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First Nations' Strategies For Sustainable Forest Management

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Abstract

Many First Nations' communities in Canada suffer from a lack of economic opportunities. If First Nations are to meet the current needs of their communities, they must develop strategies for sustainable development that build upon their human capital and available natural capital. In this study, we explore whether the projected socio-economic needs of the Little Red River/Tall Cree First Nations (LRRTCN) can be met using the natural resources to which they have access. To answer this question, we employ a dynamic optimization model to assess the capacity of the available forest resources to provide for the anticipated future needs of the LRRTCN. Results for alternative management strategies indicate that decision-makers face significant tradeoffs in deciding an appropriate management strategy for the forestlands they control.

Keywords: boreal forest, First Nations, forest management, sustainability

Introduction

The Little Red River/Tall Cree First Nations (LRRTCN) are two, closely related peoples who have historically occupied portions of the lower Peace River watershed in northwestern Alberta, and used these lands to support their culture and livelihood. These First Nations look toward the forest to provide future benefits for their communities, including long-term employment opportunities for growing populations, paths toward sustainable economies, and a land base that enables them to pursue traditional and cultural activities. Forest resources are crucial elements in the community development strategies to achieve economic self-sufficiency. Like other First Nations, LRRTCN use a variety of strategies to pursue their forest management goals and objectives (Treseder and Krogman 1999). They have recently adopted a co-management alternative for their forest lands and resources.

In 1995, the two First Nations signed a Cooperative Management Agreement (CMA) with the Alberta Provincial Government, and with Tolko Industries Ltd. (a private forest company) to develop and implement ecological management practices within a 35,000-km^2 Special Management Area (SMA) situated within the lower Peace River watershed (Webb 1996). This management area is characterized by: (1) a 10,000-km^2 boreal sub-artic plateau, within which the two First Nations and the Province have created a 6,000-km^2 protected area, situated adjacent to the northwest quadrant of Wood Buffalo National Park; and (2) a 25,000-km^2 boreal forest landscape, bordering Wood Buffalo National Park on the west and south. The protected area will contribute to the maintenance of the First Nations' way of life, while the other area is meant to ensure sustainable economic development. Within this 25,000-km^2 boreal forest landscape, the two First Nations hold forest tenures over eight Provincial forest management units (FMU). Five of them (F2, F3, F4, F5 and A9) are located to the south of the Lower Peace River, while F6, F7 and F10 are situated to the north of the Lower Peace River (Figure 1).

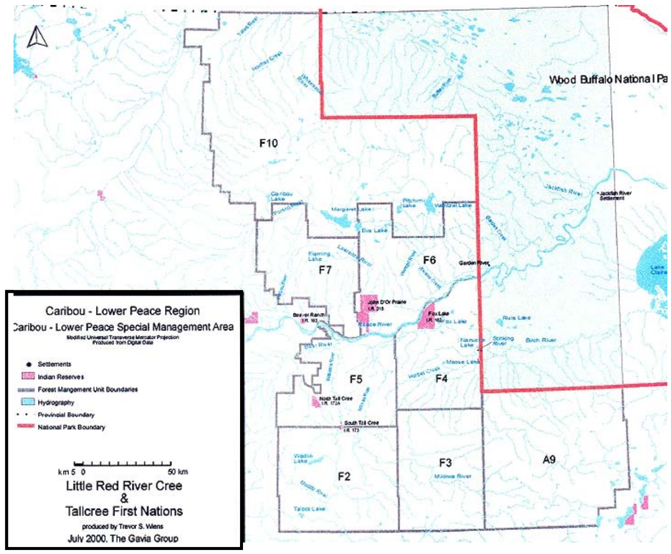


Figure 1. Caribou-Lower Peace Special Management Area

The First Nations hold tenure through four separate holding companies: Little Red River Forestry Ltd., Little Red River Askee Ltd., Tipemso (Tallcree), and Netaskinan (Tallcree). The 1995 cooperative management agreement established a commitment between the First Nations and Tolko Industries Ltd. for the joint planning and management of forestry operations within six FMUs (F2, F3, F4, F5, F6 and F7). The agreement includes a long-term commitment to supply coniferous timber from FMUs F2, F5 and F7 to the Tolko lumber mill in High Level, and an agreement for the partners to collaborate on the development of forestry management plans. In addition to the agreements with Tolko Industries Ltd., there is a recent volume agreement between LRRTCN and Footner Forest Products Ltd. to supply deciduous fiber to a new oriented strand board (OSB) mill, a joint venture between Ainsworth and Grant Forest Products. The Tolko mill consumes about 1 million cubic meters of softwood timber annually, while the OSB plant produces 1 billion square feet annually from 1.2 million cubic meters of aspen (Kryzanowksi 2001).

The First Nations' volume supply agreements include a clause that allows the diversion of up to 30% of the supply to support a First Nations' mill venture should the opportunity arise. In their plans for sustainable economic development, First Nations' communities have a particular interest in the management of FMUs F3, F4, F6 and A9 (which are not included in the commitment to Tolko). These units make up almost half of the entire area and have not yet been committed for the long term. The Little Red River Nation holds tenure in FMUs F3, F4 and F6, while the Tall Cree Nation holds tenure in A9. Our analysis focuses on F3, F4 and F6 management units (now amalgamated into FMU F23) for which comprehensive timber resource information is available (Figure 2). The LRRTCN have an equally important interest in the non-timber values of forests in the region, but this interest is beyond the scope of the current study.

Study Objectives

The forest resources available to the communities provide potential sources of economic activity within the context of other larger objectives. The Little Red/Tall Cree First Nations have identified what they would like to see in terms of the utilization of forest resources in their traditional area, which requires a balancing of social, environmental and economic needs. The specific objectives include: generating paths for economic self-sufficiency, providing employment opportunities, and protecting environmental amenities and non-timber values. The challenge is to develop a forest management plan that achieves economic, environmental and social sustainability given the available forest resources currently under LRRTCN control.

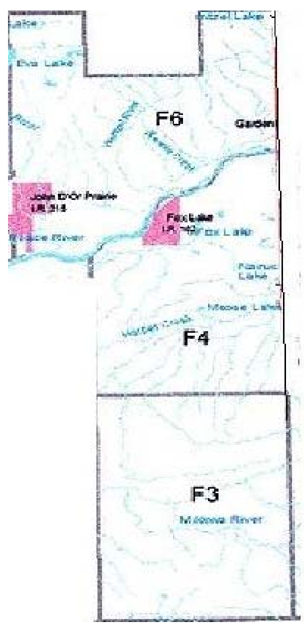


Figure 2. The study area F23 that combines the former F3, F4 and F6 forest management units

The overall goal of this study is to examine the potential for sustainable forest management on the above forest tenures. We investigate possible management strategies that could be used to establish recommendations for resource-use strategies that are compatible with the livelihood and traditional-use interests of the First Nations' people. The specific research objectives are to:

(a) Develop models to assess the capacity of the forestland base to provide for the needs of the LRRTCN under various land uses and alternative management practices;
(b) Develop a process to help other First Nations elaborate and evaluate sustainable forest management strategies; and
(c) Recommend resource use strategies that are compatible with sustainable development and traditional use of the area by LRRTCN.

Inventory

Timberline Forest Inventory Consultants Ltd. determined the net land base currently available for timber harvesting within the F23 management unit. Determination of the net harvesting land base is founded on the current Alberta Timber Harvest Planning and Operating Ground Rules and applicable land-base exclusions (Timberline 2001a). The forest inventory was determined from the approved Alberta Vegetation Inventory (AVI version 2.1).

To incorporate First Nations' requirements for forest management that is compatible with traditional land use and values, particular types of forestland are excluded from the harvest land base. The land-base exclusions consist of three major types: forest where timber harvest is prohibited, inoperable or isolated stands, and exclusions based on operating ground rules. By excluding such forest, we ensure that forest areas incompatible with commercial timber management are removed from the timber harvesting land base. Further, harvesting is prohibited on the following areas: First Nation reserves, protected areas, cultural areas, and special places and natural areas. The LRRTCN also acknowledge the need to integrate wildlife values related to woodland caribou, wood bison and trumpeter swan into the forest management planning process. As a part of defining the harvesting land base, the wildlife habitat areas have been excluded.

The timber harvesting land base covers 384,603 ha or 39% of the F23 area, divided into 15 classes (Timberline 2001a). Yield data for the 15 classes are used as model inputs (Timberline 2001b). The age class distribution of the starting inventory is shown in Figure 3. This represents the land base available for timber harvesting in 2000. A feature of the starting inventory is the large area of both coniferous and deciduous forest in the 60- to 90-year age classes (63.4% of the harvesting land base). This spike in the age class distribution is characteristic of previous disturbance regimes. About 11% of the merchantable land base is in the early regeneration stage (the 10-year age class), with this high proportion attributable to the 1998 Mikkwa fire. Compared to the proportion of coniferous stands in the early regeneration stage (14.3%), a lower proportion of deciduous stands (6.7%) is in the early regeneration stage; this suggests that deciduous stands are less susceptible to fire. On the other hand, the lower proportions of deciduous stands in the higher age classes likely reflects the fact that deciduous trees reach maturity and decay sooner than coniferous species, which also contributes to lower fire incidence.

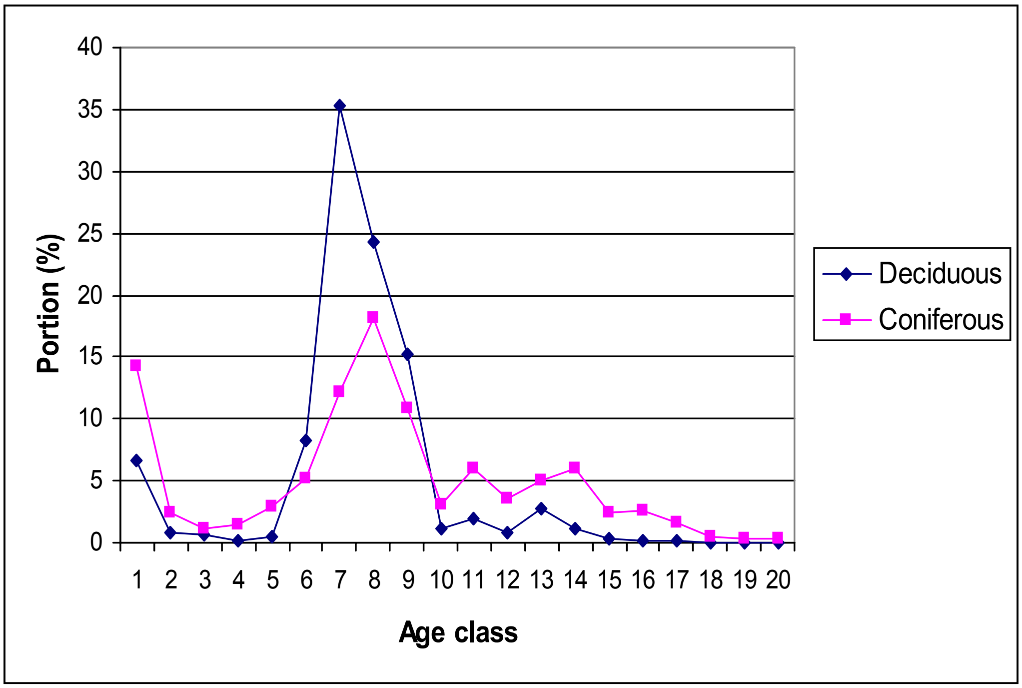


Figure 3. Age distribution (10-year intervals) of the initial inventory as a percent (%) of the harvest land base, by forest type

Current Management Regime

Alberta Environment has proposed a management strategy for the Caribou-Lower Peace SMA that divides the region into three zones:

1. Area protected from development and commercial timber operations.
2. Area allocated to <u>extensive</u> forest management that will allow multiple uses, implying commercial forestry activities at a sustainable level along with non-timber uses of the forest.

3. Area dedicated to intensive forest management. This does not mean that other activities will be excluded, but only that these are of secondary importance compared with the production of commercial timber.

About 6,000 km^2 have already been allocated to protection. First Nations within the region have advocated for extensive forest management to maintain ecosystem integrity, allow for traditional uses of forestland, and permit some mix of industrial and recreational activities within the limits of sustainability. The LRRTCN have also stated that agricultural activities (cultivation and grazing) and intensive forest management are inappropriate in this region (Webb 2000). The only aspect of intensive forest management that First Nations appear willing to accept is forest plantations on marginal agricultural land outside of the study area.

Methodology

Data derived from the harvesting land base determination are used as inputs in the current modeling exercise. The focus here is on the use of timber resources to support industrial operations as a basis for economic sustainability of local communities. In order to achieve this objective, we developed models for long-term strategic forest planning and analyses. A multi-period, linear programming model has been developed and is used to determine harvest schedules that maximize cumulative harvest volume and discounted stumpage revenue over the 200-year period 2000 to 2200. The 200-year planning horizon is divided into twenty 10-year periods. Since we employ a dynamic optimization model, it takes into account the effect of today's (or any period's) management decisions on the future state of the forest and future management options.

Current timber supply analyses and, consequently, timber rights in terms of annual allowable cut (AAC) for First Nations and forest companies are usually based on sustained-yield management. Important changes occur in forestry as sustained-yield management is replaced by sustainable forest management.

We investigate scenarios that differ by the objective function and by constraints. The mathematical optimization model is used to calculate the flow of timber harvest over time and cumulative discounted stumpage revenue as a means to estimate the revenues and employment opportunities open to the First Nations and the ability to meet their needs.

Using the model, two alternative objectives are considered: maximizing the cumulative harvest volume over the planning horizon, or the cumulative discounted stumpage revenue from timber harvests over the planning horizon. Maximization of cumulative volume addresses concerns related to adequate timber supply for the mills and, thereby, provision of employment opportunities in timber harvest operations. The stumpage revenue objective addresses the revenue concerns of First Nations, with higher revenues a potential driver of future development and economic diversification.

To develop the stumpage revenue objective function, we used historical data to estimate potential future prices of softwood lumber and OSB, the two principal products currently manufactured from timber harvested under license. We used annual SPF 2x4 lumber and OSB prices for Western Canada (in Canadian dollars) as reported by Random Lengths (Random Lengths 2003), and deflated them using the CPI. These prices are the same as those used by the Alberta Government in their stumpage calculations (Alberta Government 2003b). We used time series analysis to investigate the time trend of softwood lumber and OSB prices; for both sets of prices, we could not reject the hypothesis that prices were stationary, exhibiting no trend. Thus, we employed a constant price for both lumber and OSB in determining stumpage rates. The lumber and OSB prices were converted back into nominal prices to estimate the current stumpage following Alberta guidelines (Alberta Government 2003a), and then deflated back to real terms. This methodology resulted in estimated stumpage rates of $8.52 per cubic meter for coniferous wood for lumber production and $0.50 per cubic meter for deciduous OSB. A 5% rate of discount was used to calculate the present value of stumpage revenue.

Constraints were imposed on both the harvest volume flow and the ending inventory to reflect different sustainability goals of interest to First Nations. Two constraint scenarios were considered:

- *Sustained yield*: First, we consider a traditional sustained-yield forest management that requires non-declining flow of both coniferous and deciduous harvests over the planning horizon. While this approach addresses stable supply of timber to the mills over the planning horizon, it does not take into account other values of forest and benefit for future generations. This may be considered *weak* sustainability.
- *Sustainable management*: Second, an ending inventory condition is imposed to ensure that forest resources are not depleted by the end of the planning horizon. In addition, to

guarantee a stable supply of timber, we constrained the variability in both deciduous and coniferous harvest between subsequent periods to be no more than 10% over the planning horizon. These constraints define conditions of *strong* sustainability.

Four scenarios are thus generated by combining each objective with each of the constraint sets – in two scenarios stumpage revenue is maximized and in the other two the cumulative volume of timber harvest is maximized. The scenario outcomes are expressed in terms of annual volumes of coniferous and deciduous timber, and can be further linked to economic outputs, such as employment and revenue, using existing stumpage data (described above).

Scenario Analysis

Model outcomes in terms of total volume, average annual harvest, and discounted total stumpage revenue under different management scenarios are provided in Table 1. Table 2 contains the model outcomes in terms of the ending inventory age structure for the four scenarios.

Table 1. Cumulative and Average Annual Harvest Volumes, and Discounted Total Stumpage Revenue

	Total Harvest (mil. m^3)		**Average Annual Harvest (m^3/year)**		**Discounted Stumpage Revenue ($ mil)**		**Total Discounted Revenue ($ mil)**
Scenario	Coniferous	Deciduous	Coniferous	Deciduous	Coniferous	Deciduous	Coniferous + Deciduous
Volume Maximization							
1. Sustained yield	72.875	87.204	364,373	436,019	71.820	4.699	76.519
2. Sustainable management	54.675	66.129	273,374	330,645	106.285	6.332	112.617
Revenue Maximization							
3. Sustained yield	72.113	75.263	360,565	376,317	79.591	4.709	84.300
4. Sustainable management	53.239	62.001	266,197	310,007	115.438	7.431	122.868

Table 2. Age Distribution of the Ending Inventory

	Portion of coniferous area (%)			Portion of deciduous area (%)		
Scenario	Young	Middle-aged	Mature	Young	Middle-aged	Mature
Volume Maximization						
1. Sustained yield	90	10	0	79	9	12
2. Sustainable management	15	47	38	10	56	34
Revenue Maximization						
3. Sustained yield	86	13	1	72	17	11
4. Sustainable management	15	50	35	10	43	47

Several results can be highlighted. Naturally, the total volume delivered over time is greatest for volume maximization under the sustained-yield strategy (Scenario 1), exceeding the volume generated under revenue maximizing sustained-yield (Scenario 3) by approximately 12.6 million cubic meters (Table 1). On the other hand, the age distribution of the ending inventory is highly skewed toward early succession stands under the sustained-yield strategies. It accounts for 90 and 79 percent of the coniferous and deciduous land base, respectively, under the volume maximization (Table 2, Scenario 1) and slightly lower under the revenue maximization – 86 and 72 percent of the coniferous and deciduous land base, respectively (Table 2, Scenario 3). The outcome in terms of the age distribution under the sustained yield strategy is unacceptable both ecologically and economically, as it does not protect future forest diversity or sustainable wood production.

The final (end-period) inventory age structure is limited to 15 and 10 percent of the total coniferous and deciduous land base, respectively, in early succession stage. This constraint is similar to the age distribution of the initial inventory. It is impossible to meet these ending period inventory constraints and non-declining flow simultaneously. Rather than a strict non-declining harvest flow requirement, we impose more flexible stable flow conditions by allowing 10% variation of softwood and hardwood harvest between periods. Such a relaxation in the harvest flow constraints allows the model to meet the ending inventory conditions.

Timber flow constraints reduce revenue; the tighter the constraint, the lower the discounted stumpage revenue. Overall stumpage revenue is maximized at $122.9 million with Scenario 4 – revenue maximization and sustainable management – followed at $112.6 million by Scenario 2 – volume maximization and sustainable management. The lowest revenue outcomes are achieved under the sustained-yield management strategy, ranging from $76.5 to $84.3

million for the volume and revenue maximizing scenarios, respectively. These comparisons clearly show that significant financial benefits may be achieved by relaxing the sustained-yield constraint and allowing some variation in between-period harvests. The difference in discounted revenues between the highest and lowest net revenue scenarios is $46.3 million (Table 1).

The modeling outcome that maximizes the stumpage revenue reflects a strategy to achieve economic objectives, while the outcome that maximizes total volume is aimed at creating the basis for employment opportunities in harvest operations and potentially the wood processing industries.

To link timber outputs to economic quantities, we reviewed the literature on employment and wood processing (Delcourt and Wilson 1998) plus existing research on management strategies and the issues involved in industrial and community relationships (Beckley and Reimer 1999). Using employment per m^3 of wood for the logging and processing industries (which covers all solid wood product manufacturers), and multiplying by the average annual harvest volume for each scenario, it is possible to derive employment levels associated with the various scenarios. These are provided in Table 3. Employment opportunities in the wood product industries are more than double those in logging, reflecting the higher multipliers associated with wood products' manufacturing. It should be emphasized that actual employment opportunities may differ depending upon the type of wood product establishment; the numbers in Table 3 are based on an industry-wide average that is weighted towards sawmilling.

Table 3. Employment Opportunities in Logging Operations and Wood Industries

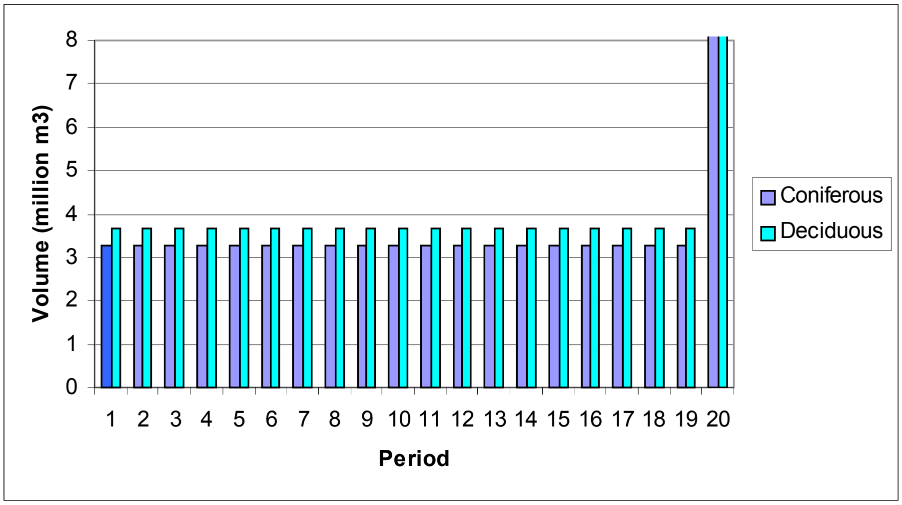
	Total Average Annual Harvest (m^3/year)	**Average Annual Employment (employees/year)**[a]	
Scenario	Coniferous + Deciduous	Logging	Wood Industry
Volume Maximization			
1. Sustained yield	800,392	192	432
2. Sustainable management	604,019	145	326
Revenue Maximization			
3. Sustained yield	736,882	177	398
4. Sustainable management	576,204	138	311

[a] These figures are calculated on the basis of the employment data in the BC forest industry (BC Ministry of Forest 2000).

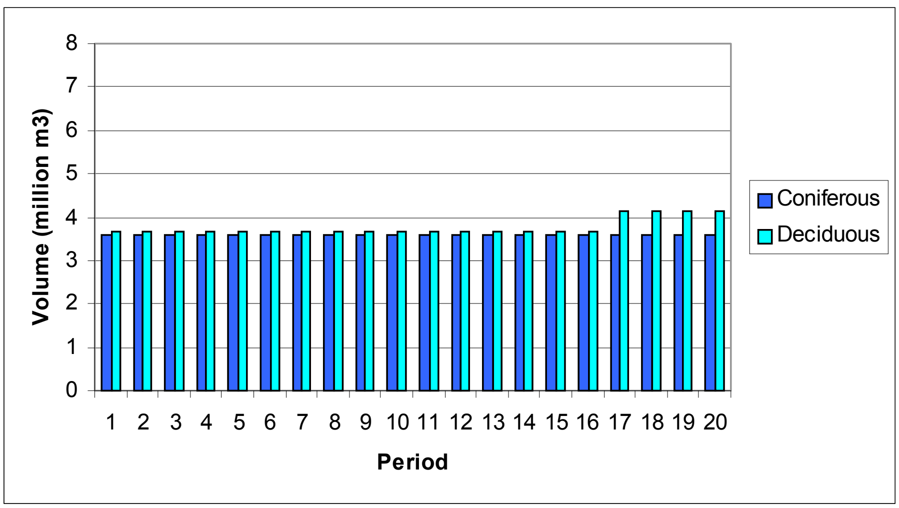
Model projections of decadal timber flows for coniferous and deciduous varieties are found in Figures 4 and 5 for the sustained-yield and sustainable-management strategies, respectively. In each of the figures, the results from *volume* maximization are compared with those of *revenue* maximization, with both subject to the same constraints reflecting different sustainable development strategies. Note the spike in harvests in the final period in Figure 4(a) because there is no real constraint on ending inventory in the sustained-yield scenarios.

The figures illustrate the time paths of timber harvests under the various management approaches, indicating that there are greater differences among scenarios than are apparent from the aggregate data. Maximum and minimum timber volumes differ substantially over periods, which is an important concern for LRRTCN given their contractual commitments under their current tenure arrangements. In both of these scenarios, large timber harvests are generated in the final period.

The results indicate that decision-makers must make tradeoffs among four different aspects: (1) total timber volume to make available to mills in the long term (jobs generated); (2) total discounted revenues generated over the planning periods (wealth generated); (3) the time path associated with different management regimes (community stability); and (4) forest age structure (ecological concerns). Permitting 10% variation between period harvests maximizes revenue (Scenarios 2 and 4), regardless of which objective function is actually employed. However, when this variation in the period harvests is coupled with the ending inventory constraints, average annual volumes start out high but drop steadily to well below half of the initial levels by the midpoint of the planning period. Several techniques are available for helping decision makers address these dilemmas. We discuss some of these approaches in the next section investigating future research directions.

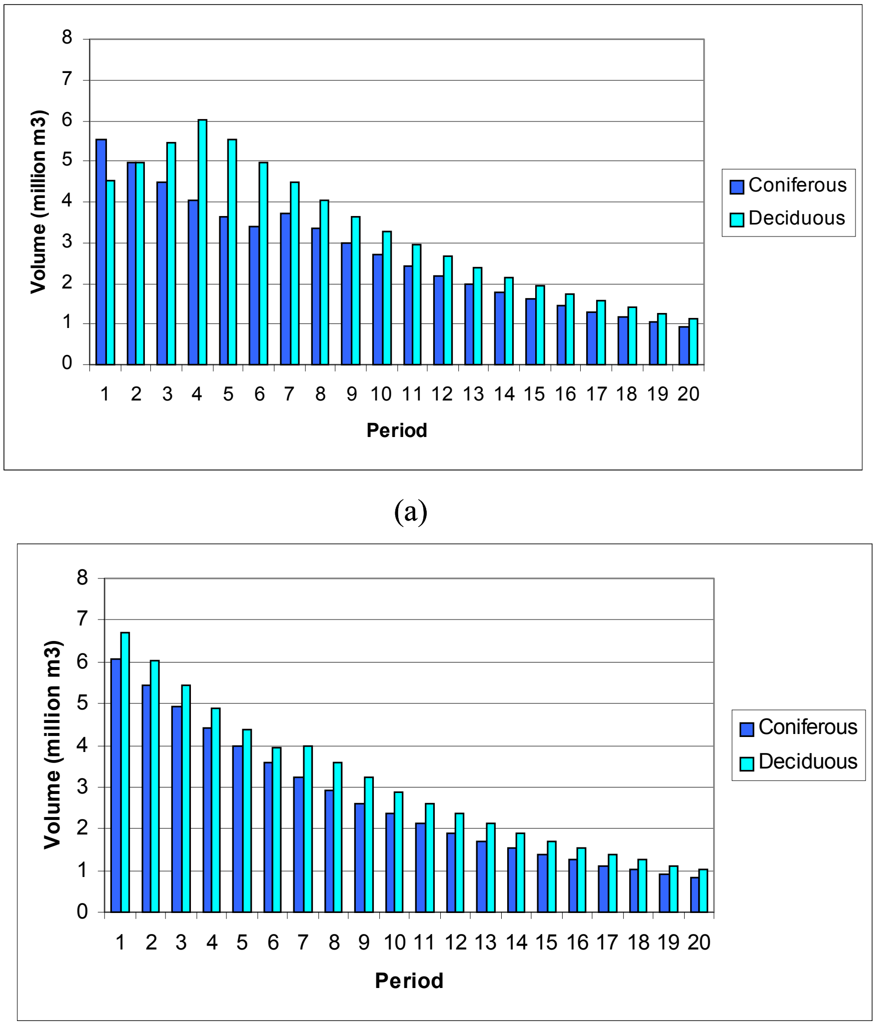


(a)



(b)

Figure 4. Harvest volumes by decade for the (a) volume maximization and (b) discounted stumpage revenue maximization scenarios, under the sustained-yield management strategy.



(a)

(b)

Figure 5. Harvest volumes by decade for the (a) volume maximization and (b) discounted stumpage revenue maximization scenarios, under the sustainable forest management strategy.

Further Research Directions

The research results to date call for further investigation of some of the issues. Research is required to aid decision-makers in making tradeoffs among the revenue, community stability and employment objectives, and ecological values, at least to the extent that discounted stumpage values, timing of timber flows and total timber harvested over the planning horizon can be considered representative of these respective objectives. Some techniques that might be worth considering in future research using this framework are the use of multi-objective decision analysis and elicitation of preference information from community leaders/decision-makers.

The current model is non-spatial in nature. Spatial aspects may need to be taken into account more explicitly, although doing so will constrain the results even further, thereby leading to lower revenues, lower timber availability and altered time paths of harvest. It may be worth the effort to identify the extent to which spatial considerations affect the revenue, community stability and employment objectives.

Because of ecological concerns and associated non-timber values, decision-makers may be concerned with preserving additional wildlife habitat within the harvesting land base. Imposition of these constraints could be expected to change the flow of possible harvests over time, and would provide another way in which decision-makers could choose among scenarios to identify what, from their perspective, would be the best mix of outputs from the timber resources available to them. Again, this is an area that requires further research, including articulation of management objectives from leaders/decision-makers.

An important extension of the current research will be to identify opportunities for expanding the resource base for intensive management and tree plantations on marginal agricultural lands outside of the study area. This opens up possibilities for selling carbon credits that could enhance LRRTCN revenues. The current model can be re-structured to take these opportunities into account, enabling decision-makers and community leaders to identify the value of such investments.

Finally, and perhaps most challenging from a modeling perspective, it is important to take into account uncertainty with respect to fire risk (holding mature trees in inventory leads to greater risk of loss due to fire), growth (*viz*., the effect of climate change), and stumpage values that change over time. Fire risk can be analyzed using data from existing SFM Network studies, with the information to be incorporated in the model. However, the effect of stochastic revenue (due to uncertainty about movements in stumpage prices, or, ultimately wood product prices) will be more difficult to model.

One possibility would be to investigate what might happen under alternative scenarios that incorporate changes in product prices and resulting changes in timber values. We also investigated creating a shadow price for timber, using estimates of conversion costs for OSB and softwood lumber to determine the appropriate shadow price for coniferous and deciduous lumber in the region. However, further development along these lines requires obtaining reasonably good estimates of fixed costs for these types of manufacturing facilities and determining how to model scale effects.

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