THE ECONOMICS OF ALASKA WILDFIRE MANAGEMENT:

PRINCIPLES, PROBLEMS, AND NEEDED RESEARCH

by

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INTRODUCTION

Wildfire management in Alaska is expensive. Over the past eight years, the federal and state governments have spent an average of $28 million annually on wildfire management. In planning and justifying these expenditures, agencies need to determine the economic benefits of fire management. This paper discusses economic principles for measuring these benefits, problems in estimating benefits of fire managment in Alaska, and areas of research which would help to improve these estimates.

WILDFIRE MANAGEMENT IN ALASKA

There are more than 250 million fire-prone acres in Alaska, excluding Southeast, the Aleutians, and the North Slope.[1] Historically, lightning-caused fires burned vast areas every year, primarily in the interior. While hundreds of fires continue to be started each year by lightning and man, vigorous fire suppression efforts have reduced the average area burned annually. Nevertheless, fires burned more than one million acres in four of the last twenty years.[2]

Currently, the Federal Government pays for fire suppression on federal and native lands, while the State of Alaska pays for fire suppression on state lands. As lands selected under the statehood act are conveyed to the state, the area protected by the State and the State's annual costs for wildfire protection have been increasing (Tables 1 and 2). Total State expenditures for presuppression and suppression increased from $3 million in 1977 to $11 million in 1984.

Alaska Fire Services, an agency of the Bureau of Land Management (BLM), carries out most wildfire suppression in the Interior, billing the agencies which own or manage the lands for the cost of suppression. Smoke jumpers attack small, remote fires; other special crews and Native emergency fire fighting crews are brought in to fight larger, "escaped" fires. Total costs of fighting some large fires have been in the millions of dollars.

Since 1982, fire protection agencies have developed nine interagency fire management plans for different areas of the state (Table 3). These plans designate certain areas to receive full fire suppression, in particular where fires may threaten human life, private property, or man-made developments. Suppression efforts are to be more limited in other areas, under the principle that the "dollars spent on fighting fires should be commensurate with the value of the resources warranting protection."[3]

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1. Russ Hanson, Bureau of Land Management (personal communication).
2. Alaska Fire Service, 1983 Fire Season Statistics and Summary.
3. Alaska Interagency Fire Management Plan, Copper Basin Planning Area, June 1983, page 1.

TABLE 1. ANNUAL AREA PROTECTED AND BURNED

Year	State of Alaska		Federal Government	
	Acres Protected	Acres Burned	Acres Protected[a]	Acres Burned
1977	22,651,000	1,700	245,349,000	2,295,808
1978	24,515,000	3,800	243,485,000	7,757
1979	24,018,000	42,900	243,982,000	389,925
1980	30,170,000	58,400	237,830,000	129,892
1981	57,052,000	224,300	210,948,000	536,217
1982	56,000,000	1,295	212,000,000	70,798
1983	58,000,000	32,004	210,000,000	82,152
1984	67,500,000	7,719	200,500,000	—
1985	134,000,000	—	134,000,000	—

[a]Based on estimate of 268 million fire-prone acres in Alaska.

— Not available.

SOURCES: Alaska Fire Service, "Fire Season Statistics and Summary," 1983; State of Alaska, Alaska Department of Natural Resources, Division of Forestry, Fire Management Section, Annual Report 1981-1984.

TABLE 2. COST OF FIRE FIGHTING IN ALASKA
(millions of dollars)

	State of Alaska[a]			Bureau of Land Management[b]			State and BLM Total
	Presuppression	Suppression	Total	Presuppression	Suppression	Total	
1977	2.6	0.6	3.2	1.5	27.8	29.3	32.5
1978	2.6	1.0	3.6	1.4	16.5	17.9	21.5
1979	1.5	5.2	6.7	1.8	19.4	21.2	27.9
1980	2.1	2.9	5.0	1.5	20.7	22.2	27.2
1981	3.5	8.6	12.1	1.4	20.2	21.6	33.7
1982	3.8	1.2	5.0	1.3	20.4	21.7	26.7
1983	3.8	6.7	10.5	1.1	19.8	20.9	31.4
1984	5.4	6.0	11.4	1.0	16.0	17.0	28.4

[a]Includes payments to the Bureau of Land Management.

[b]Does not include payments to State of Alaska.

SOURCES: State of Alaska, Department of Natural Resources, Division of Forestry, Fire Management Section Annual Report 1984; Bureau of Land Management.

TABLE 3.
FIRE MANAGEMENT PLANNING AREAS IN ALASKA

Plan Name	Size of Planning Area (millions of acres)	Date of Initiation
Tanana/Minchumina	31.0	3/82
Copper Basin	19.8	6/83
Kuskokwim-Iliamna	42.5	6/83
Kenai Peninsula	5.5	4/84
Seward-Koyukuk	33.2	4/84
Upper Yukon-Tanana	44.5	4/84
Forty Mile	17.8	4/84
Kobuk	32.0	4/84
Yukon-Togiak	32.0	6/84
Alaska Peninsula	--	To Be Initiated in 1985
Mat-Su	13.6	To Be Initiated in 1985
Arctic Slope	47.0	To Be Initiated in 1985
Southeast	--	To Be Initiated in 1986

-- not available.

SOURCE: Alaska Department of Natural Resources.

THE SIMPLE ECONOMICS OF WILDFIRE PROTECTION

Wildfire management, like other economic activities, pays as long as the marginal benefits exceed the marginal costs--that is, as long as another dollar spent on wildfire management results in at least a dollar's worth of additional benefits. Thus,

> The optimal level of wildfire protection is that at which additional expenditures would no longer provide additional benefits at least as great in value.

The benefits of wildfire management are resources saved. This is probably the most fundamental and most forgotten principle in evaluating fire management:

> Fire management expenditures are justified not by the values lost, but by the values saved.

If a fire burns thousands of acres and causes millions of dollars in losses, this is irrelevant as a justification for expenditures in fighting the fire. What matters is how much more would have been lost if less had been spent (or how much less would have been lost if more had been spent).

> To estimate the benefits of fire management expenditures we need to estimate the resource value losses likely to occur with different levels of fire management.

Below, we discuss how resource values losses for a given burn might be calculated in principle. We then discuss some of the many problems that arise in calculating resource value losses in practice.

MEASURING RESOURCE VALUE CHANGE IN PRINCIPLE

Fires do not necessarily cause resource value losses. In some cases, fires may be beneficial. Therefore we will use the term "value change" instead of "value loss" in measuring the economic effects of wildfires.

The value change for a given fire may be defined as the sum of the value changes for each resource affected by the fire. For each resource, this is the sum of the changes in the present value of all future benefits which it will provide.

Mathematically, the total value change may be defined as

$$T.V.C. = \sum_{i,t} \frac{V.C._{it}}{(1 + R)^t}$$

where T.V.C. = total value change
$V.C._{it}$ = change in the return from resource i in year t

R = discount rate
i = subscript for resources
t = subscript for years

In principle, we may think of using this formula to calculate value change in four steps:

The first step in quantifying value change for a resource is to define units in which benefits provided by the resource are measured.

For example, a resource such as wildlife habitat provides benefits such as moose hunting or fur-bearer trapping. Thus appropriate units for measuring value change for wildlife habit due to a fire would be the changes in the number of moose taken or the number of beaver trapped.

The second step in assessing value change is to quantify changes in physical benefits provided by resources affected by the fire, based upon both biological and economic analysis.

These changes depend partly on the location, extent and severity of the fire, as well as the kinds of resources physically affected. Assessing these changes requires not only biological but also economic analysis. For example, timber value change depends not only on how much timber is destroyed by a fire but also by what extent future harvests are actually reduced.

The next step in assessing value change is to calculate values for these changes in resource benefits.

Current and future market prices provide one measure of resource values. For resources which are not bought and sold, such as subsistence resources, values may be estimated in principle using other methods such as comparison with the price of substitute resources, willingness-to-pay surveys, or travel cost studies.

The final step is to discount value changes which would occur in the future.

PROBLEMS IN MEASURING RESOURCE VALUE CHANGE

In practice, of course, numerous problems arise in measuring resource value change due to wildfires. Below, we briefly summarize some of these problems.

There is a deep-rooted preconception that fires are bad.

An entire generation of Americans has grown up with Smokey the Bear admonishing them to prevent forest fires. Established terminology in evaluating the effects of fires, such as "values-at-risk," implies that fire causes losses. This preconception may bias estimates of resource value changes due to fire.

Fire suppression policies are controversial political issues. Since value change estimates affect fire suppression policies, they become controversial political issues as well.

The employment, property, and livelihoods of many people are affected by fire suppression policies. The values affected by fire are important to the determination of these policies. Disagreement over the definition and calculation of values will also reflect disagreement as to the proper interpretation of these values and the tradeoffs which may be made based on them.

Every fire and every fire season is different.

Fires have different effects in different ecosystems. In addition, the effects vary depending upon the successional stage of the ecosystem, the weather conditions prior to and during the fire, and the suppression activities used to fight the fire. Thus, it is very difficult to make general conclusions about the effects of fire. Conclusions such as "fire is good for moose" or "fire is bad for mature timber stands" are valid only under specific circumstances which may or may not apply to any given fire.

Fire affects many resources.

These include sawtimber, fuelwood, water, many different species of wildlife important for hunting and trapping, air quality, and real property, to name a few. Fire may have beneficial effects upon some resources and harmful effects upon others. It is much more difficult to measure value change for some resources than for others. As a result, estimates of value change may be biased towards those kinds of value change which are easily measured, such as timber losses, while ignoring potentially positive non-monetary effects, such as improvements in wildlife habitat.

The environment is a dynamic system.

One biologist summarized this point with the phrase, "You can't pickle a forest." Fire may reduce productivity for certain resources for a period of time. However, without fire productivity of the same or other resources may decline over time. Because the short-run effects of fire may be different from the long-run effects, calculating resource value change requires comparison of resource benefits with and without fire over very long periods of time. It would be no more correct to ignore long-run beneficial effects of fire for wildlife or timber than it would be to ignore short-term losses of real property or timber.

Resource values depend upon the location of the resources and their present and possible future uses.

Sawtimber has value only if it is accessible and can be marketed. Thus the timber value of Alaska's forests varies widely. Similarly, resource values may differ due to differing land use plans between owners. Timber and other resources may have widely differing values depending upon whether they are located on a national park, a state forest, or native lands.

Substitution of unburned for burned resources may reduce value changes attributable to wildfire.

Assessing the actual change in benefits due to a fire is complicated by the fact that people may substitute resources in other areas for the resources in burned areas. If fishing along one stream is ruined, people will fish on other streams. If fire destroys timber in one area where a road had been contemplated to permit future timber harvests, the road may be built to another area. Conversely, if moose hunting in one area is improved by fire, other areas may be hunted less intensely. The effect of these "substitution effects" is to reduce the net change in benefits and, hence, the value change attributable to wildfire. However, such substitution effects are very difficult to quantify.

Future fire suppression costs and the risk that other fires would have occurred in the future reduces the value change attributable to any given fire.

An unburned area accumulates fuel and may become very susceptible to fire. Especially in "bad fire years," which occur about once per decade in Alaska, such areas may burn despite suppression efforts, because fires are so difficult to control or because suppression forces are spread so thin. The value loss if a resource such as immature timber is burned is reduced by the possibility that the timber would have burned anyway before it could have been harvested. A risk in expending large sums of money to protect such

resources is that they will merely have been saved to burn another year. Even if future suppression efforts successfully protect an area against a burn, the costs of these suppression efforts reduce the net value of the resource benefits provided by the area.

The rate at which future benefits should be discounted is uncertain.

Neither economists nor others agree on the proper rate at which future benefits and costs should be discounted. Reasonable arguments can be made for both low discount rates and high discount rates. Since the choice of the discount rate is very important in valuing future resource benefits, this adds to the uncertainty of resource value change estimates.

Fire management agencies' legal liability for resource losses may differ from the actual economic value of the resources.

Especially on private lands for which State or Federal agencies have fire protection responsibilities, courts will not necessarily assess fire damages at the current economic value of the resources. In addition, such assessments may not take into account possible positive but non-monetary benefits of wildfires.

We never know exactly what is saved by fighting a fire.

How much would have burned and what resource losses or benefits might have resulted would only be known if the fire actually burned. Thus any estimate of the benefits of actual fire management expenditures must be based on events that did not actually occur. Put differently, the only way we can really find out what a fire suppression expenditure is worth is by not spending it.

AREAS OF NEEDED RESEARCH

Despite these problems, fire management agencies still need to estimate value changes due to wildfire, if they are to try to ensure that "dollars spent are commensurate with the value of the resources warranting protection." As federal and state budgets become tighter, agencies will be under increasing pressure to justify wildfire management expenditures. Advocates of reduced suppression activities may also seek to demonstrate that the benefits of wildfire suppression are low.

There are several areas of research which could improve our ability to estimate resource value changes due to wildfire:

1. Examination of the extent to which the area and resources burned in any given year, and for different kinds of fires, are affected by the level of suppression efforts.

This information is critical to estimating what is saved by wildfire protection efforts, and how this varies under different conditions. It is fundamental to justifying fire agencies' expenditures. Fire agencies should regularly attempt to document the costs and benefits of fire suppression activities, in particular for larger fires.

2. Documentation of the effects of wildfire in terms of changes in benefits provided, and the accompanying range of uncertainty.

It is very difficult to place an economic value on acres of forest or habitat burned. Economists need these effects defined in terms of benefits such as potential timber or wildlife harvests over time, along with estimates of the potential range of variation in effects of fire upon these benefits--for different types of fires under different conditions. This is admittedly a very difficult task.

3. Examination of the risk that an area will burn despite fire protection efforts, and how this risk and the effects of fire change as the period of time without a burn increases.

This kind of information may help to determine the extent to which fire protection efforts may merely delay rather than preventing resource losses.

4. Examination of current and possible future market values for timber and other resources in different areas of the state.

Improved estimates of these values are needed to estimate resource value changes due to wildfire. These estimates need to take account of the effects of current and possible future transportation routes, local and international markets, the availability of alternative resources, and the resource management plans of public and private landowners.

5. Examination of fire management agencies' legal responsibilities and liabilities.

One particularly important area for research is current and future state and federal responsibilities for fire suppression on native lands.

6. Where estimates of value change are highly speculative or artificial, such as for non-monetary values, documentation of the effects of fires in physical terms which can form a basis for subjective value judgments.

It is not necessary to estimate dollar values for the effects of wildfire smoke on the health of urban residents, or unsightly burns on scenery values. Such value estimates are likely to be met with skepticism in any case. In many cases, it is more appropriate simply to describe these effects. Agencies and the public and large can then make a subjective--but equally valid--judgement as to whether expenditures to prevent these effects are worthwhile.

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THE ECONOMICS OF ALASKA WILDFIRE MANAGEMENT: PRINCIPLES, PROBLEMS, AND NEEDED RESEARCH

THE SIMPLE ECONOMICS OF WILDFIRE PROTECTION

1. THE OPTIMAL LEVEL OF WILDFIRE PROTECTION IS THAT AT WHICH ADDITIONAL EXPENDITURES WOULD NO LONGER PROVIDE ADDITIONAL BENEFITS AT LEAST AS GREAT IN VALUE.

2. FIRE MANAGEMENT EXPENDITURES ARE JUSTIFIED NOT BY THE VALUES LOST, BUT BY THE VALUES SAVED.

3. TO ESTIMATE THE BENEFITS OF FIRE MANAGEMENT EXPENDITURES WE NEED TO ESTIMATE THE RESOURCE LOSSES LIKELY TO OCCUR WITH DIFFERENT LEVELS OF FIRE MANAGEMENT

PROBLEMS IN MEASURING RESOURCE VALUE CHANGE

1. THERE IS A DEEP-ROOTED PRECONCEPTION THAT FIRES ARE BAD.

2. FIRE SUPPRESSION POLICIES ARE CONTROVERSIAL POLITICAL ISSUES.

3. EVERY FIRE AND EVERY FIRE SEASON IS DIFFERENT.

4. FIRE AFFECTS MANY RESOURCES.

5. THE ENVIRONMENT IS A DYNAMIC SYSTEM.

6. RESOURCE VALUES DEPEND UPON THE LOCATION OF THE RESOURCES AND THEIR PRESENT AND POSSIBLE FUTURE USES.

7. SUBSTITUTION OF UNBURNED FOR BURNED RESOURCES MAY REDUCE VALUE CHANGES ATTRIBUTABLE TO WILDFIRE.

8. FUTURE FIRE SUPPRESSION COSTS AND THE RISK THAT OTHER FIRES WOULD HAVE OCCURRED IN THE FUTURE REDUCE THE VALUE CHANGE ATTRIBUTABLE TO ANY GIVEN FIRE.

9. THE RATE AT WHICH FUTURE BENEFITS SHOULD BE DISCOUNTED IS UNCERTAIN.

10. FIRE MANAGEMENT AGENCIES' LEGAL LIABILITY FOR RESOURCE LOSSES MAY DIFFER FROM THE ACTUAL ECONOMIC VALUE OF THE RESOURCES.

11. WE NEVER KNOW EXACTLY WHAT IS SAVED BY FIGHTING A FIRE.

AREAS OF NEEDED RESEARCH

1. EXAMINATION OF THE EXTENT TO WHICH THE AREA AND RESOURCES BURNED IN ANY GIVEN YEAR, AND FOR DIFFERENT KINDS OF FIRES, ARE AFFECTED BY THE LEVEL OF SUPPRESSION EFFORTS.

2. DOCUMENTATION OF THE EFFECTS OF WILDFIRE IN TERMS OF CHANGES IN BENEFITS PROVIDED.

3. EXAMINATION OF THE RISK THAT AN AREA WILL BURN DESPITE FIRE PROTECTION EFFORTS, AND HOW THIS RISK AND THE EFFECTS OF FIRE CHANGE AS THE PERIOD OF TIME WITHOUT A BURN INCREASES.

4. EXAMINATION OF CURRENT AND POSSIBLE FUTURE MARKET VALUES FOR TIMBER AND OTHER RESOURCES IN DIFFERENT AREAS OF THE STATE.

5. EXAMINATION OF FIRE MANAGEMENT AGENCIES' LEGAL RESPONSIBILITIES AND LIABILITIES.

6. DOCUMENTATION OF THE EFFECTS OF FIRES IN PHYSICAL TERMS WHICH CAN FORM A BASIS FOR SUBJECTIVE VALUE JUDGMENTS.