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A Decision Context for Timber Supply Modelling[1]

by

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Abstract

Projection of timber supply is an important component of most timber management planning systems. One of the factors limiting the improvement of such systems is the difficulty involved in clearly understanding the context of timber supply projection within management of the forest as a whole. A simple decision structure is employed in this paper to illustrate this context. Management of the timber resource is described as a subproblem of managing the forest. A timber management plan is shown to be comprised of the answers to two intricately linked questions: (1) how much to harvest over time and (2) how to schedule a sequence of activities to support the desired rate of harvest. Each of these decision processes is described briefly and the role of timber supply modelling in providing answers is examined. Although the information presented in the paper is general, it represents an initial attempt at ordering perceptions of the timber management decision environment into a more understandable form.

Key words: timber management planning, timber supply modelling.

Résumé

La projection de l'approvisionnement en matière ligneuse est une composante importante de la plupart des systèmes de planification de la gestion de la matière ligneuse. Un des facteurs qui limitent l'amélioration de tels systèmes est constitué par la difficulté de bien comprendre le contexte de la projection de l'approvisionnement en matière ligneuse au sein de l'aménagement global de la forêt. Une structure simple de décision est utilisée dans cet exposé pour illustrer ce contexte. La gestion de la ressource ligneuse est décrite comme étant un sous-problème de l'aménagement des forêts. Un plan de gestion de la matière ligneuse est élaboré à partir de questions corrélées : (1) Quelle quantité récolter au cours de la période, et (2) Comment élaborer une séquence d'activités pour supporter le niveau désiré de récolte? Chacun de ces processus de décision est brièvement décrit et l'utilité du modèle d'approvisionnement en matière ligneuse pour générer des réponses y est examinée. Même si l'information présentée dans cet exposé est génnérale, ceci représente une tentative initiale pour mettre en ordre les perceptions de l'environnement décisionnel de la gestion de la matière ligneuse en une forme plus compréhensive.

Mots-clés : Planification de la gestion de la matière ligneuse. Modèle de l'approvisionnement de la matière ligneuse.

Introduction

Implicit or explicit projections of the supply of various forest resources are an integral part of any planning system. These supply models are one source of the information used in selecting a level of use for any resource and the management strategy necessary to support that level of use. Supply models are particularly important in timber management planning because of the complex nature of the resource, its importance to local and national economies, the many management options available and the long time between regeneration and final harvest on any particular piece of land (Baskerville 1982).

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Advances in computer technology have allowed the application of more complex solution techniques to timber supply models than was possible in the past. This permitted the development of models that better reflect the true nature of the problem and allowed the formulation of potential management strategies in conjunction with projection of the timber supply (Field 1978). Despite these technological advances, most operational timber supply models still assume that the model parameters are known with certainty although this is never so.

Development of timber supply models is currently at a plateau. Mathematical decision theory and mathematical programming techniques have developed to a point where uncertainty can be readily incorporated into theoretical decision analyses. (See Sengupta [1972], Kolbin [1977] or any other stochastic programming text for a description of the techniques available). However, problem size limitations have made application of these techniques to operational models of timber supply difficult (Dixon and Howitt 1979). Recent attempts at producing operational approaches have concentrated on the development of approximate procedures that can handle large problems. Examples include Hoganson (1981), Casti (1983) and Hoganson and Rose (1984). None of these approaches has gained operational acceptance to date.

It is likely that techniques will eventually be developed that will prove effective for timber supply modelling problems. Whether such procedures will improve the timber management planning process, however, is contingent upon factors external to the technology employed in solving such models. These include recognition of sources of uncertainty internal and external to the timber supply model environment, improved understanding of the contribution of these sources and better comprehension of the role of timber supply modelling within the forest planning framework. It is this latter issue that will be addressed in this paper.

A simple decision structure has been chosen as the mechanism for providing a context for timber supply modelling. The reasons for choosing such an approach are two fold.

1. Specific discussions of risk and uncertainty in timber supply modelling are impossible without a specification of the decision context in which the models are applied. As indicated above, such discussions are a necessary step if timber supply models that incorporate certain sources of uncertainty are to be usefully employed in the timber management planning process.

2. A decision structure can be constructed in a general fashion so as to be applicable to a variety of forest management agencies. This generic structure subsequently could be adapted to fit specific management systems.

The Forest Management Problem

The forest has been described as a system by various authors (e.g. Seale 1965, Duerr 1966, 1982, Christiansen 1968). The forest system produces returns for the owner/user in two distinct ways. Some returns, such as aesthetics, may exist simply as a result of our preference for natural forest and require no active input from man. Other returns are consumptive in nature and result in changes to the biophysical structure of the system. Examples of this include timber extraction and wildlife harvesting.

Management of the forest system involves deliberate intervention in the system processes. In the broadest sense, management includes all activities introduced to the system by man for the purposes of producing consumptive returns in the present and/or altering the structure in anticipation of future requirements. A sequence of planned activities that could be introduced at different points in time and space constitutes a management strategy.

A difference (gap) between the actual state and the desired state of any system can be defined as a problem (MacCrimmon 1980). It would be possible, albeit difficult, for the owner of a forest resource on a particular area to define an ideal structure (desired state) for his forest based on present perceptions. It is unlikely that the present structure (the actual state) is identical to the ideal structure. It is this gap that is identified here as the forest management problem.

Management of the forest system involves trying to solve this problem (*i.e.* close the gap). Solution requires identification of the present and the desired states of the system and movement of the system from its present state to the desired state.

Charting a course that will close this gap is not a simple matter. The desired state of the forest system as a whole is seldom explicitly stated, nor would it be easy to do so. Changes in the values of society as a whole will probably alter future perceptions of an ideal structure. Uncertainties arising from within and outside the system handicap the movement of the forest towards some desired state. Even if sufficient research were to be conducted on the physical and biological mechanisms of the system and unlimited information were available about the present state, uncertainty about the future would preclude the development of a management strategy that is sure to be optimal. The end result is that the gap between the actual and the desired state of the forest is quite difficult to close, and even if closed, unlikely to remain closed for long.

Solution of the forest management problem involves answering two intricately linked questions:

(1) What mixture of forest resource uses is desired?
(2) How should each resource be managed to maximize return?

There are considerable difficulties associated with providing simultaneous answers to these two questions on public forest land. These difficulties are addressed in some of the considerable body of literature available on multiple use of the forest. The approach often taken involves subdividing the forest management problem conceptually and jurisdictionally into subproblems pertaining to a particular resource or group of resources. The subproblems consist of developing a strategic plan for a particular resource on a well-defined forest area which is compatible with some overall strategy for the forest as a whole. While the subproblems are generally solved in partial isolation from one another, linkages are maintained by existing policy and consultation during the planning process.

Timber Management as a Decision Problem

Management of the timber resource is often an important component of the forest management problem. In some areas, the two terms may be used interchangeably without loss of information since timber management is the only aspect of forest management practised. Since timber harvesting is a consumptive use of the forest, the rate of extraction has a profound influence on the future state of the system. Some policy structure (e.g. sustained yield) usually exists to govern the rate of timber extraction and control changes to the state of the timber resource through time.

The forest manager must address two intricately linked questions when preparing a timber management plan for a particular forest area: (1) how much to cut over time (selection of a timber harvest profile) and (2) where to harvest this timber and what additional activities are necessary to support the proposed harvest in an efficient manner (selection of a timber management strategy). The relationship between these two decisions is not difficult to illustrate.

A major consideration in the choice of a timber management strategy is the rate of harvesting 'allowed' by existing policy under that particular strategy. In a similar sense, the choice of a particular harvesting profile implies the choice of a sequence of management actions that will attempt to maintain a forest structure which is compatible with such a harvesting rate under the guidelines specified by policy. In short, selecting a harvesting profile implies, or at least constrains, the selection of a timber management strategy. Decisions can not be made about appropriate levels for one without considering the other.

It is often useful to think of the timber management subproblem in terms of its component parts. (See Figure 1.) It should be noted that such a separation is suggested purely for analytical purposes and it would be quite impractical to attempt to implement a decision for one aspect of the problem without considering the other. There are, however, definite decision analytical advantages to such a separation resulting from the isolation of the sources of uncertainty that affect both decision processes. Separate analyses of these two decisions may be warranted in the early stages of a planning process, but compatibility should be assured prior to the preparation of a final plan.

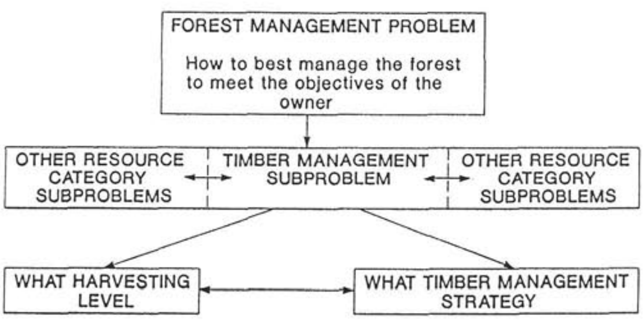

Figure 1. Partitioning of the forest management problem.

The Role of Timber Supply Modelling

Models of timber supply can be employed to aid both timber harvest profile and timber management strategy decisions. Such models require as input the forest land base and existing inventory as well as some specification of either management strategy or harvesting profile. Present policy is normally implicit within the structure of the models. The timber supply model may differ in structure depending upon what is given, but this is not a necessity.

The choice of a timber harvest profile is related to the decision maker's conception of a desirable future state of the forest system. As such it requires consideration of resource use categories other than timber and includes information sources beyond the bounds of the forest system. This precludes modelling solely at the management unit level.

A timber supply model can, however, be used to monitor the potential effects of various policies and harvesting patterns on future forest structure. While it is important that some linkage be maintained with the present state of the timber resource, more emphasis should be placed on the desired future state of the forest system and policy formulation (see Figure 2). Some assumptions concerning timber management strategies must be made in such analyses, but the strategies assumed should be kept general.

Simulation would be an ideal modelling approach under these circumstances. It would allow the examination of many 'what if' questions without forcing the problem into some rigid structure to allow mathematical solution. The information sources involved make any formal decision methodology difficult.

A harvesting profile is generally selected for specific areas within the total area managed by a particular agency. Any profile, while sensitive to local conditions, will likely follow the same broad parameters and economic assumptions as patterns chosen for other areas within the same jurisdiction at around the same time.

Ultimately, the applicability of timber supply projections to the choice of appropriate timber harvesting patterns depends on how closely the future envisioned resembles the conditions that will occur. This we can not know. However, it is possible to analyze the impact of present decisions under different future conditions. Although this will not indicate whether present policy and decisions are 'correct', it will provide some idea of possible repercussions in case certain conditions arise. This should aid the decision maker in the decision process.

Choice of a timber management strategy is dependent upon the harvesting profile desired over time. The idea is to manipulate the growing stock base in such a manner that the desired harvest profile is supported efficiently. The timber management strategy decision tends to be more of an individual management unit decision than the selection of the timber harvesting profile because the existing land and growing stock base play a more dominant role in the decision process.

Timber supply projection is central to the process of formulating a timber management strategy (see Figure 3). It provides the essential linkage between what is currently present on the ground, the harvesting profile selected and the policy structure in effect.

If the proposed harvesting profile is to be attained, the growing stock must be of a suitable size and distribution to 'allow' the projected harvesting level at various points in the

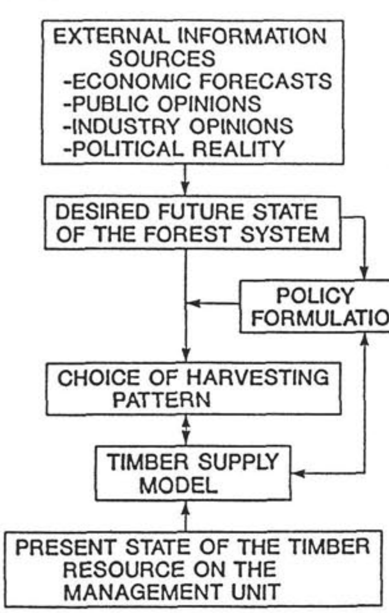

Figure 2. Role of timber supply modelling in harvest profile decisions.

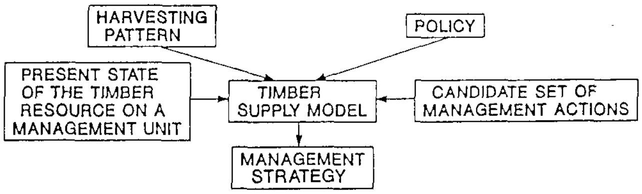

Figure 3. Role of timber supply modelling in timber management strategy decisions.

future. As long as a harvesting profile does not require a growth rate and a forest structure that are physically impossible for the forest to attain, it should be possible to follow the profile with some timber management strategy. Whether such a strategy is recognized, or the cost of applying such a strategy is prohibitive, are entirely different questions. The key point is that overcutting is not solely a matter of setting a harvesting level that is too high, but also may be a matter of not selecting or implementing a management strategy that causes the forest to respond in the manner expected.

For selecting a management strategy for a particular forest area, the existence of a particular harvesting profile and policy structure can be considered as part of the structure of the decision problem. The selection of a management strategy could then be made within existing constraints assuming a particular harvest profile. Choice among prospective strategies could be made on the basis of cost of application and degree of risk involved in not producing a forest structure that will 'allow' the harvest profile proposed using an apporach similar to that suggested by Marshall (1984). Iteration between analyses of the harvest profile decision and the timber management strategy decision at the planning level should ultimately lead to compatibility between the two decisions.

Conclusions

Although the information presented in this paper is general, it represents an initial attempt to order perceptions of the timber management decision environment into a more understandable form for the forest manager. How a decision maker perceives the timber management decision environment cannot change the reality of the situation, but it can influence how the timber resource and the forest as a whole are managed.

The extent to which the direction and rate of change of the forest system can be controlled defines the boundaries of forest management. The length of time between successive harvests on a given unit of land and the uncertainty of response of that land area to various management actions make the control of the forest system a slow and risky process. Furthermore, since the desired future state of the forest system envisaged in the present is not likely to be the desired state in the future, the forest manager is essentially aiming at a shifting target.

For the decision maker to make rational choices within this complex environment he must understand it to the extent possible prior to any simplification necessary to allow analytical solutions to particular problems. Establishment of a proper decision context is an initial step towards attaining this understanding.

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The Annual Meeting Schedule

1987 — August 3-6, St. John's, Nfld.
Theme: Forestry Communication — the Essential Link

1988 — September 19-22, Prince Alberta, Sask.
Theme: Forest Management — A Shared Responsibility

1989 — Rocky Mountain Section