

A Conceptual Basis
for the Optimization of Pest Management
in the Vancouver Forest Region:

A brief discussion paper

by

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ABSTRACT

This paper discusses pest losses in the context of broad timber management goals, outlines the concepts of opportunity that pest management provides in support of these goals, and proposes a format for the optimization of pest management in the regional timber management program.

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1. Introduction

The management of forest pests provides some of the largest opportunities for enhancing timber productivity in the Vancouver Forest Region. In order to place these opportunities into perspective, pest management must be given consideration relative to other forest management options that are aimed at the enhancement of timber productivity. Lack of a clear conceptual basis for pest management, however, has largely inhibited this required perspective.

"Good" forest management implies an optimum pattern of forest management options. The implication in this report is that pest management has not yet been optimized in this region. In an effort to help correct this deficiency, this report attempts to clarify some of the basic concepts of pest management.

Although it is recognized that pest management can mitigate damage to non timber forest values such as landscape aesthetics, this report is restricted to the influences of pests and pest management on timber production.

2 Pest losses in the context of broad timber management goals

2.1 Volume losses in relation to predicted timber yield

Timber volume losses can be categorized as below:

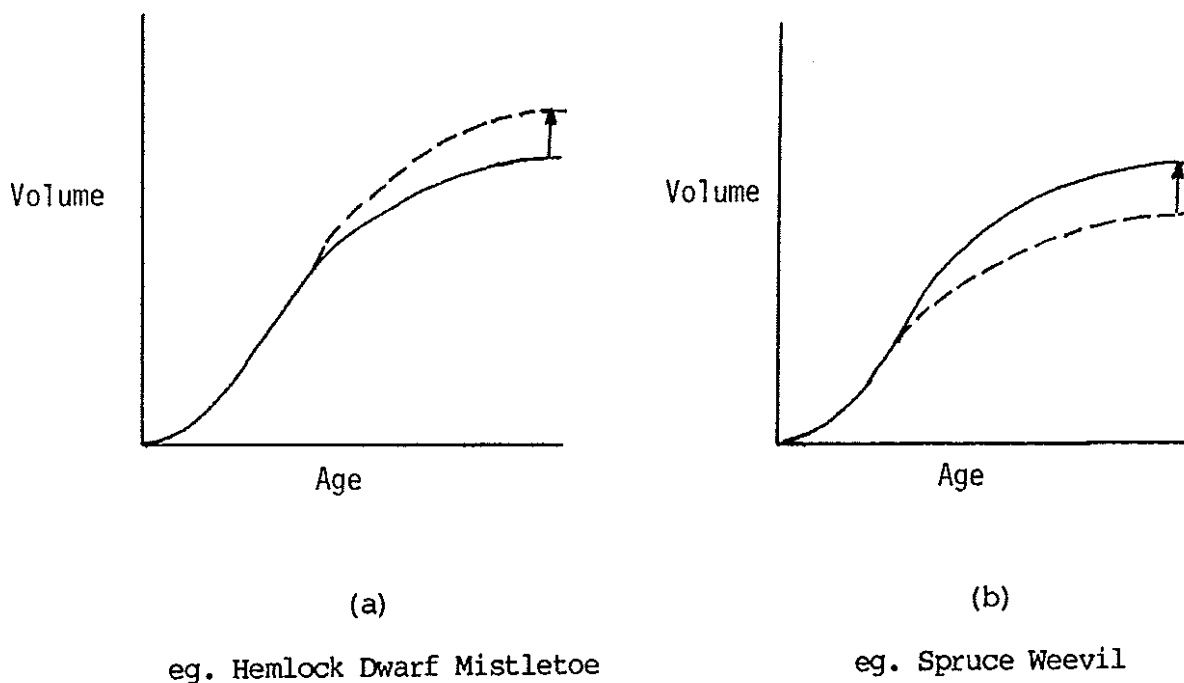
1. Losses incorporated in the predicted timber supply.

These are anticipated losses, or losses already accounted for in the natural volume over age curves. Hemlock dwarf mistletoe is a good example. From a timber management point of view, it can be seen that these anticipated losses do not impede on productivity targets. This is not to be confused with a lack of opportunity for pest management to help meet these productivity targets.

2. Losses detracting from the predicted timber supply.

These are unanticipated losses from the natural volume over age curves. Leader weevil damage is an example. From a timber management point of view, it can be seen that these unanticipated losses directly impede on production targets.

These losses can be schematically represented as in figure 1, below:



↑ = pest management opportunity

Figure 1: Pest losses can be either incorporated in VACs (a), or detract from VACs (b).

It is important to not confuse these two categories of losses with the terms "epidemic" and "endemic", because some "epidemic" losses are incorporated in volume over age curves (eg. western spruce budworm). The terms "endemic" and "epidemic" refer to fluctuations in pest populations.

2.2 Types of forest pest losses

Forest pests cause timber volume losses in four ways:

1. Mortality: Unsalvaged losses caused by the death of trees. (e.g. unsalvaged lodgepole pine trees killed by mountain pine beetle)
2. Incremental: Losses caused by a reduction of annual growth (height and/or diameter). (eg. reduced current annual increment caused by the parasitic Hemlock Dwarf Mistletoe)
3. Form distortion: Losses due to the distortion of bole form. These are losses in useable, or net merchantable, volume. (eg. leader weevil damage to sitka spruce resulting in forks, crooks and distorted growth; severe defoliation in Douglas-fir from Western budworm, resulting in dead tops, crooks and forks).
4. Opportunity Loss: Loss in potential timber production. This type of loss has been invariably overlooked in the past, yet represents perhaps the single largest loss to pests in this region. (eg. non-productive holes in Douglas-fir stands caused by Phellinus root disease).

3. Timber production opportunities through pest management

3.1 Concept of opportunity in pest management

Given the two categories of pest losses described above, anticipated and unanticipated losses, it would appear that:

- a) for Pest Management, anticipated losses represent an opportunity to enhance timber productivity, whereas,
- b) the reduction of unanticipated losses could be considered as basic protection, or maintenance, of the timber resource.

As discussed below, this is not necessarily a particularly good model from a pragmatic point of view.

Likewise, on the surface, it would appear that these two categories of pest losses are the parallel of Silviculture's "basic" and "intensive" silviculture. These two silviculture terms, although pragmatically based on licensee responsibilities, are conceptually based on "natural productivity". Basic silviculture conceptually refers to "maintenance of the natural productivity of accessible productive forest sites" (W. Young, 1982, see Appendix). "Natural productivity" refers to the productivity predicted by empirical volume over age curves.

Unlike pest management, however, silviculture is essentially sequential. For example, a site must be reforested before it can be spaced. In general, the "basics" of silviculture must be achieved to the "free growing"⁽²⁾ seedling stage before projects aimed at enhancing productivity (ie. "intensive") can be considered.

This is not true for pest management. Losses to pests are losses to pests, regardless of whether or not they are anticipated in the timber yield calculations. Pest management projects do not have a sequential basis. Each pest management prevention/control project represents an opportunity to realize wood volume that would otherwise be lost to pests. Pest management does not have a basic/intensive equivalent to silviculture.

(2) Definition of "free growing" seedling from Ministry Policy concerning Allowable Annual Cut - Incentive Increase (Section 52 (a)): "an established seedling of an acceptable species that is free from unacceptable brush competition five years after planting or natural regeneration.

3.2 Economic Considerations

3.2.1 Costs of implementation

Each potential pest management project has an associated cost of implementation. An important consideration is that the major portion of potential pest management prevention/control projects do not require funding by Pest Management; being interdisciplinary, pest management costs are frequently incorporated in other programs. An example in this region is the implementation of the 3 metre knockdown clause in hemlock stands for the preventative control of Hemlock Dwarf Mistletoe; the costs are incorporated in the stumpage appraisal. Another example is the control of Phellinus root disease by planting to a resistant species; the costs are currently incorporated in Section 88 planting contracts administered by the Silviculture Program.

3.2.2 Opportunity Costs

The traditional view of pest management considers only the unanticipated losses from pests. These are the losses where pest damage has allowed a stand to fall below its "natural productivity". Even within this narrow view of pest management, the traditional approach has been confined predominantly to mortality losses alone.

This viewpoint has been manifested in statements such as the following:

"unsalvaged losses from fire and pests will not exceed 26 000 m³ per year." (3)

This example is the total consideration given to pest management opportunities in a recent T.S.A. plan.

The large scale opportunity for pest management to enhance the growth potential of stands beyond their "natural productivity" requires immediate recognition. In an economic context, failure to implement recognized pest management opportunities aimed at the enhancement of timber productivity creates opportunity costs as real as the creation of NSR lands by failing to reforest after harvesting.

3.2.3 Benefits accruing from pest management

Good pest management is the prevention of losses due to pests. If losses are being incurred from pests, whether they are mortality, incremental, form distortion or opportunity losses, or whether or not they are already incorporated in the predicted timber supply (ie. "natural productivity"), they represent, in one sense, a lack of pest management.

Ideally, therefore, the benefits accruing from pest management would be the sum total of all potential losses to pests. Obviously, this is not a practical approach. On the other hand, any attempt to formulate a practical approach is faced with the difficulty of determining the benefits of preventing potential losses.

(3) Soo T.S.A. draft plan, November 1982

For those pest management prevention/control projects aimed at the enhancement of productivity (ie. above the productivity level predicted by the natural volume over age curves), relatively precise estimates of volume gains are attainable. The merchantable volume of affected stands (or affected portions of the stand) is compared with the volume of unaffected stands (or unaffected portions of the same stand) growing in similar site conditions. Alternatively, stem analysis may reveal patterns of damage that lend themselves to extrapolations that calculate the potential volume (ie. volume lost due to the pest).

For those pest management projects aimed at the mitigation or prevention of unanticipated losses (ie. losses detracting from the natural productivity predicted by volume over age curves), the dilemma of determining potential losses tends to persist. For example, how many cubic metres of wood are prevented from being lost because of the well timed sanitation harvest of an insipient mountain pine beetle infestation? Answers to this type of question depend on predictions of what pest damage would have occurred without the prevention/control treatment. These predictions are influenced by a number of biological, environmental and other variables, many of which are not well understood, or are beyond our current predictive capacity.

Recognizing that our ability to rationally determine these predictions is limited, the dependency on credible professional judgement becomes clearer.⁽⁴⁾

4. Proposed basis for the optimization of pest management

4.1 Introduction

This report proposes a non dual (neither basic, nor intensive) approach to the consideration of pest management options using volume productivity and cost as criteria in a non temporal (zero discount rate) context.

The goal of maintaining timber productivity or enhancing the productive capacity of forest land is central to timber management. Maximum cost effectiveness is central to forest economics. In effect, these two concepts imply that all potential forest management options could be ranked according to their cost effectiveness toward maintaining or enhancing timber productivity. (Social, environmental, political and other factors exert influence, of course, but are not discussed here.)

(4) This is one of the often overlooked but indisputably essential functions of pest managers.

As mentioned above, however, silviculture is sequential in that the "basics" (maintenance of natural productivity) must be given priority to "intensive" silviculture (productivity enhancement). That pest management does not have the equivalent of "basic" and "intensive" categories has been discussed in section 3.1.

The proposal in this report is that pest management projects be ranked relative to silvicultural and other management options primarily on the basis of their potential contributions to forest productivity per unit of cost.

4.2 Timber Productivity

Productivity is expressed as a rate of growth per unit area of forest land (eg. $m^3/ha/yr.$). The general formula for estimating a gain in productivity is⁽⁵⁾:

$$\text{Gain in productivity} = \frac{V_R}{R} - \frac{V_r}{r}$$

- where: V_R = Estimated total merchantable volume production until culmination age R for the treated stand (m^3/ha).
- V_r = Estimated total merchantable volume production until culmination age r for the untreated stand (m^3/ha).
- R = Estimated rotation age of maximum mean annual increment for the treated stand (years).
- r = Estimated rotation age of maximum mean annual increment for the untreated stand (years).

(5) from Annex "A" of Ministry Policy concerning Allowable Annual Cut - Incentive Increase (Section 52(c)).

4.3 Benefit/cost estimations

4.3.1 Project Ranking

It can be seen that either productivity gain per unit cost, or cost per unit of productivity gain, is an acceptable criterion for comparing (or ranking) pest management projects relative to other management options.

This approach allows pest management projects to be compared with not only "intensive" projects, but with "basic" projects as well. For example, spruce weevil control may be as "basic" (and as cost effective) as site rehabilitation or brushing and weeding.

4.3..2 Net Costs

It is important to keep in mind that the costs of many pest management prevention/control projects may be borne in the course of other programs, as discussed in section 3.2.1. In this context the net cost of implementation must be used. For example, planting to a resistant species for the control of root disease involves planting costs that would be borne by Silviculture's reforestation budgets (ministry or Section 88) anyway. The net cost for the consideration of this pest management treatment would be the extra planting costs due to "microsite" planting and the root disease survey costs.

4.3.3. Discount Rates

The gain in productivity from a pest management treatment implemented this year, will not be realized until rotation, which in most cases is many years in the future. In theory, therefore, the value of the increased volume attributable to the treatment should be discounted to the present. In practice, however, it is the volume, not the value, that is being considered as the accruing benefit. This volume contributes to the rate of productivity for the area in consideration. Rate of productivity is one of the factors that contributes to cut determinations; the volume can therefore be realized in the present. Discounting benefits to the present is therefore not applicable. Productivity and its effects on yield analysis is discussed in more detail in section 4.4.

This concept⁽⁶⁾ is manifested in the Allowable Cut Effect, expressed in Section 52 of the Forest Act:

"the regional manager may... increase the allowable annual cut...by a volume equal to the regional manager's determination of the gain of productivity..."

(6) This concept is only valid given certain yield analysis assumptions, including a projected future deficit situation. Full discussion of these factors is beyond the scope of this paper.

4.4. Yield Analysis

The proposal presented in this paper uses productivity per unit cost as the primary factor for the optimum selection of timber management options. Yet productivity is only ³of many factors which bear influence on cut determinations and management strategies. Section 7 of the Forest Act, for example, lists factors the Chief Forester uses in the determination of allowable annual cut. Many of these factors must also be considered in the structuring of the regional timber management programs. It is important, therefore, to not overemphasize productivity such that it impedes on other management considerations.

Of particular relevance to pest management is the timing of production targets. In T.S.A.s where a shortfall is expected (falldwon effect), priority would usually be given to projects that can deliver merchantable productivity gains at the time of the expected falldown.

Section 2.1 of this report points out that some pest losses are incorporated in volume over age curves (VAC's) and some are not. Section 3. 1 presents the argument that this factor is irrelevant for the purposes of ranking pest management projects. For the purposes of yield analysis, however, this factor is vitally important.

Reduction of those pest losses incorporated in the VAC's represents a real gain in forest productivity. This productivity gain may mitigate a falldown effect in a T.S.A. if the gain can be realized at the time of the expected falldown, as mentioned above, and/or may increase the long range sustainable yield (IRSY) of the T.S.A. if the loss reductions can be maintained in the long term. Some pest management treatments also have the potential to ameliorate anticipated uneven age class distributions for a particular species type group.

It is also important for Pest Management to identify losses detracting from the VACs that are not expected to be reduced. Failure to quantify these losses can lead to an overestimate of forest productivity.

4.5 Opportunity Costs

Recognition of opportunity costs are valuable from two points of view:

- (a) Opportunity costs can be used as an expression of the value of potential pest management activities in real terms. As mentioned previously, failure to implement recognized pest management opportunities creates opportunity costs as real as the creation of NSR lands by failing to reforest after harvesting.

(b) Although this report discusses the optimization of pest management relative to other management options, the absolute optimization of pest management can be defined as the level that minimizes total costs (meaning the combined total of opportunity costs and costs of implementation). This concept can be schematically illustrated as in figure 2 below:

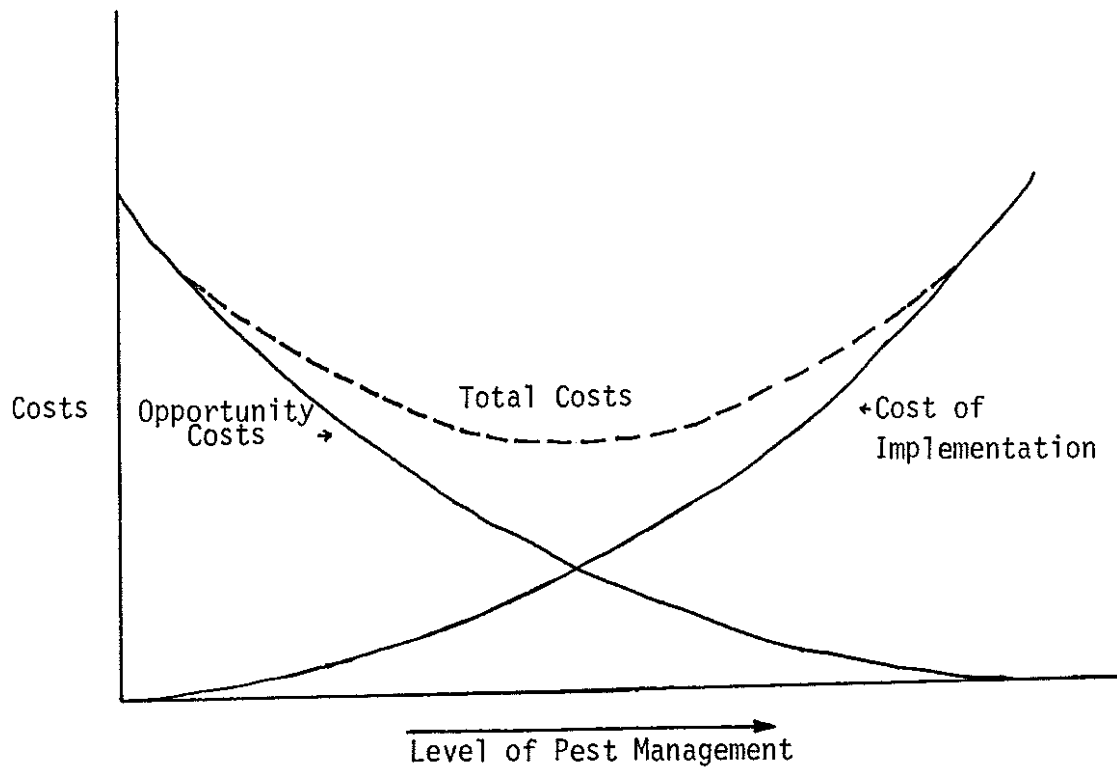


Figure 2: The optimum level of pest management is the point of minimum total costs.

From this viewpoint, pest management is, at present, considerably below its optimum level, as is most of forest management.

5. Appendix:

Memorandum concerning Basic Silviculture, W. Young, November, 1982

	Province of British Columbia	Ministry of Forests FOREST SERVICE	MEMORANDUM
To: All Regional Managers			RECEIVED NOV 10 1982 VANCOUVER OFFICE
			From: W. Young Date: November 5, 1982 File: 955-7

I have been asked to clarify in writing some aspects of Basic Silviculture, and free-growing seedlings with respect to regeneration and licensee responsibilities.

Basic Silviculture

- Includes the maintenance of the natural productivity of accessible productive forest sites by:

1. preserving the natural productive capacity of forest sites through the application of ecologically-based site specific prescriptions to harvesting, site preparation and regeneration activities
2. restocking forest sites with desired tree species within an acceptable time frame and in accordance with approved stocking standards
3. protect the regeneration from suppression by undesirable brush, weed or tree species to ensure that regeneration attains a "free-growing" status within an acceptable period specified in the cutting permit or, in the absence of such period, not more than five years from initial establishment.

"Free-Growing Seedlings"

- An established seedling of an acceptable species that is free from unacceptable brush, weed and tree competition by the time and standards specified in the cutting permit, or, in the absence of such specification, by five years after planting or natural regeneration.

- 2 -

Licensee Responsibility

- All tenures that have embraced a mandatory responsibility to regenerate logged-over areas include the responsibility to ensure that regeneration attains the status of "free-growing seedlings".

W. Young
Chief Forester

Noted

T. H. Apsey
Deputy Minister