The Economic Impact of Forest Fire

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Abstract

Three elements of a simple economic analysis of fire's impact on the forest industry are described. The first is a projection of timber supply and the reduction in AAC caused by fire. The second is a relationship between fire control expense and the resulting average annual burned area. The third is the value to be placed on a unit volume of wood as it is harvested. The concept focuses on the whole forest and its timber yield rather than on the burned area and its fire-killed timber. The principle that emerges could be called "maximized net return".

Introduction

It is now some five or six decades since the first efforts at measuring the economic impact of forest fire in North America, and a small but continuous flow of literature has continued to the present day. Yet after all these years of organized fire control, the subject is still not resolved to everyone's satisfaction. Furthermore, the pressure for a rational answer is rising steadily among the major forestry provinces of Canada.

It would be tempting to say outright that the reason for this apparent failure is a wrong turn taken at the start. But it would be presumptuous to dispose so easily of the "least cost-plus-loss" concept that has held the stage for all this time. Perhaps it is not the concept itself but rather how it has been interpreted that should be questioned. So far, the interpretation of loss has been "net-value-change on the burned area", with the consequent demand for rules to measure "values-at-risk" from hectare to hectare. This activity leads directly into economic problems of great complexity and still we do not have a satisfactory answer. Add to this the nagging doubt as to exactly who it is that sustains the loss, and just whose bank account is being depleted.

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How can one measure the economic impact of fire and judge just how much protection to give the forest? Let us step back a moment from economics, whose medium is dollars, and look at the forest instead, whose medium is wood. Let us also consider just the forest industry and the use it makes of the forest, setting aside other forest uses and benefits for the present.

What exactly is it that keeps the forest industry in business? It is, obviously, nothing less than an assured annual timber supply. Strictly speaking, what goes on in the standing forest is of second order relevance as long as the timber supply is forthcoming every year. If so, then the real job of the fire control agency is to protect the forest's annual increment rather than the standing forest per se. This may seem a subtle distinction, but once the point is accepted the decks are cleared for a logical chain of analysis.

Timber Supply and the AAC

The first step is to shift our focus away from the burned area and its fire-killed timber. The timber supply comes from the forest as a whole, and we must broaden our view to encompass it all. We must, in fact, delve into the mysteries of timber supply analysis. But, in its natural state, most of the Canadian forest is cycled and renewed by random periodic fire, and has been for ages. Should we not then apply the same cool logic to the effect of fire on timber supply as we give to the harvesting process itself? And this means projecting the effect of future fire as well as simply tracking the results of current depletions.

At Petawawa we have designed a little model that projects the available timber supply in a forest affected by fire as well as logging (Van Wagner 1983). The operator is required to state the annual proportions of the whole forest area that will be logged and burned, plus the forest's yield curve and initial age class distribution. The model then runs by two simple rules: 1) fire strikes at random at any age, and 2) the stand of highest volume is always cut. Here is a sample of the results we obtained, based on a yield curve like that of black spruce in Western Quebec (Fig. 1).

It is clear that for any given proportion of area burned annually there exists an optimum harvested area that will yield the maximum sustainable annual allowable cut (AAC). A graph of these maxima constitutes a direct measure of the impact of fire on the maximum potential timber supply, providing the first essential information for an excursion into an economic analysis of the fire control effort (Fig. 2).

Balancing the Fire Control Effort

The second step is to enquire just how the average annual burned area depends on the amount of money expended on fire control. The form of this curve is of great interest and importance. Let us assume two things:

1) If there were no fire control at all, the annual burned area would no doubt be much larger, but still finite.

2) It is impossible to reduce the burned area to zero without the expenditure of infinite funds.

The limits of the curve are therefore defined, and its shape will look something like (Fig. 3). Of course some real data would be greatly desirable, but just as obviously these would be very hard to come by. We have at least one point, namely the current state of affairs, and we must do the best we can to estimate the rest. This curve is the second essential for an economic analysis.

The third step is to place a value on the wood harvest itself, and now for the first time we must truly explore the mysteries of economics. What is a cubic metre of wood actually worth? I can think of at least four viewpoints, and an economist no doubt even more.

There is, first, the viewpoint of the accountant who collects stumpage. For example, the provinces at present, for purposes of reporting fire losses, place a weighted average of about $300 on a hectare of merchantable timber, say about $3 per cubic metre of harvested wood. But then, what about the viewpoint of the woods manager who judges a lost cubic metre by what it costs delivered to the mill entrance? And what about the viewpoint of the sales manager who thinks in terms of the value of the finished product as it is loaded for shipment? Finally there is the social economist who views the whole economic scene with its values-added and multiplier effects. So, for example, we saw that, in 1980 in Ontario, while the Ministry of Natural Resources rated its timber loss in mere tens of millions, the forest industries were proclaiming that billions of dollars had gone up in smoke. Such a spread of two orders of magnitude in loss estimate serves only to drive home more strongly the problem of what value to place on the timber supply for purposes of protection.

Nevertheless, whatever a cubic metre of harvested wood is actually worth, we have now identified the third and final ingredient of a basic economic analysis. Clearly, we must simply maximize the difference between harvest value and fire control expense. Multiplying the AAC by its value per cubic metre, the two quantities are graphed in dollars over annual area burned, as shown in Fig. 4. The ideal position, when the difference is optimum, occurs where the two curves have an equal slope.

Maximized Net Return

In all of this, we have not really discarded the concept of of "least cost-plus-loss". It is just that the loss is now conceived as a reduction in timber supply rather than as the fire-killed timber on the burned area. As it turns out, loss conceived in this way actually seems higher, since the reduction in AAC will generally turn out to be greater than the volume of fire-killed timber. But, the harder one looks, the more confused the very meaning of loss seems to be. Is it the value of the reduction in potential AAC? But this will be a true loss only if a market plus the industrial capacity exist for the entire potential AAC. Or is it the cost of the fire control operations? And does it include the cost of substitution when imminent harvest plans are interrupted by fire?

When the system is operating at its economic optimum, then the marginal cost of further reduction in burned area just equals the value of the corresponding increase in AAC. If loss were then defined as "economically available increased harvest", there would, in the optimum state, be no loss. With your permission I will leave the definition of loss in an unresolved state, and suggest that the simplest way out of the confusion is to rename the whole concept. Instead of "least cost-plus-loss", call it "maximized net return". The pieces of the puzzle then fall neatly into place.

For example, the way to improve the whole position would be through improvements in the effectiveness of fire control, either through better organization or improved working tools. Research will surely be important. The climate and weather with respect to fire and the essential flammability of the forest are always, it is agreed, beyond our control.

Further Concerns

Some additional observations are appropriate. How does one relate individual fires or fire seasons to reduction in AAC? The answer lies again in timber supply projection. Current fires reduce the AAC in a stream of subsequent years, and new ways to quote this effect will be required, perhaps as the present value of a series of these future annual reductions.

This concept also directs the fire control agency very logically how to distribute its protection effort. First, it will protect the different kinds of forest more-or-less in proportion to their respective mean annual increments. Thus, if the harvest value curve in Slide 4 lies all or in part below the curve of fire control cost, then it may be difficult to find a comfortable level of fire control that will justify trying to protect the forest at all. This situation would obviously be more and more likely as one proceeds north in the boreal forest. Second, the agency will protect best those age classes that are in short supply in terms of future harvests. Thus, if the 40-year class is most poorly represented, the agency will save a 40-year-old stand even at the risk of losing a recent cutover that just cost $500 per ha to regenerate. It appears, then, that investments in regeneration are properly regarded as distributed over the whole forest rather than as concentrated on the particular hectares that happen to be treated.

The point is worth repeating that loss is commensurate with demand. If there is no demand, presumably there can be no loss. Or, in the case of limited demand, it is clear from Fig. 1 that a reduced but appreciable timber supply is available from any forest almost regardless of the amount of fire in it.

What about other uses and benefits of the forest and how they are affected by fire? It is fair to say that any forest use that depends on age can probably be analyzed in a similar manner, namely by always considering the whole forest rather than the burned area alone. As for natural benefits such as wildlife, water supply, oxygen balance and the like, the simplest view is that there is no effect. The argument is simply that these are natural parts of ecosystems that have been cycled for millenia by random periodic fire; the patterns shift from place to place but the yields from the whole forest remain the same.

Then there is the problem of scale. What exactly is the whole forest? A large system is obviously implied, of a size that can accommodate the largest fires and the most severe fire years without serious disruption. As the scale is reduced, a size is eventually reached when one good-sized fire could put a small forest operation out of commission. The viewpoint described here is, therefore, more appropriate for large fire control agencies and timber licenses than for small single-mill operations. For, if no substitution from outside the unit is feasible, the problem seems almost more like one of insurance than of economics.

The concept of "maximized net return" carries with it a significant consequence. No longer can fire control be evaluated economically as a distinct operation separate from the rest of forestry. It must instead be regarded as just one component of forest management in general; evaluation and ultimate judgement rest logically at some higher level where all aspects of the forestry scene come together. The key word is integration.

Conclusion

Once the question of fire's impact is seriously raised in the open, it seems to me that there is only one way to tackle it, namely with objective logic, letting the chips fall where they may. If the answers are not in perfect agreement with conventional wisdom, this cannot be helped. Nevertheless, the whole question can be divided into two aspects, one of which may be considered "soft", the other "hard".

Consider first the economic aspect. If one accepts the whole-forest/AAC concept just described, plus the principle of "maximized net return", it is clear that the value placed on the harvest is the crucial factor. Given the potential range in the value of a cubic metre of wood for protection purposes, the result of any such analysis will depend overwhelmingly on the unit value chosen. Can the economists agree on a common yardstick? Even if they could and it could be proved that the fire control effort was either too great or too small, no one is obliged to change his ways. The idea of maximized net return is as old as commerce itself in human affairs, and governs various levels of our economy. Nevertheless, social and environmental concerns, acting through the political process, may control what is done about forest fire just as much as rational economic analysis. The whole economic side of the question is, in effect, probably rather "soft".

The timber supply aspect of fire's impact is, by contrast, a very "hard" issue indeed. Only the coolest of logic will suffice, it seems to me, when analysing the impact of fire on what is the lifeblood of the forest industry, namely its annual allowable cut. The clear message from this analysis is that the correct measure of fire's impact is not the fire-killed timber, but rather the reduction in the annual harvest. And the true business of the fire control agencies is the protection of that annual harvest.

Reference

Van Wagner, C.E. 1983. Simulating the effect of fire on long-term annual timber supply. Can. Jour. Forest Res. 13(3): 451-457.

Figure Captions

Fig. 1 Curves of equilibrium annual harvest over percentage of area cut annually, for various levels of area burned annually.

Fig. 2 Annual allowable cut over percentage of area burned annually; the focus of the maxima of the curves of Fig. 1.

Fig. 3 The relationship between average annual burned area and annual fire control expense, with the supposed present state marked on the curve. Scales not quantified.

Fig. 4 Diagram of the maximum net return as the maximum difference between harvest value and fire control expense, each plotted over annual area burned. Scales not quantified.

Figure 1

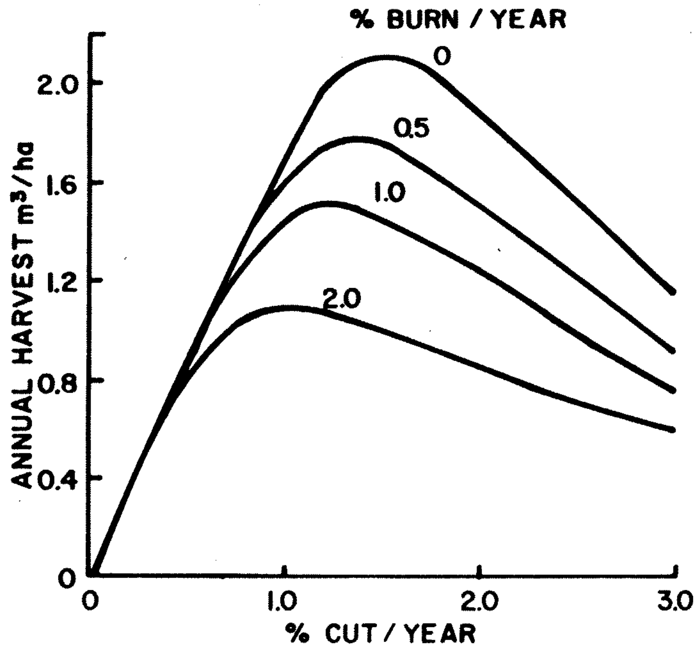

Figure 2

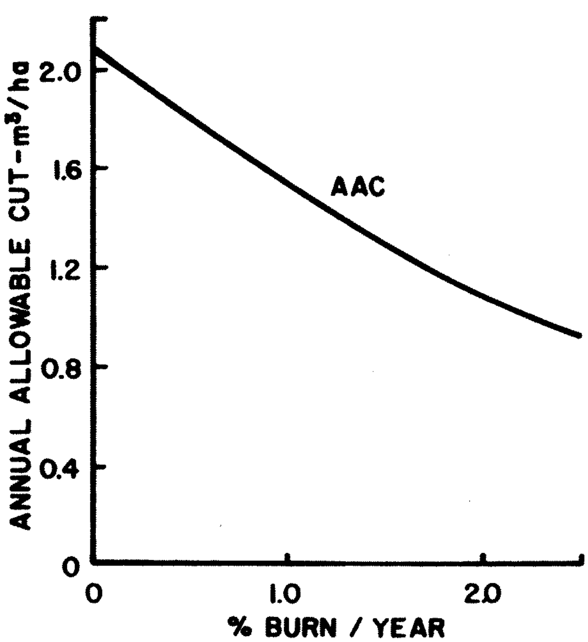

Figure 3

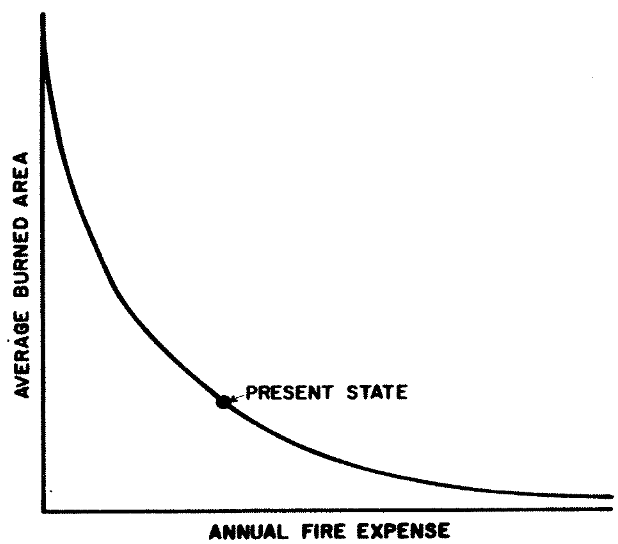

Figure 4