Extension Note

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Arrow IFPA Series: Note 7 of 8

Criterion 4: Timber economic benefits

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Abstract

This extension note is the seventh in a series of eight that describes a set of tools and processes developed to support sustainable forest management planning and its pilot application in the Arrow Timber Supply Area. It demonstrates how forest-level modelling can be used to forecast criteria and indicators of timber economic benefits and how sensitive these indicators are to changes in the constraints affecting the timber harvesting land base and harvest practices. In an economic sense, forests are assets with the potential to generate wealth through a sustainable flow of benefits. Managing this asset to maximize economic returns and to minimize the risk of loss to natural disturbances are important objectives. This extension note develops these concepts and identifies indicators that can measure economic performance. A harvest simulation model is used to forecast harvest volume, growing stock, and delivered wood cost for the Sustainable Forest Management Pilot Basecase Analysis. A sensitivity analysis shows how harvest volume changes as management assumptions change. Harvest simulation models can help to identify strategic trade-offs between value and risk.

KEYWORDS: *criterion and indicators, forest economics, forest-level modelling, risk assessment, timber supply.*

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Introduction

Sustainable forest management (SFM) requires the balancing of economic, environmental, and social objectives. The linkage between SFM and timber economics lies in the desire to achieve a sustainable flow of economic goods from forests and to maintain healthy forests capable of providing benefits into the future. In financial terms, a forest is an asset and the flow of goods generated from the forest is the return on that asset. Timber production requires economic efficiency in selecting inputs (e.g., labour and capital for silviculture, harvesting, and forest protection) to produce the most valuable outputs (e.g., high-valued logs produced at competitive cost). Timber production must also recognize and address risks that threaten the asset. For example, forests that lack diversity in age-class and species composition may be highly susceptible to losses from natural disturbances, such as the mountain pine beetle outbreak. Similarly, forests with high delivered wood costs and low revenues are economically inefficient and therefore risky investments.

To have sustainable timber production, we must have sustainable wealth in the form of healthy forests and an efficient system of timber harvesting and wood products processing. This is referred to as "resilience." In addition, we also need to consider the distribution of value from the forest to corporations, labour, communities, and governments. The value of consumption from a forest, the distribution of this value, the resilience of the forest and the conversion system are important elements of sustainable forest management that help to guide the identification of appropriate SFM criteria and indicators (C&I).

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The two objectives of this extension note are to demonstrate:

1. the use of forest-level modelling to forecast C&I of timber economic benefits for the Arrow Innovative Forest Practices Agreement (IFPA) Sustainability Project (see sidebar); and
2. the sensitivity of these indicators to changes in the constraints affecting the timber harvesting land base and harvest practices.

The IFPA Sustainability Project

The Arrow Innovative Forestry Practices Agreement (IFPA) was established as a co-operative effort between the five licensees* in the Arrow Timber Supply Area (see Figure 1, Extension Note 1) and the B.C. Ministry of Forests' Nelson Forest Region. The Sustainability Project was an important initiative of the Arrow IFPA that partnered forest practitioners and academic researchers to develop a comprehensive approach to planning and implementing sustainable forest management.

The result of this work has been the Sustainable Forest Management Framework, which is now being used by Canfor* to guide certification and sustainable forest management planning in their British Columbia operations. For further background, refer to: *http://www.sfmportal.com*

Disclaimer

The ideas presented in this extension note form part of a project (outlined in a series of eight notes) that was initiated to develop a system for evaluating management options under a criteria and indicators framework. These ideas do not represent real management options for the Lemon Landscape Unit, or the Arrow TSA, although they could form the basis of such options.

* The Arrow Forest Licensee Group was comprised of Slocan Forest Products, Kalesnikoff Lumber, Atco Lumber, Riverside Forest Products, and Bell Pole. In 2004, Slocan Forest Products Ltd. was acquired by Canadian Forest Products Ltd.

TABLE 1. Indicators and measures identified for Criterion 4

Indicator	Measures
1. Value produced	Total value, net value, forecast harvest flows, log values
2. Distribution of value to corporations, labour, communities, and governments	Profit, return on investment, income, employment, taxes, and rents
3. Resilience of the forest and the timber processing system	Growing stock of timber, timber supply certainty, competitive delivered wood costs, access to capital, investment in research and development, market share

The note's first section identifies indicators and measures for the timber economics criterion. The second section outlines the use of a harvest simulation model to forecast a subset of these indicators and measures for the basecase scenario proposed for the Lemon Landscape Unit (Extension Note 4) in the Arrow Timber Supply Area (TSA; see Figure 1, Extension Note 1). The third section describes the sensitivity analysis of harvest flow using the assumptions made in the basecase scenario. Finally, conclusions are drawn from this work and suggestions made for future work on expanding the set of economic indicators used in this extension note.

Criterion and Indicators

Internationally, SFM has been implemented by means of C&I. These are used to evaluate alternative SFM scenarios during the planning process and to monitor achievement of the plan objectives over time. Several C&I were developed for the Arrow SFM framework (see Extension Note 2). Criterion 4 states: "The long-term flow of economic benefits derived from Arrow TSA forests through the forest industry will be sustained." Consistent with the important economic elements described in the introduction, Table 1 summarizes the currently identified indicators and measures.

The importance of timber economic benefits was confirmed over the course of the SFM framework's development. During the public consultation process (Extension Note 3), timber economics was ranked high in importance (third after biodiversity and water) by stakeholders in both the Arrow TSA and the Lemon Landscape Unit. This process also identified a public interest in non-timber economics and in the diversification of the local economy beyond the traditional timber economy.

Applying Criterion 4 to the Basecase Scenario

A subset of the measures identified for Criterion 4 (Table 1) were applied to the basecase scenario developed for the Lemon Landscape Unit (Extension Note 4). For Indicator 1, the projected harvest flow was used as the measure, and for Indicator 3, projected growing stock of timber and delivered wood costs were used. These measures were chosen because they are common outputs from forest-level computer models. Projected harvest flow is the amount of timber available for harvest based on a forest's physical characteristics (e.g., size, structure, productivity) and the proposed objectives and practices for its management. Growing stock is defined as the inventory of timber on the timber harvesting land base; this is determined by summing the volume of every stand, regardless of age. Delivered wood costs include road construction, road maintenance, tree-to-truck harvest costs, and hauling costs.

The Lemon Landscape Unit is a smaller planning unit within the Arrow TSA covering approximately 42 000 ha; 14 000 ha are in the timber harvesting land base. A basecase scenario for this landscape unit was developed by a team of planners, all of whom had an objective to protect or enhance specific resources (e.g., timber, water, biodiversity, recreation, visual). This scenario included constraints that prevent or limit harvesting in riparian zones, old-growth management areas (OGMAs), under-represented ecosystems, mule deer winter range, hardwood reserves (Extension Note 5), and prime recreation areas. In addition, 20–40% of most stands within the working forest were left as within-block reserves to provide for recreation and visual objectives (Extension Note 8). In visually sensitive areas, shelterwood silviculture systems with 40–60% overstorey retention were prescribed.

The FPS-ATLAS model, which simulates forest-level timber harvesting (Nelson 2003), was used to analyze the basecase scenario for 35 ten-year periods (335 years). The objective of the model was to maximize the harvest volume, while maintaining long-term equilibrium in harvest flows, growing stock, and delivered wood costs. Figure 1 shows the projected harvest flows, growing stock, and delivered wood costs generated for the basecase scenario.

The short-term decline in both harvest and growing stock (Figure 1) indicates a surplus of timber at or above the minimum harvest age at the start of the analysis, which suggests a potential forest health risk from natural disturbances that favour older stands (e.g., bark beetles). A large portion of the working forest was between 101–140 years old (Figure 2). By year 150, age-classes in the working forest were diversified (mostly between 0 and the minimum harvest age), resulting in less risk from natural disturbance. Delivered wood costs were highest in the first 5–10 years when extensive road construction was required to access the shelterwood harvests. Thereafter, delivered wood costs stabilized in the \$35–\$45/m^3 range. When more volume was harvested from the shelterwood systems, the costs tended to increase towards \$45/m^3. Consistent with Criterion 4, all three indicators stabilize over the long term. An important benefit of harvest simulation models is that they enable a quick examination of different management assumptions, which may lead to higher harvest flows and (or) lower delivered wood costs. Examples include concentrating intensive operations in relatively easy terrain, reducing road development, and avoiding expensive silviculture systems such as the shelterwoods used in the visually sensitive areas. Simulation models also allow us to explore management options that decrease risk, such as minimizing roads to incur fewer environmental liabilities and creating diverse age-classes to lessen susceptibility to natural disturbances.

Sensitivity Analysis of Projected Harvest Flow

Forest-level timber harvesting models can be used to explore the sensitivity of forecasted harvest flow to changes in constraints on the timber harvesting land base and the management practices required to protect

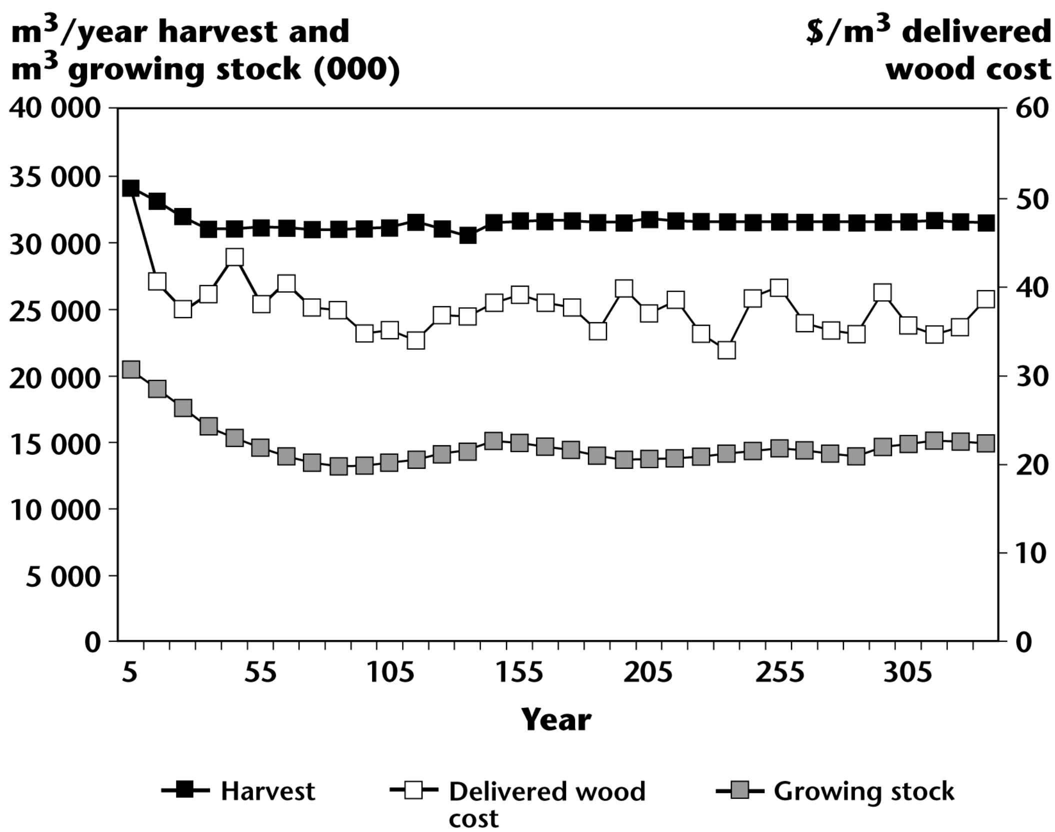

FIGURE 1. Forecasts for harvest, growing stock, and delivered wood costs in the basecase scenario.

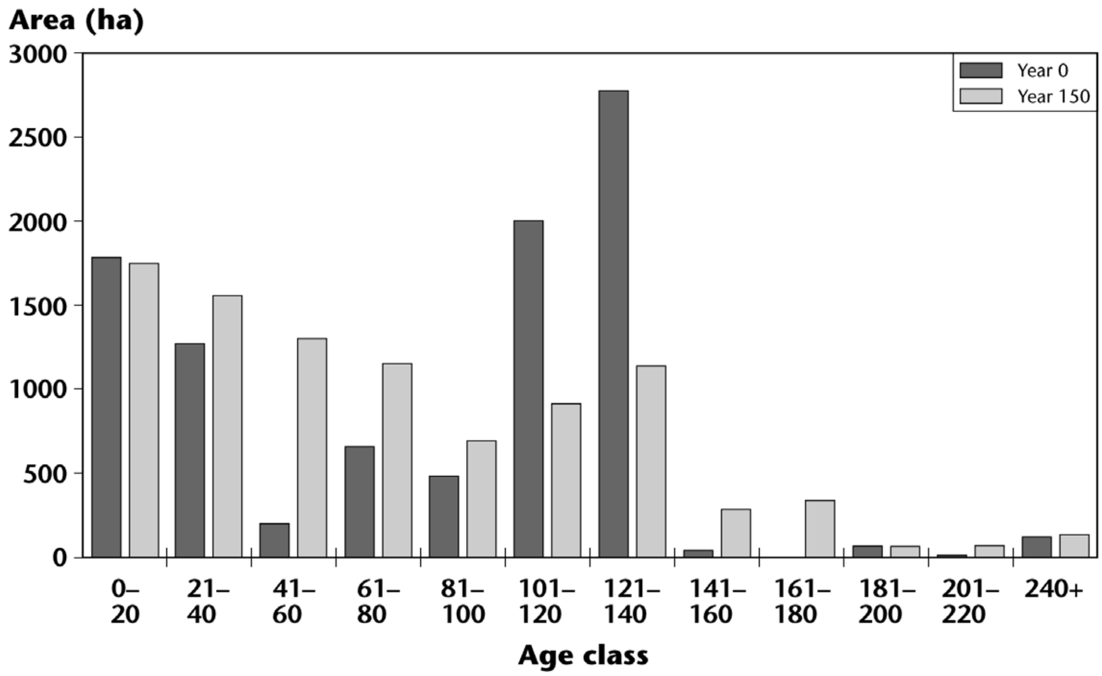

FIGURE 2. Age-classes in the working forest at time 0 and projected to year 150 in the basecase scenario.

or enhance non-timber values. In Extension Note 4, a sensitivity analysis was conducted to test the effects of individual constraints on projected harvest flows. In the analysis of Criterion 4, the cumulative impact of these constraints on the basecase scenario were quantified by sequentially removing constraints and reporting changes in the projected harvest flow. Beginning with the basecase, 10 additional scenarios were created, each with one less constraint than its predecessor (Table 2). In all scenarios, the ATLAS model was used to maximize

TABLE 2. Description of scenarios used in the sensitivity analysis

Scenario No.	Name	Description
1	Base Case	Includes constraints that prevent or control harvesting in riparian zones, old-growth management areas (OGMAs), under-represented ecosystems, mule deer winter range, hardwood reserves, visual areas, and recreation areas
2	Enterprise Deer	Removes mule deer winter range rules in the Enterprise watershed
3	Springer Deer	Removes mule deer winter range rules in the Springer watershed
4	Enterprise Hardwoods	Allows harvest in hardwood stands in the Enterprise watershed
5	Springer Hardwoods	Allows harvest in hardwood stands in the Springer watershed
6	Recreation 20%	Removes 20% retention rule in moderately sensitive recreation areas
7	Recreation 40%	Removes 40% retention rule in highly sensitive recreation areas
8	Visual 20%	Removes 20% retention rule in moderately visually sensitive areas
9	Lemon Hardwoods	Allows harvest in hardwood stands in the Lemon watershed
10	Lemon Deer	Removes mule deer winter range rules in the Lemon watershed
11	OGMA	Allows harvest in old-growth management areas, including old-growth recruitment areas

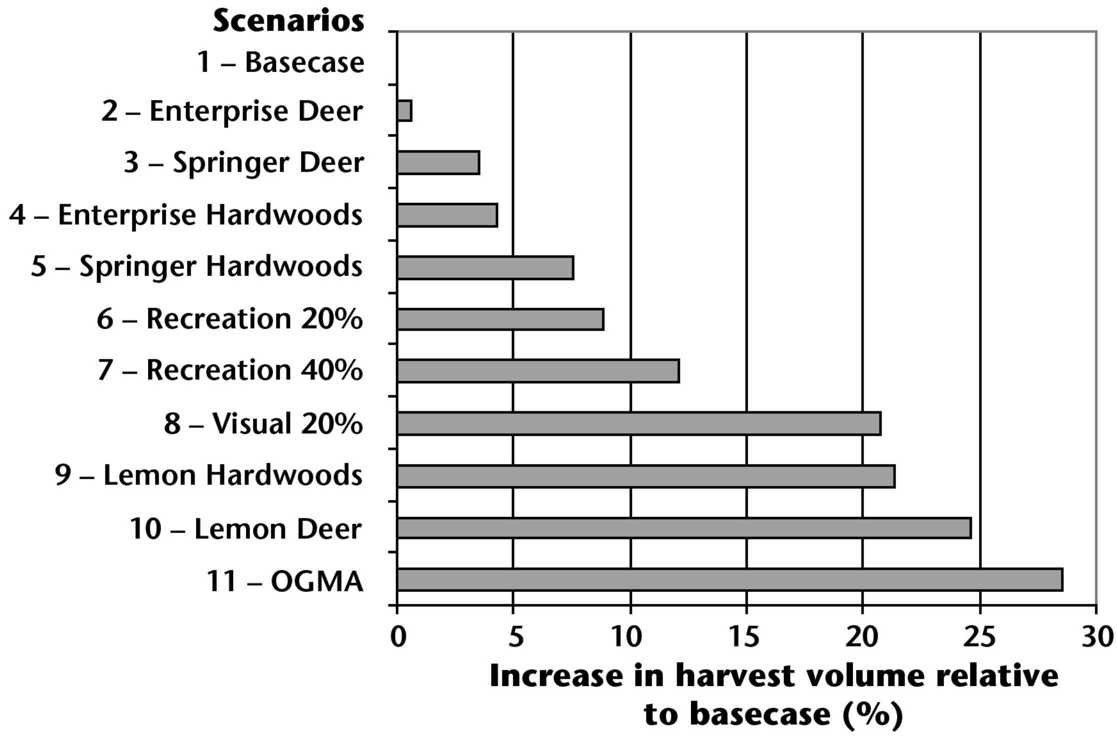

FIGURE 3. Sensitivity analysis showing the percent increase in the average annual harvest volume as constraints are sequentially removed from the basecase. Percent increases are cumulative (e.g., Scenario 11: OGMA includes all modifications made in Scenarios 2–11).

harvest volumes, but maintain long-term equilibrium in harvest flow, growing stock, and delivered wood costs, with projections made for 335 years. Removing constraints led to increases in the projected harvest level relative to the Scenario 1 basecase (Figure 3).

Figure 3 shows that substantial gains in the harvest are possible as constraints are collectively dropped; however, as each constraint is dropped the environmental and (or) social risks associated with the scenario increase. Other scenarios are possible, depending on which constraints are dropped and on the order in which they are dropped. The information in Figure 3, when combined with data on environmental and social risks, can be used in the planning process to identify scenarios with an acceptable balance between economic, social, and environmental objectives. For example, dropping the visual constraint (Scenario 8: Visual 20%) results in a large incremental gain in harvest, poses no environmental threat, but would likely carry a significant social risk.

Conclusions and Future Directions

For the basecase scenario, the FPS-ATLAS model projected a long-term harvest of 30 000 m^3/year and a corresponding growing stock of 15 000 000 m^3. Under the basecase scenario, the model also projected a more diversified age-class structure in the future timber harvesting land base than the current age-class structure. Delivered wood costs were highest in the first 5–10 years when extensive road construction was required to access the shelterwood harvests, after which they stabilized in the \$35–\$45/m^3 range. A series of FPS-ATLAS scenarios examining the cumulative impact of timber harvesting land base and management constraints on the annual harvest level showed that the harvest could potentially increase by upwards of 30% in the absence of these constraints.

The three indicators for timber economic benefits used in the SFM basecase (i.e., harvest flow, growing stock, and delivered wood cost) are widely used

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measures for assessing sustainable timber economics. Models such as FPS-ATLAS routinely simulate these indicators, and are important tools in forecasting how these indicators behave over time according to management objectives. These models are also used to conduct sensitivity analyses that show how various constraints and assumptions affect the indicators. This information, when combined with environmental and social C&I, can be used to identify scenarios that achieve an acceptable balance within the SFM context.

Future work should aim to expand the set of economic indicators used in this extension note. This would include the collection of data on log revenues, corporate profitability and investment levels, labour income, and government rents. To provide a more complete analysis of timber economic benefits, data on economic multipliers (e.g., employment, personal, and corporate taxes) should also be collected and applied to harvest forecasts. Most importantly, economic indicators should not be considered in isolation. When evaluating management scenarios, other C&I representing social and environmental objectives must be considered simultaneously. Future work should consider the inclusion of all C&I in scenario analyses so that we make management choices that lead to healthy, low-risk forests capable of providing a sustainable stream of benefits.

References

Nelson, J.D. 2003. Forest planning studio: ATLAS program reference manual version 6. URL: *http://www.forestry.ubc.ca/atlas-simfor/extension/docs.html#FPS_2003*

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Test Your Knowledge . . .

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How well can you recall some of the main messages in the preceding extension note? Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. Which three factors contribute to economic risks in forests?
   - A) High operating costs, high fuel loads, monocultures
   - B) High fuel loads, drought, cultivation of illegal drugs
   - C) Flooding, logging protest, earthquake
   - D) All of the above

2. Match each of the following measures with the corresponding indicator (A = Value; B = Distribution of value; C = Resilience) as defined in the C&I section.

   Growing stock ____
   Log value ____
   Taxes ____
   Delivered wood cost ____
   Harvest flow ____

3. Harvest simulation models have many benefits. For instance, these models can (more than one choice is possible):
   - A) Forecast economic indicators
   - B) Explore impacts of management assumptions on economic indicators
   - C) Generate the absolute, correct harvest plan
   - D) Determine the market share of local wood product producers
   - E) Generate Pareto optima

ANSWERS

1. A, but in the broadest sense D is acceptable.

2. C, A, B, C, A 3. A, B