus of material available after the termination of WWII and Korean conflict. The FS acquired mechanized vehicles as well as numerous helicopters and airplanes permitting it to pursue an aggressive nationwide program of aerial firefighting and an on the ground mechanized attack. An important measure contributing to the expanding capabilities of the FS was the *federal surplus equipment program,* which provided military surplus equipment to the agency. Even of more impact was the ability to transfer equipment acquired through this program to cooperating states, building the cooperators capabilities as well creating a formidable nationwide fire suppression organization. These series of events and situations reinforced the FS wildfires suppression policy leading to virtual fire exclusion from the landscape and a continued disregard for fuels reduction.

A New Era: 1968 – until Present

While the fire exclusion policy was consolidating, the issue of the role of fire on forest lands and the implication of fire suppression were renewed. Numerous scientific studies in fire ecology from within the FS as well as other federal agencies and universities were showing that low-intensity fires had an important role in ecological cycles and in reducing the risk of high intensity wildfires. In addition, the results of these studies were demonstrating that the very same policy promoting fire exclusion was responsible for increasing the amount of fuels in the forest floor creating high fire risk conditions, and when burned, these forests burned under high fire severity conditions (MacGregor and Haynes 2005, Stephens and Ruth 2005, USDA Forest Service 1999).

The winds of change finally started blowing in the western USA with the seminal work by Leopold and others (1963). This work associated the fire exclusion policy with detrimental effects on wildlife habitats. Previously in the southeast, some prescribed burning had taken place on federal lands in Florida (Stephens and Ruth 2005). Between 1968 and 1978, both the National Park Service and the Forest Service introduced changes in their fire policy allowing for the use of prescribed burning under certain conditions. However, by and large, full fire suppression continued to be the predominant strategy.

Wildfires continued to rage through the 90s. The tremendous fuel loads that built up because of the fire suppression policies were aggravated by the population increase near and around forest lands nationwide. The abandonment of rural areas in the 50s, 60s, and 70s saw a reversal in the 1990's with urban dwellers wanting to experience the wilderness, and live "close to nature." . The 90s experienced the combination of higher wildfire risk, because of unnatural hazardous fuels build up, in association with a larger population and housing stock near and around forest lands (wildland-urban interface problem) at risk. This has proven to be a bad combination as demonstrated by the difficult fire seasons in 1994, 1996, 1997 and 1999. The 1994 fire season, though not the worst in terms of area affected was the first in which suppression expenditures reached almost $1 billion! In addition, 34 firefighters lost their lives and significant damages to natural resources and private property occurred. This jolted the system and accelerated the urgency to focus on safety, wildland fire impacts and the integration of fire and resource management (Zimmerman and Bunnell 2000).

The 1994 fire season was the catalyst for a fire policy review in 1995. The new policy "…directs federal agencies to achieve a balance between suppression to protect life, property, and resources, and fire use to regulate fuels and maintain healthy ecosystems (Zimmerman and Bunnell 2000: 289)." This represents a marked shift away from full fire suppression and exclusion. Managers are asked to consider not only and foremost safety concerns of firefighting personnel and communities, but also to account for the beneficial effects of fire on the ecosystem and resources when deciding a course of action on a wildfire. In addition, managers are supposed to consider the *economic efficiency* of the actions in response to a wildfire situation. However, immediately after the new policy had come into effect, another difficult fire season impacted the system again causing further evaluation and revisions to the standing policy.

The fire policy revision of 2001 cemented the concept of the role of fire as an important ecological process. More specifically, the policy states that "Fire, as a critical natural process, will be integrated into land and to resource management plans and activities on a landscape scale, and across agency boundaries" (NWCG 2001). Along with this recognition came the National Fire Plan and the Ten-Year Comprehensive Strategy providing the necessary financial resources to federal agencies. Included in the plan was the objective of involving communities in trying to reduce the accumulated fire hazardous fuels resulting from past fire suppression policies. Substantial federal financial resources were committed during the earlier years of the initiatives, over $300 million form 2000 to 2003. The reasoning behind these initiatives is that a reduction in hazardous fuels will bring about a reduction in the number of wildfires and the associated suppression costs; otherwise these will continue to increase.

The Healthy Forest Restoration Act (HFRA) of 2003 provides a mechanism to improve the implementation of hazardous fuels reduction strategy by streamlining the administrative and public review process of fuels treatment projects as well as limiting appeals of the projects. In addition HFRA requires that 50% of the funds provided by the act be allocated to projects that protect communities from the risk of wildland fires.

As can be seen from the previous discussion there has been a significant attempt and progress by the Forest Service and other federal agencies on updating their fire policy in response to the continued and expanding wildland fire problem. However, we are still far away from being successful in dealing with wildland fire problem nationwide. This is evidenced by the continued increase in the area affected and the increase in costs associated with wildfire suppression; as well as the lost of life and property, and resource damages experienced in the recent years. All of this in spite of the large increase in financial and firefighting resources made available to agencies and communities. Many in the fire management and policy analysis field believe that for all the efforts of the recent years, both administratively and legislatively, "… there is no comprehensive policy to deal with fire and fuels, and there are few indications that such a policy is in development ([Franklin and Agee 2003] as cited in Stephens and Ruth 2005). It is clear that designing an effective national fire management policy will require large sustained investments in fire suppression and fuels reduction programs to reduce the escalating risk of wildfires. Implementation of such policy will not be easy, even if the financial resources were available. The increasing exposure of forest lands to the wildland-urban interface is making the risk of wildland fire more severe in more places, and the value of the resources at risk much higher. In addition, the unwritten *social contract* between the Forest Service and society has locked the agency into a protection commitment that it may not be possible to provide any longer.

Fire Management Economic Efficiency in the USDA Forest Service

From its very inception in 1905 wildland fires have been one of the most pressing problems facing the Forest Service (FS). As a result of severe fire events at the turn of the 19th and beginning of the 20th century, a course of complete fire suppression and exclusion of fire from the ecosystem was set in motion. This was conveyed in terms of the fire policies instituted at different times by the FS and is best represented by the 10:00 a.m. fire policy that was established in 1935 and lasted well into the 60s. Simply stated the policy said that fires will be fought aggressively in all locations, but if not controllable immediately or within the first burning period, the objective would be to put the fire out before 10:00 a.m. the next day. However, the economic dimension of the policies was not given appropriate consideration. For example, the economic implication of such policy is that "… wildfire protection is worth whatever it costs or that values protected are almost immeasurably large" (Gorte and Gorte 1979). Even today with major changes in the fire policy, an economic analysis of the fire management and suppression actions is hampered by not really knowing the value of the resources being protected. By not knowing the value of those resources we are, in essence, assuming that they have "an almost immeasurable value."

Economic efficiency of fire management actions was an issue of concern to economists and managers even before the establishment of the FS. As applied to fire management, the concept of economic efficiency was expressed in the form of minimizing the cost of fire management plus net fire damage. Following is a summary of the history of the economic efficiency concept as applied to fire management in the USA.

The Formative Years: 1925-1936

As early as 1916, Lovejoy, and Headley (1916) formulated the economic efficiency question of fire management programs as a minimization problem. The objective was to minimize the cost of fire management plus net fire damage. That is, the most efficient level of fire protection is that level at which the cost of fire management (prevention, presuppression, suppression) plus resulting damages are minimized. Theoretically, as the fire suppression expenditures increase, the damages are supposed to decrease; and as the presuppression investment increases suppression expenditures decreases. The result of this analysis is a U-shape function, with a minimum point that represents the optimum presuppression level.

The cost plus damage concept was later expanded by Sparhawk (1925) and expressed as the least cost-plus-loss model. Conceptually this model is similar to the more traditional cost-benefit analysis used in the economic literature to evaluate investments in public projects (Mills and Bratten 1982). However, as pointed out by Gorte and Gorte (1979:4) the "…least-cost-plus-loss is used much more frequently in fire economics literature than benefit/cost because of the perceived difficulty of defining "values protected" and measuring damages averted." Similar to Lovejoy (1916) and Headley (1916) earlier, the basic principle of Sparhawk's model is the minimization of the sum of suppression costs plus resource losses ("total liability") and protection costs (presuppression); presuppression being the independent variable determining suppression costs and damages. Total liability is inversely related to the primary protection efforts: as presuppression expenditures increase, suppression costs and damages decrease. His graphical representation of this concept can be seen in figure 1.

Like Sparhawk, Flint (1928) uses the least-cost-plus-loss conceptual model to find the most efficient fire protection level. But it was not until Hornby (1936) that a slightly different approach to the analysis was introduced. His approach included acres burned as the independent variable used to explain suppression expenditures and damages. As acres burned increased so did damages and suppression expenditures. Headley (1943) and Craig and others (1946) continued the use of least cost-plus-loss concept to evaluate the efficiency of fire management programs. However, Craig (1946) is the first to recognize the need to conduct marginal analysis. Others, including Arnold (1949), Mactavish (1965), and Parks (1964) continued using the least-cost-plus-loss model introducing only minor changes to the basic model.

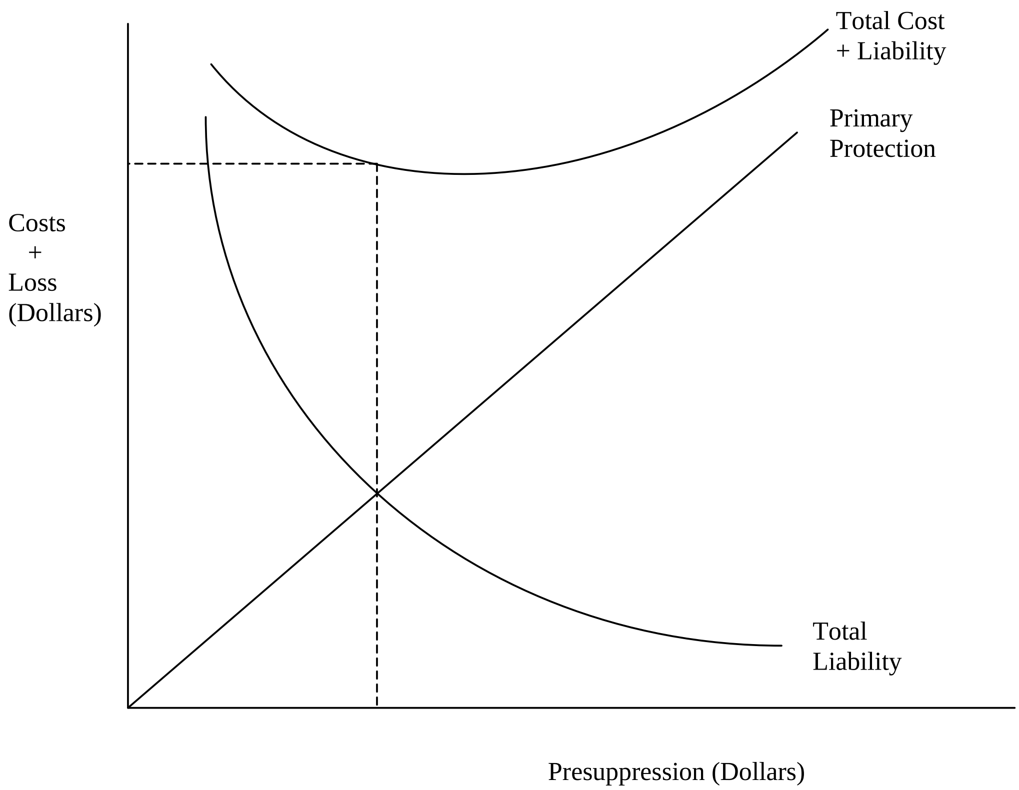

Figure 1--Sparhawk's least-cost-plus-loss model representation

Consolidation years: 1968-1979

By the late 60's the least-cost-plus-model was the model of choice in trying to explain and determine the most efficient level of fire suppression expenditures. Some additions to the model were made by Gamache (1969) extending Parks (1964) model by including changes in suppression levels, which resulted in a model similar to that of Arnold (1949). However, it was Davis (1971) who for the first time recognized that there are some limitations in the use of the least-cost-plus-loss model. He pointed out that there are problems in estimating costs, estimating damages, and associated changes in costs with changes in damages. Of these three, Davis (1971) thinks the most difficult is that of associating changes in costs with changes in damages. Part of the problem as he sees it is the lack of "… a good way to estimating damage with zero organized presuppression effort." This has proven to be a problem that continues to haunt fire economists today (González-Cabán 1993, Mills and Bratten 1982).

In 1976, Simard pointed out that since its inception there has been basically no consistency in the definition of the independent variables in the least-cost-plus loss model. And that the diagram has remained virtually unchanged regardless of the definition of the x axis. More importantly, he highlights that the underlying production function of the relationships between cost and damage functions have not been explicitly examined. To address these concerns Simard (1976) uses production economic theory to develop a marginal analysis model equating marginal damage of fire to marginal costs (figure 2). In addition he is the first one to include the beneficial effects of fire into the analysis.

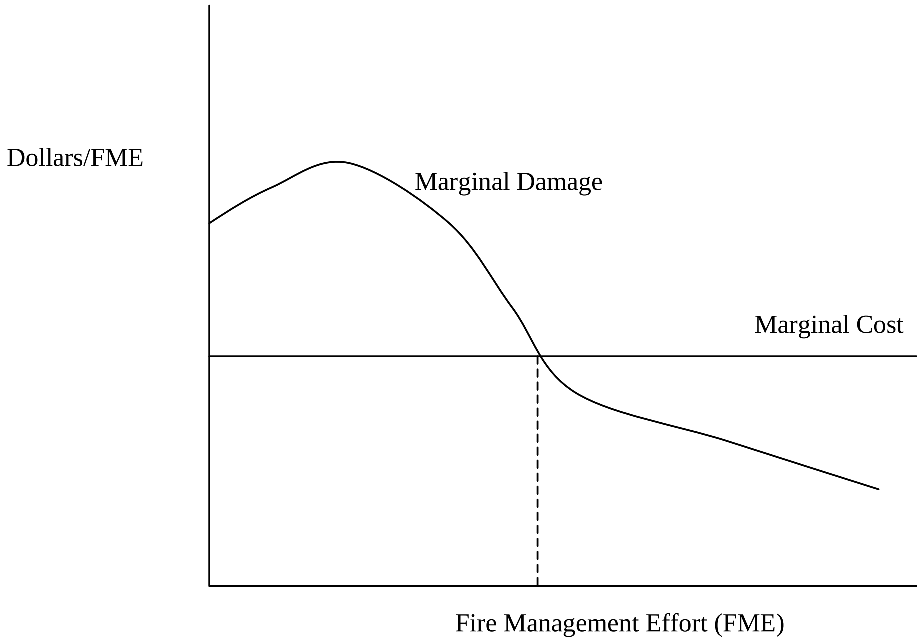

Figure 2--Simard's marginal analysis model.

Following the tremendous increase in fire suppression expenditures in the 70's without a commensurate reduction in area burned, Congress instructed the Forest Service to develop a cost-benefit analysis for all future budget requests. As a result, the Forest Service developed the National Fire Management Analysis System (NFMAS) (USDA Forest Service 1985). The system was built on the tradition of the least-cost-plus-loss economic model of fire management analysis. The major departure from previous efforts was that this was the first time a system was built to actually develop budget requests for operational activities. In addition, NFMAS incorporated estimates of beneficial fire effects directly into the analysis, along with estimation of nonmarket values. This is a significant difference from previous models. The model was renamed as Cost-Plus-Net-Value Change (C+NVC). The model still attempts to estimate economic efficiency by minimizing the sum of all monetized costs (Presuppression, suppression and Net value change). The graphical representation was the same as in figure 1.

Economic Efficiency Modeling to Date: 1980 – to present

By 1982, Mills and Bratten were engaged in development of a Fire Economics Evaluation System (FEES) for fire management strategic planning to develop operational budgets. They too used the standard cost-plus-net value change concept. They stated “The minimization of the sum of the fire program costs and the dollars value of net resource output changes which result form fire is a correct economic efficiency criterion (Mills and Bratten 1982: 2).” Their graphical representation is somewhat different and can be seen in figure 3.

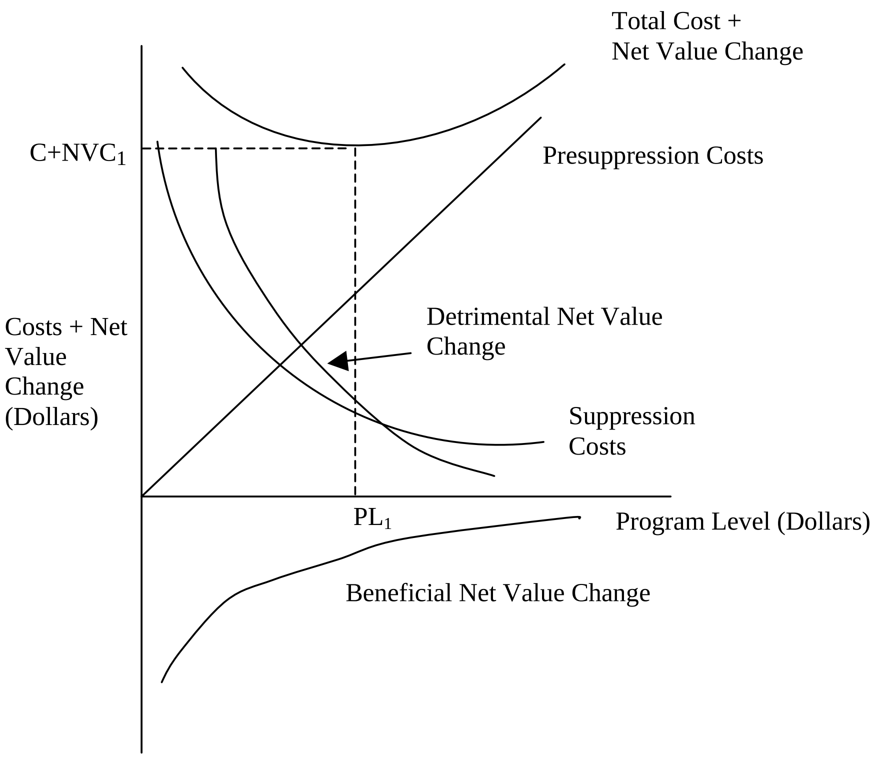

Figure 3--Mills and Bratten (1982) Cost + Net Value Change graphical representation.

Schweitzer and others (1982) and Bellinger and others (1983) also used the cost-plus-net value change model to evaluate economic efficiency of fire management on nonfederal forest lands and on six national forests respectively. Both studies find the approach valid and providing useful information to policy makers for efficient management of forest lands in the public and private sector. González-

Cabán and others (1986) provide a mechanism on how the estimated budget levels can be allocated.

Until 1990 there seems to have been no general disagreement on the usefulness and correctness of the C+NVC formulation. However, the 90s saw the initial questions about the formulation of C+NVC. For example, Rideout and Omi (1990) argued that an alternate expression of the economic theory of forest fire management is necessary to better account for the induced potential benefits of forest fires. They propose that a reformulation of the C+NVC as profit maximization instead of a cost minimization provides a more general model that "… allow[s] a more direct comparison between the fire problem and the economic literature (Rideout and Omi 1990: 620)." This reformulation provides a direct correspondence with the theory of the firm. In addition, they also propose that their system of equations would permit the investigation of other issues like substitution effects between suppression and presuppression; as well as potential tradeoffs between fire damage and benefits.

Donovan and Rideout (2003a) review the arguments presented in Rideout and Omi (1990) and provide an analysis of what is considered inherently incorrect in the least-cost-plus-loss formulation by Sparhawk (1925) and the more recent variation of C+NVC (Mills and Bratten 1982). They argue that suppression is incorrectly portrayed as a model output and that suppression and primary protection (presuppression) are incorrectly modeled as negatively correlated. They further argue that these errors "… have serious implications for the model's capacity to correctly identify the most efficient level of fire management expenditures (Donovan and Rideout 2003 a: 318)." The authors go into great mathematical detail, not suited for this paper, in demonstrating their arguments. Interested readers are encouraged to read the original paper. However, it is important to show here the proposed correct graphical representation of the C+NVC model (figure 4). As stated by Rideout and Omi (1990), in a correct representation of the C+NVC model, presuppression and suppression should be modeled as independent inputs. In other words, they should be allowed to vary independently, using the NVC function to relate them. However, in order to represent these three functions in two dimensions it is necessary to hold one of the variables constant. Per Donovan and Rideout (2003a) figure 4 makes such representation holding the presuppression expenditures at its optimal level. Rideout and Ziesler (2004) go into more details in discussing how a misapplication of the C+NVC model has created some myths that have long endured in the literature.

Continuing with their work in extending the frontiers of the C+NVC model, Donovan and Rideout (2003b) proposed an integer programming model to optimize resource allocation for wildfire containment. As implied by the C+NVC model the most economically efficient firefighting organization for a particular fire requires determining which resources should be dispatched in which time periods to contain the fire at minimum costs (Donovan and Rideout 2003b). They propose that the problem can be presented in term of an Integer Programming because of the fact that firefighting resources are indivisible units and are dispatched as such. Expressed as an integer programming problem the objective function would be (as in the C+NVC model) to minimize the sum of fire-related costs and damages, selecting from a set of discrete firefighting resources, subject to fire containment (constraint). There is a temporal dimension of the problem that complicates the containment constraint, but still can be managed in the system. They apply the integer programming technique to a sample fire to test the feasibility of the technique and found the results credible. They conclude that one of the most important advantages of using the technique to solve the optimal firefighting organization problem is "… that sensitivity analysis can be readily performed on model parameters to isolate those parameters that may have a significant effect on the optimal solution (Donovan and Rideout 2003b: 334)" Extending this technique to modeling a complete fire season would introduce additional difficulties but the authors think that is a viable methodology.

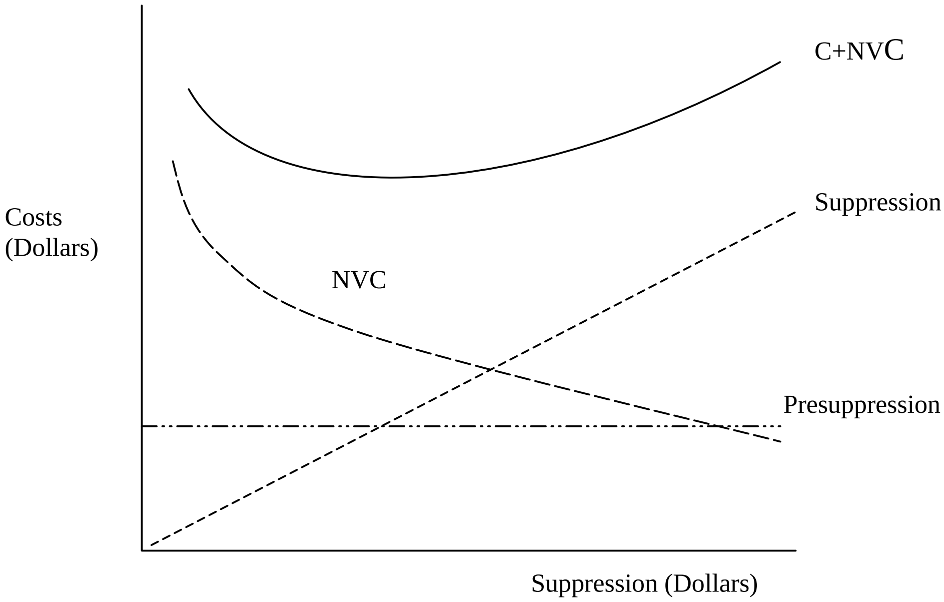

Figure 4--Correct illustration of the C+NVC model per Donovan and Rideout (2003)

What have we learned and where do we go from here?

The wildland fires at the turn of the 19th century and beginning of the 20th century established the basis for the Forest Service fire management policies in place for most of the 20th century. The response to the early problem was fueled by the loss of million of hectares of timber lands and many of lives. The agency and the nation embarked on a journey of total fire exclusion from the ecosystem without understanding its potential consequences. The science and management of wildfires available at the time was not developed well enough to really understand the potential perils of the policies. There was a major problem that needed solution and total fire exclusion seemed like a reasonable approach to solve it. However, now it is widely accepted that excluding fire completely from the ecosystem was not the best option.

One of the most lasting and potentially damaging results of the fire exclusion policies of the 20th century has been the unnatural build up of hazardous fuels in the forest floor (Busenberg 2004, Gardner and others 1985, Hesseln and Rideout 1999, Husari and McKelvey 1996, USDA Forest Service 1999, Wildland Fire Leadership Council 2004). The early success of the fire community in controlling and suppressing wildfires from the ecosystem lead to fire policies focused only on one dimension of the wildland fire problem: fire suppression, while ignoring the fuels dimension and the role of fire in the ecosystem (Busenberg 2004).

By the late 70s scientific studies had demonstrated the beneficial effects of fire and the role it played in ecosystem development and maintenance (Bell and others 1995, Gardner and others 1985, Hesseln and Rideout 1999, Husari and McKelvey 1996). Guided in part by the new knowledge that fire plays a significant role in ecosystem health and the detrimental effects that fire exclusion was having, and in part by the tremendous increase in fire suppression costs, the Forest Service introduced changes in its fire management policy. The new policy introduced in 1978 shifted the emphasis from total fire control to fire management. However, while promoting the use of fuels management to help reduce fire risk, and to request that fire management be cost effective, the thrust of the response remained fire suppression. This could be in part explained by the *social contract* the agency had bought into, which promised suppression of all wildfires regardless of location as quickly as possible. The shift to full implementation of the new policy would take a long time.

By 1995 the wildland fire problem had grown largely unabated. In addition, the wildland-urban interface continued growing at accelerated pace. 1994 saw the first $1 billion fire season! Implementation of the 1978 fire policy had not significantly altered unnatural levels of hazardous fuels and the national forests were experiencing an increase in the risk of catastrophic wildfires (Busenberg 2004, Hesseln and Rideout 1999). These two forces prompted a new revision of the Forest Service fire management policy. The new policy emphasized the need to reintroduce fire into land management actions, and the need of fire management activities based on science and sound ecological and economic principles (USDI/ USDA 1995). However, implementation of such policy has proven contentious both at social and economic levels.

The new millennium has seen a continuation and even an aggravation of the fire problem. In the first seven years an average of almost 3 million hectares of forest lands have been affected at an average suppression cost of $1.22 billion per year! (Table 1). Although it is now widely accepted that hazardous fuel reductions may hold the key to a successful resolution to the wildland problem at the national level, this will not be easy. Reintroduction of fire at the landscape level to reduce hazardous fuel is extremely expensive and often not socially acceptable. To obtain public acceptance it is important that the public understand the long-term costs and benefits of both prescribed and wildfires (Hesseln and Rideout 1999). Furthermore, fire managers must understand and evaluate the long-term effects and physical relationships between fire management activities and their long-term ecological changes. The long-term economic effects of such relationships must also be evaluated. Success of the reintroduction of fire policy will require managers to evaluate the costs and tradeoffs between prescribed fire and wildfire and the effectiveness of presuppression and suppression both financially and socially. Of course, cooperation amongst federal agencies and between federal, state and local agencies is a must!

The new fire management policy requires that fires be managed taking into consideration firefighters and the public safety above all, then secondly, property and natural resources considerations are evaluated based on economic efficiency criterion. These considerations have economic implications that agencies have not been able to resolve. Trying to suppress fires at the minimum possible costs will require a clear definition and estimation of the values to be protected. This has proven difficult particularly in measuring nonmarket values associated with fire effects and forest goods and services (González-Cabán 1993). Measuring beneficial fire effects has proven an elusive proposition, but it is necessary for economic efficiency estimation of fire programs. Human life is the first priority in fire protection but determining protection priorities for other resources is challenging in part because their values are difficult to measure. A framework is needed to evaluate the priorities as well as the values to be protected (Hesseln and Rideout 1999).

Growth in the wildland-urban interface is increasing the complexity of the wildland fire problem nationwide and contributing to increases in fire management costs. The unwritten *social contract* between the Forest Service and the public has created the expectation on the public's part that it is the agency's responsibility to protect them regardless of the circumstances. This expectation is taxing the capabilities and abilities of government agencies to respond to fire situations. By subsidizing fire protection and hazard reduction the public feels no responsibility and sees no need to take measures to reduce the hazard around their properties themselves. In addition, it is important to present the publics with an assessment of the real risk potential to allow them to make informed decisions. One potential solution to this conundrum is to ask households to pay for the fire protection services provided so they face the true costs of their decisions to build in the wildland urban interface.

We don't know the potential impact of the present fire management policy, but we do know where the past 100 years of fire suppression has leaded us. For a national wildland fire policy to succeed we must avoid focusing on just one dimension of the fire problem and understand the social and financial investments necessary to redress 100 years of fire exclusion policies. These will be enormous challenges. We no longer can rely solely on the federal, state or local agencies to address the problem. It is time for a change in the existing *social contract* and for the public to take responsibility for their decisions to live in high fire danger prone areas. The Forest Service is already changing its view of the *social contract* as evidenced by the recent statement of Tom Harbour (2007:1), Director of Aviation and Fire Management: "We need to be telling people with even more clarity that just because you built something here [wildland-urban interface], we're not going to die for it." We all need to learn to live with fire as a natural force on our planet.

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