A Two-Phase Method for Timber Supply Analysis

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Abstract: There is an increasing need to clarify the long-term wood supply implications of current harvesting rates. To assess the wood supply and to set timber production objectives, different linear programming techniques are applied to the short and long term. The transportation method is applied to the short term and the B. C. Forest Service computer-assisted resource planning method is applied to the long term.

INTRODUCTION

Of all the decisions facing forest policymakers, probably the most critical, because of its economic importance, is the rate at which timber is to be made available for harvesting. The timber-producing base is diminishing through increased recognition of an array of legitimate non-timber users, through environmental protection measures, and through changes in the economics of logging. The nature of the productive forests is changing from unmanaged large old-growth to young-growth forests whose products will be smaller and in different proportions by species. In this changing world the British Columbia Forest Service must maintain a continuing wood supply to support a healthy competitive forest industry and ensure the productive integration of land uses. All these factors generate an increasing need to clarify the long-term wood supply implications of present timber harvesting rates.

In 1976 the Royal Commission on Forest Resources (Pearse 1976) recommended changes in the current methods of timber yield regulation. In particular it recommended that yield controls should (1) apply to Timber Supply Areas (TSA's) serving manufacturing areas and communities, (2) recognize log supply patterns and transportation facilities within the timber supply area, (3) embody reasonable expectations about future trends in forest growth and values, and (4) recognize the uncertainty surrounding long-term forecasts. This paper describes a small part of the response by the British Columbia Forest Service to these recommendations.

TIMBER SUPPLY AREAS

Within the regions of the Province, timber supply areas can be identified which serve manufacturing areas and communities. The supply areas have largely evolved from establishment of forest industry and the development of associated communities. Insofar as public policy is to be directed toward supporting the income and employment base of forest-dependent communities, yield controls must be designed to apply to the relevant timber supply areas. There should be some flexibility in setting short-term harvesting rates, together with a mechanism for clearly showing their long-term implications for the future wood supply.

TWO-PHASE METHOD

To meet the described requirements for revised yield controls, the approach has been to separate the relatively short term (the next 20 years) from the very long term (about two rotations). In defining timber production objectives over the 20-year horizon, the Forest Service must ensure that the short-term rate of cut will not result in an unacceptable decrease in the future wood supply. Accordingly a practical, conceptually simple process consisting of two phases has been developed, from which timber supply area wood production goals can be derived.

Phase 1 (Short Term)

Develop and describe 20-year production goals in the form of a simple wood flow plan. The plan describes a feasible, efficient movement of wood from the different localities within the timber supply area to the different broad industrial sectors. In practice this 20-year "look ahead" would be used to set 10-year objectives. The 10-year production objectives are to be reviewed every 5 years.

Phase 2 (Long Term)

Determine the projected timber production curve over one or two rotations for the entire timber supply area, setting the overall cutting rate for the first two decades equal to that developed in phase 1.

If the results of phase 1 cause the long-term rate of cut to drop below the 90% of the long-run sustainable yield, then phase 1 must be modified until it is in harmony with the long term goals.

FORMULATION OF THE SHORT-TERM ANALYSIS

The supply area can be described as a network in which there are localities (supply points) supplying industrial sectors (demand points). The 20-year horizon can be divided into four 5-year periods. Each supply point has an inventory of accessible, usable timber; each demand point has a minimum

demand to be satisfied and a physical capacity which cannot be exceeded. The objective is to select, for the duration of the horizon, a routing plan which satisfies all the demands, does not exceed the supplies and physical plant capacities, and attempts to maximize the value of the routing plan.

One formulation of the problem is given below:

Maximize $\Sigma_{ijk}\, r_{ijk}\, x_{ijk}$

Subject to the demand constraints:

$-\Sigma_{jk} x_{ijk} \leq D_i$	minimum total sector demands over the 20 year horizon	(1)
$-\Sigma_{jk} x_{ijk} \geq M_i$	maximum total sector demands over the 20 year horizon	(2)
$\Sigma_j - a_{ijks}\, x_{ijk} \geq SD_{iks}$	maximum sector demand by species and time period	(3)

where - SD_{iks} $g_{iks} P_{ik}$

$-\Sigma_j\, x_{ijk} \leq PD_{ik}$	minimum total demand by sector i in time period k	(4)

and subject to the supply constraints:

$\Sigma_{ijk}\, x_{ijk} \leq T$	total wood supply	(5)
$\Sigma_i \Sigma_k\, x_{ijk} \leq S_j$	total wood supply for each management unit	(6)
$\Sigma_i\, x_{ijk} \leq MS_{jk}$	wood supply for each management unit in each time period	(7)
$\Sigma_k\, x_{ijk} \leq SS_{ij}$	total supply available to sector i from management unit j over the 20 year horizon	(8)

x_{ijk} = volume of wood allocated to sector i from management unit j in time period k

r_{ijk} = value of a unit of wood allocated to sector i from management time unit j in time period k

D_i = total minimum demand for sector i over the 20 year horizon

M_i = total maximum demand for sector i over the 20 year horizon

P_{ik} = maximum demand for sector i in time period k

a_{ijks} = proportion of species s in a unit of wood from management unit j which can be used by sector i in time period k

SD_{iks} = maximum demand by sector i for species s in time period k

g_{iks} = the average proportion of species s used by sector i in time period k

PD_{ik} = minimum total demand by sector i in time period k

T = total wood supply in the supply area available for cutting in the next 20 years

S_j = total wood supply in the jth management unit available for cutting in the next 20 years

MS_{jk} = total wood supply from management unit j in time period k

SS_{ij} = total supply available to sector i from management unit j over the 20 year horizon

$i = 1,5 \quad j = 1,10 \quad k = 1,4 \quad s = 1,6$

LONG-TERM ANALYSIS

Obviously it is not sufficient to allocate existing mature timber inventories from the management units within the supply area, without looking at the long-term consequences for the supply area as a whole. Use of a subset of the Computer Assisted Resource Planning System (Williams and others 1975) allows calculation of a long-term production curve for the entire timber supply area, constrained for the first two decades to the harvest level set in the short-term calculation. In this calculation the harvest scheduling formulation is that produced by Timber-RAM (Navon 1971).

APPLICATION OF THE METHOD

After assessing present and projected industrial demands and the net timber supply, a simple question-and-answer sequence can be followed to arrive at a set of timber production goals. Those questions, in the order that they are addressed in the process, are:

Can the present cutting rates be maintained over the next twenty years?

What effect will maintenance of the present cutting rate have on long-term timber supply?

What are the projected increased industrial demands over the next twenty years and can cutting rates be raised to meet them?

If increased demands can be met over the next twenty years, what will be the effect on the long term supply?

The method also has the following capabilities:

Likely periods of scarcity for a particular industrial sector can be highlighted.

Areas that have to be developed by a certain time to meet wood supply needs can be pinpointed.

The effects of changing sector demands on the wood supply picture can be predicted.

The effects of changing the log supply pattern on the wood supply picture can be predicted.

A starting point is given for long-range strategies to ameliorate impending wood supply problems if they are indicated.

RELATING TO NONTIMBER RESOURCE USES

An initial wood supply analysis provides valuable input to determining overall resource use policy. With this information "out on the table" other resource managers can participate effectively in the development of alternatives for a timber supply area and, later on, for a complete region.

Once alternatives are developed which express the needs of other resources, one can be chosen by the decisionmakers, or additional alternatives can be prepared prior to the decision.

RESULTS OF THE PROCESS

Tables and graphs are generated showing planned rates of harvest for the timber supply area in each of the next four 5-year, periods. Planning harvest rates are broken down by management unit and industrial sector.

For the long term, graphs and tables are generated allowing an assessment of the long-term wood supply which will result from implementing the 20-year harvesting plan.

These results enable the Forest Service to set timber production objectives and are a starting basis for the development of associated reforestation and silvicultural goals.

The method outlined in this paper is part of the Forest Service planning system (British Columbia Forest Service 1978).

REFERENCES

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