



**Forestry Research
Partnership with
Tembec Inc. and
the Ontario Ministry
of Natural
Resources**

Business Case for
Enhanced Forest
Productivity Measures
Within the Gordon Cosens
Forest Area using a Risk
Analysis Framework

**DRAFT
Report**

Submitted by

HLB Decision Economics Inc.

January 6, 2005

HLB DECISION ECONOMICS INC.

RISK ANALYSIS • INVESTMENT AND FINANCE
• ECONOMICS AND POLICY

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EXECUTIVE SUMMARY

The overall objective of this study is to conduct a business case analysis for Enhanced Forest Productivity (EFP) measures within the Gordon Cosens Forest (GCF) area. EFP measures are geared to the creation of long-term certainty in harvest levels by:

- Developing a dynamic local forest management strategy with an emphasis on increased timber production in suitably zoned areas;
- Exploring the biological effectiveness and economic efficiency of employing enhanced forest management in selected forests;
- Fully developing the potential productivity of the available forest land-base within the parameters of existing land-use plans and the Forest Practices Code; and,
- Enhancing the non-timber and socio-economic benefits of EFP investments.

Although quantifying the non-timber gains resulting from EFP is challenging and somewhat abstract, there are two potential outcomes resulting from EFP silviculture investment that have an inherent connection with non-timber indirect-use benefits: (i) an increase in the wood supply available in the forest, and (ii) a decrease in the risk in not obtaining an adequate sustainable wood volume by increasing the yield and exercising control over species composition. Assuming current harvest levels do not change, the non-timber effects of these outcomes may manifest themselves as follows:

- Since more timber is being grown from the same land-base, silviculture leads to an increase in the residual growing stock (since harvest levels are fixed); as a result of this larger residual stock, enhanced non-timber benefits may be realized in the form of improved watershed services, soil stabilization, air quality, etc.
- Since more timber is being grown from the same amount of harvested area, there may be a case to withdraw some lands for protection (since harvest levels are fixed). These protected areas may provide additional non-timber values through improved wildlife habitat, watershed protection, biological diversity etc.

Thus silvicultural investment may lead to incremental gains to the non-timber value of the forest. Indeed, recent studies have suggested ways in which silvicultural interventions can be used to create ecological attributes more rapidly than by simply allowing forests to attain these attributes through aging¹.

¹ Kohm, K. & J.F. Franklin (Eds.). 1997. Creating a Forest for the 21st Century: the Science of Ecosystem Management.

The Trade-Off

In agreeing to invest in silviculture, which will likely generate increased social values for the government, industry demands benefits in the form of an increase in the allowable harvest level *in the current period*. However, from the government's perspective, it can be convincingly argued that increasing current harvest levels will reduce non-timber values (recreation use, indirect use, etc.), although increased benefits may be realized through local employment opportunities.

Thus the trade-off is as follows: increasing silviculture may lead to enhanced social values for the government; to entice industry to undertake this investment an increased harvest level may be granted in the short-term to justify initial treatment costs. This increased harvest level, however, negatively affects non-timber values. Thus, this harvest level must be chosen in such a way as not to erode all the social values accruing from the increased silviculture.

Inherent Risks

The government's objective is to achieve the greatest net benefit to society while minimizing the risk of any adverse effects to the environment, wildlife, and sustainable wood supply. As the government objective is not the same as the industry objective, the government's expected net present value (NPV) and return on investment (ROI) are not the same as those calculated for industry. In addition, it can be argued that since the government is interested in long-term benefits while industry is demanding short-term gains, the risk to the government is bound to be higher than that to industry. This increased risk to the government is compounded given the stage of the science in estimating timber conditions such as growth and yield curves, natural and post-treatment succession, response to silviculture, natural disturbances, etc., as well as the state of infancy of non-timber valuation methodology.

Industry argues that their demand for immediate gain is justified since the government sets the forest management regulations, and thus any investment that industry makes now may be thwarted in the future if regulations change. Although the primary concern to industry may currently be short-term costs and available volume (annual allowable cut, AAC), mid- to long-term industry objectives also need to be considered, such as minimizing the dip in timber volume and net benefits which are expected 30 to 60 years into the future, and sustaining the wood supply for future harvest. The answer to mitigating risks lies in responsible harvest and EFP practices in the current period and a feasible EFP partnership with the government.

Finding a Win-Win Solution

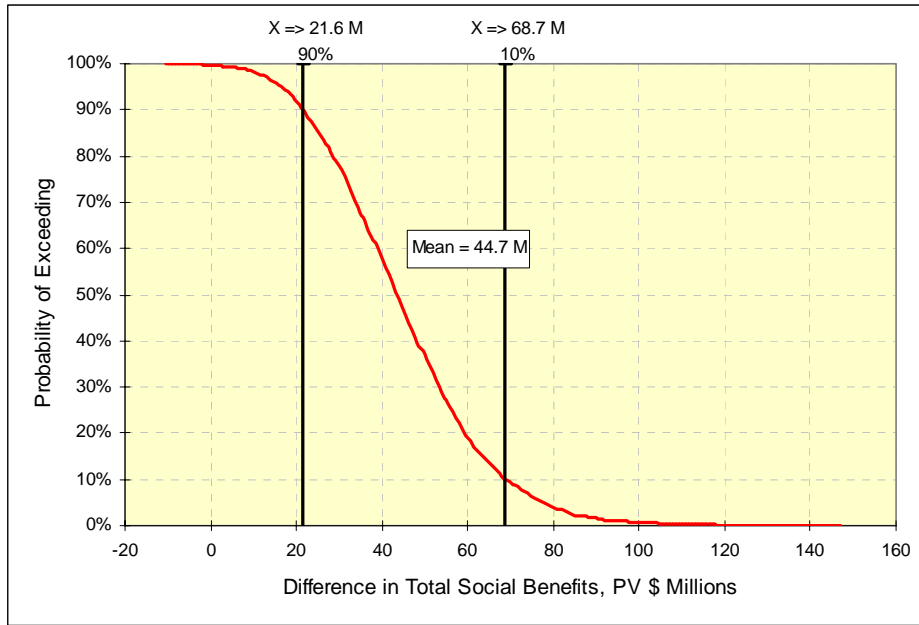
Finding the balance between an increased silviculture investment to generate non-timber social benefits and an increased harvest volume to entice industry is an iterative process. A win-win cost-sharing mechanism between the government and industry rests in finding a compromise in which increased silviculture investment results in *both* a viable increase in AAC in a foreseeable time horizon and a net gain in social values.

Several harvest scenarios were examined for the GCF area to assess the impact of varying harvest levels and silviculture expenditure on timber, non-timber, and socio-economic values. The main findings indicate that:

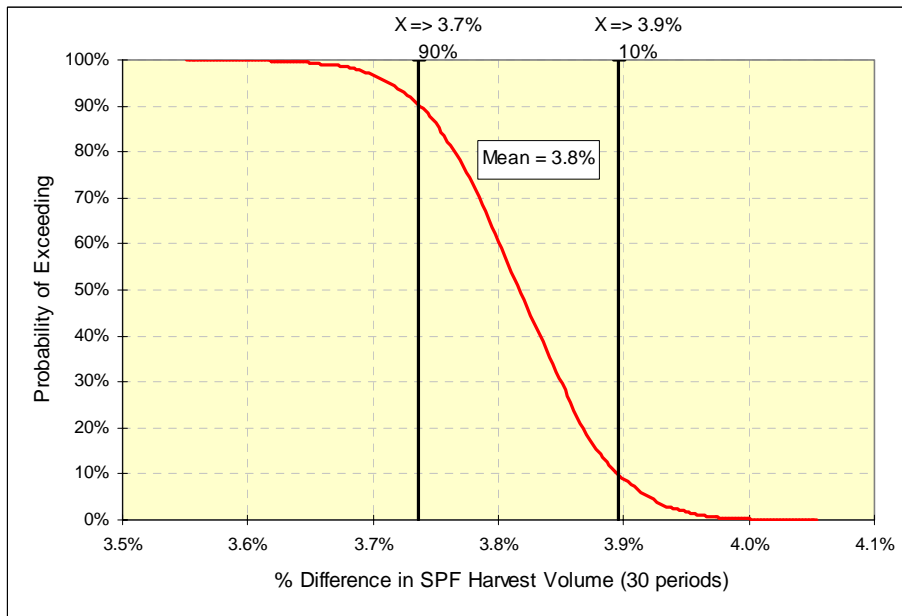
- When the amount of silviculture investment is chosen to satisfy an increased harvest target without consideration for the impact on social or environmental values, then the net change in social values is negative. That is, the loss in non-timber benefits is not offset by the increase in socio-economic benefits; however, there is a gain to industry in terms of increased harvest levels.
- When silviculture investment is increased while harvest level remains fixed, the gain in long-term non-timber benefits greatly out-weighs the incremental silviculture expenditure.
- Since the increased timber production resulting from silviculture investments takes a considerable amount of time to be realized, immediate increases in harvest level by even a modest amount quickly erodes any gains in non-timber benefits that would be felt by moderate to large increases in silviculture expenditure. However, as there are socio-economic benefits associated with increased harvest levels, it is possible to meaningfully increase harvest levels and still produce a gain in net social value (non-timber benefits + socio-economic benefits).
- Based on the scenarios chosen for this analysis, it is possible for the public and private sector to engage in a win-win investment partnership if the regional socio-economic gain from increased harvest levels is truly incremental² and not just a regional transfer of economic resources. More specifically, increasing the SPF harvest level by 3.8 percent above the base level of 1.1M cubic meters per annum while increasing silviculture from \$3M per year (the level required to sustain harvest at 1.1 million m³ per annum) to \$4M per year (a 33 percent increase) produces a net gain in social benefits over a 150-year planning period. However, the non-timber benefits under this increased harvest and silviculture level drop relative to the base case. The net social gain and increased harvest level under this arrangement is shown in the summary plots below.

² The Ministry would not consider the employment related to the silviculture investments to be a benefit unless it represented a net increase in jobs for the province. Unless there is regional unemployment for individuals with the skills to fill these jobs, the increase in employment would not be considered a net economic benefit to the province but rather a transfer of resources from one region to another. However, if there is unemployment amongst workers with the skills for these jobs, then the silviculture investment and the associated jobs should be considered as an economic benefit.

Summary Figure 1: Present Value of Net Social Benefits



Summary Figure 2: Overall increase in SPF Harvest Level



1. INTRODUCTION

The overall objective of the HLB study is to conduct a business case analysis for Enhanced Forest Productivity (EFP) measures within the Gordon Cosens Forest (GCF) area. The business case is formulated using the ForestRAP tool, output from the Spatial Planning Systems (SPS) forest-planning tool (PatchWorks), and the risk analysis business case framework that was recently developed as part of the Romeo Malette Enhanced Forest Productivity Pilot Study for the Ministry and Tembec.

The report has five main sections: Section 1 outlines the main objectives for EFP investment from both the government perspective and that of industry and provides a brief description of the ForestRAP model and the research methodology used to conduct the EFP business case for the GCF area; Section 2 provides an overview of the non-timber valuation methodology of the GCF area; Section 3 discusses the socio-economic impact of EFP measures within the GCF; Section 4 presents the scenarios that were considered in the analysis and discusses possible win-win investment relationships between the government and industry; concluding remarks and the identification of additional research areas required to address uncertainty and risk are provided in Section 5.

1.1 Partnership Objectives

The main government objective in developing an EFP forest management strategy is in achieving the greatest net benefit to society while minimizing the risk of any adverse effects to the environment, wildlife, and sustainable wood supply. Not only is the impact of EFP on long-term regional socio-economic activity and sustained wood flow of concern to the government, the effect of EFP investment on ecological attributes is also of primary interest. That is, the effect of EFP measures and harvest activity on recreational activities, wildlife and environmental conditions such as nutrient cycling, water supply, carbon sequestration etc. are also of key importance.

The primary industry objective is controlling costs and maximizing the available harvest volume (annual allowable cut or AAC). Although emphasis is on short-term gain, mid- to long-term industry objectives also need to be considered, such as minimizing the dip in timber volume and net benefits which are expected 30 to 60 years into the future, and sustaining the wood supply for future harvest.

A feasible EFP partnership between industry and the government lies in balancing the objectives of the two parties. Fully developing the potential productivity of the available forest land-base through responsible EFP activity and greater investment in silviculture, without increasing annual harvest levels, can generate increased social benefits for the government through enhanced environmental conditions and positive impacts on wildlife and habitat indices. On the other hand, increasing harvest levels without increasing silviculture expenditure may generate short-term benefits to industry and may improve regional socio-economic conditions, but would do so at the expense of long-term ecological and other social (non-timber) conditions. Thus,

developing a feasible partnership for EFP investment lies in choosing a harvest level that does not erode all the social values accruing from the increased silviculture expenditure.

1.2 ForestRAP

ForestRAP is a decision-support tool for provincial agencies and the forest industry engaged in multi-year planning to determine the economic viability of intensified forest management practices. The four main components of the ForestRAP model include:

- A. The incorporation of the non-timber impact of EFP measures within the GCF area, including the impact on recreational use activities as well as ecosystem use values;
- B. The incorporation of the socio-economic impact of EFP measures within the Gordon Cosens Forest (GCF);
- C. The incorporation of harvest volume and transportation costs based on the scenario results using an independent forest planning tool; and,
- D. The incorporation of forest management risk and uncertainty.

It should be mentioned that the ForestRAP model is dependent on the following information supplied by an independent forest-planning tool³:

- 1 Area harvested by planning period, forest unit, and treatment type (i.e. basic treatment, intensive treatment, elite treatment, extensive treatment, etc.);
- 2 Product values OR volume harvested by: planning period, forest unit, stand origin, age class, and product type (i.e. SPF large, SPF medium, SPF pulp, other);
- 3 Silviculture expenditure by planning period and treatment type;
- 4 Kilometres of new road construction by planning period and road type (i.e. highway, primary, secondary, tertiary, etc.);
- 5 Length of active road by planning period and road type; and,
- 6 Haulage ($m^3 \cdot km$) by planning period and road type.

ForestRAP incorporates forest management risk and uncertainty in unit values associated with product values, transportation costs, the uncertainty in growth and yield curves as well as the uncertainty in non-timber values. Note that all base values used in the model (such as unit timber values, unit transportation costs, etc.) are assumed to be unbiased median values. That is, for example, if the unit value for loading costs in $\$/m^3$ are off by a factor of 2, ForestRAP does not

³ The Spatial Planning Systems forest-planning tool, PatchWorks, was used in this analysis. However, alternative forest-planning tools can be used if they have sufficient reporting capability to address ForestRAP input requirements.

account for this and this bias is not captured in the risk curves. In addition, since the ForestRAP model is dependent on harvest scenarios supplied by an independent forest-planning tool, all assumptions that were used in the development of these scenarios carry over to the ForestRAP analysis.

1.3 Research Methodology

Our analytical approach involves the following five tasks:

1. Pilot test planning;
2. ForestRAP program modifications;
3. Development of a default database and alternative harvest scenarios;
4. Running model simulations; and,
5. Final report documentation including an executive summary of key findings.

These five tasks are presented in detail below.

Task 1: Pilot Test Planning

The project commenced with a kick-off conference call with key individuals involved in the study, including Tembec and Ministry representatives as well as the Spatial Planning Systems (SPS) team. At this meeting, HLB presented the preliminary work plan, work schedule, proposed methodology, and data requirements. Following the meeting, a detailed final work plan and work schedule was developed outlining individual task components, as well as the timing and dates of deliverables.

Task 2: ForestRAP Program Modifications

Task 2 involved a review of recent changes to the SPS PatchWorks model that provides HLB with median cost estimates and timber outcomes under the scenarios specified in Task 3. Task 2 also involved making the necessary modifications to non-timber unit values and recreational demand projections to ensure they are representative of the GCF area. Model development of regional socio-economic benefits of EFP measures was also conducted. More specifically, Task 2 involved:

- Review updates made to PatchWorks model;
- Update non-timber values relevant to Gordon Cosens Forest;
- Identify additional community/social EFP benefits; and,
- Develop social benefit measures.

Task 3: Develop Default Database and Options

Task 3 involved three main activities: (i) the development of a dataset representing the base case forest management plan within the Gordon Cosens Forest; (ii) populating the forest management risk analysis model with results from the PatchWorks forest-planning tool; and (iii) the examination of alternative EFP scenarios.

The risk-analysis framework provides a vehicle for quantifying and understanding the risk-reward relationships under various forest management regimes. Three forest management alternatives are proposed:

- 1) **Base Case:** The base case usually represents current or best planned forest prescriptions in the areas selected under current budget allocations. The base case will establish SPF harvest levels, silviculture investment costs and the treatment of Ontario Living Legacy areas under current practices, as modeled by PatchWorks.
- 2) **Regime 1 Options:** Regime 1 options are specified by varying SPF harvest levels while holding silviculture expenditure fixed. This allows us to evaluate the effect of increased harvest levels on regional socio-economic conditions, recreational activity and other non-timber benefits (such as wildlife and non-use environmental outcomes).
- 3) **Regime 2 Options:** Regime 2 options are specified by varying EFP investment levels while holding harvest levels fixed. Silviculture is set at and above the amount required to sustain harvest volume over the 30-period planning horizon. This allows us to evaluate the effect of silviculture investment on long-term social benefits.

These three scenarios are such that, taken together, they can be used to ascertain whether a mutually beneficial EFP partnership is viable, and if so identify the harvest level and silviculture mix that is likely to result in gains to both the government and to industry.

For all scenarios, it was assumed that parameters as specified in the SPS model met the requirements and regulations specified in the existing Forest Management Plan (FMP). Once the base case and alternative regimes were analyzed, modifications to the input specifications were made in order to help identify possible win-win partnering scenarios.

Task 4: Conduct Risk Analysis Scenario Simulations

In planning for enhanced forest productivity there must be careful consideration of how to maintain the quality of the environment, human well-being, and economic security. Thus, all EFP impacts need to be considered when developing the business case model. The HLB Risk Analysis Process (RAP) incorporates all identified costs, benefits, and associated measures of uncertainty (or risk) into the development of a comprehensive business case assessment.

A main challenge for EFP business case development is the conversion of environmental and social costs and benefits into their fiscal equivalents. Where environmental and social cost-benefit measurement benchmarks exist, they have been incorporated into the ForestRAP model. Where there are no benchmarks, suggestive methods for metric development are described and incorporated into the economic business case assessment. Measures of uncertainty in these quantities are also provided and have been incorporated into the EFP scenarios that were conducted.

Task 5: Documentation: Final Report and Summary of Key Findings

The final report provides an overview of the risk analysis business case framework that was used in this study. More specifically, the report provides an overview of the non-timber valuation of the GCF area, discusses the socio-economic impact of EFP measures within the GCF, presents the scenarios that were considered in the analysis, discusses possible win-win investment relationships between the government and industry, and identifies additional research areas. Moreover, the final report is geared toward:

- Recognition of the trade-off and balances between EFP objectives through a study of the social, economic, and environmental impacts;
- Identification of scenarios in which win-win partnering is feasible;
- Within feasible partnering scenarios, identification and specification of investment cost sharing options within which partnering is feasible;
- The identification of key sources of risk to both parties; and,
- Recognition of additional research areas required to address uncertainty and risk.

An overview of the business case model and a summary of key results are presented in the executive summary order to facilitate the development of feasible government-industry EFP partnering options and to discuss key sources of risk to both parties.

The framework presented herein can be applied to other forest areas and can be used to aid in the identification of potential roles the government could provide in EFP uptake in the GCF and other forest areas.

2. NON-TIMBER VALUATION

In planning for enhanced forest productivity there must be careful consideration of how to maintain the quality of the environment, human well-being, and economic security. Given the long-term impact of harvest activity on forest growth, the effect of altering harvest practices on the environment is of crucial importance to the public sector.

The quantification of environmental and social impacts of EFP practices and increased harvest volumes is a main challenge for EFP business case development as the valuation of both direct-use and indirect-use forest services (“non-timber” benefits) is in its infancy. For recreational activities, valuation is typically carried out by multiplying unit value estimates of recreational activities by the demand for these activities. For environmental measures unit value estimates are multiplied by the quantity or supply of environmental by-products. Unit values are generally obtained through studies using estimation techniques such as contingent valuation or travel cost methodologies and vary greatly from study to study and across regions. Linking changes in recreational and environmental conditions to EFP measures is even more arduous since it involves projecting how varying harvest practices will affect supply and demand values.

This section outlines the methodology used for the valuation of “non-timber” benefits and provides the unit values, demand assumptions, and heuristics used to provide order of magnitude impact analysis.

2.1 Direct Use Recreational Values

Recreational Activities in the GCF

Based on the socio-economic profile of the Gordon Cosens Forest, the following recreational activities are applicable to the GCF and are thus considered in this study:

Table 1: Recreational Activities Within the Gordon Cosens Forest

Recreational Activity	Applicability to GCF
Moose Hunting	Very popular activity.
Bear Hunting	Applicable. All of the Gordon Cosens Forest has been designated as Bear Management Areas. Revenue data is private and is not collected by the government.
Trapping	102 partial or full trap line areas fall within the Gordon Cosens Forest; revenue information is private; work is valued beyond the amount of revenue. Hearst District 97/98: 2282 beaver, 515 mink, 3470 marten, 140 otter, 446 muskrat, 75 lynx, 385 weasel, and various other species.

Table 1: Recreational Activities Within the Gordon Cosens Forest (Cont'd)

Small-Game Hunting and Fishing	The majority of the Gordon Cosens Forest is allocated for commercial baitfish harvest; forest operations have little impact on baitfish operations other than the creation of access roads. There are several active non-commercial hunting and fishing clubs in the communities. As forest access roads are constructed, new areas are made accessible for hunting and fishing, and some lakes can be vulnerable to over-fishing. The issue of the creation and maintenance of access roads and water crossings is one of the most important to the people of the area.
Snowmobiling	Approximately 1700 trail permits were sold in 1999 to local residents. It is estimated that on any given day from January to March there are about 200 tourist snowmobilers between Cochrane and Hearst; these tourists spend significant amounts on motels, meals, and supplies. Forest access and harvesting are rarely in conflict with trails, due to the location of trails near the Hwy 11 corridor, which is rarely mature enough to harvest. Snowmobile clubs maintain the trails.
ATVing	Rapidly growing activity in the GCF area.
Canoeing	The Missinaibi River Provincial Park is a popular canoe route used by local people and visitors. The impact of access and harvesting will be mitigated by widened reserves and restrictions on winter crossings.
Camping	Most of the access roads for popular cottaging and private recreation camps were built and maintained for forest harvesting. Crown land camping is also permitted across the Forest. The construction of forest access roads tends to open up new areas for camping.
Berry Picking	Applicable.

Table 2 below provides the median unit values and risk ranges that reflect the uncertainty inherent in the valuation of these recreational activities. Table 3 describes the benefits transfer approach employed by HLB to develop the unit estimates and ranges. In-depth research of the literature was conducted to uncover relevant empirical studies that attempt to measure the value derived by individuals engaging in a particular recreational activity. In general, these studies utilize a particular estimation methodology (e.g. travel cost, contingent valuation) to derive the economic value individuals attach to a recreational activity (e.g., hunting, fishing, etc). For example, a contingent valuation study may conduct a survey of fishing enthusiasts in a particular region and develop a model to estimate their average willingness to pay (in dollars) for a fishing trip. This measures how the individual values the perceived benefits from pursuing that activity.

While there are a number of studies focusing on activities such as big-game hunting and sport fishing in the literature, there is comparatively far less work relating to activities such as snowmobiling, ATVing and berry picking. For cases with multiple studies, there is usually an extremely wide range of values available in the literature. This can stem from differences in valuation methodology, geographic focus and date of the study. In developing median unit value estimates, HLB sifted through the literature to determine the most appropriate study or studies in terms of applicability to the GCF area (for example, a paper on moose hunting valuation in Ontario would be preferred to a similar study conducted in Wyoming), while reflecting alternate values within its uncertainty range based on the approach outlined in Table 3.

Table 2: Direct Use Recreational Activity Unit Values

Activity	Median Value (\$/person trip-day)	Lower 10% Value	Higher 10% Value	Reference Study
Moose Hunting	\$200	\$176	\$228	Sarkar and Surry (1998)
Bear Hunting	\$50	\$25	\$100	Reid (1981)
Small-Game Hunting	\$35	\$10	\$70	Reid (1981)
Trapping	\$35	\$18	\$53	As per small-game hunting
Sport Fishing	\$20	\$10	\$65	Various sources
Snowmobiling	\$80	\$60	\$100	May (1997)
ATVing	\$80	\$40	\$120	As per snowmobiling
Canoeing	\$50	\$35	\$58	Rollins et al. (1997)
Berry Picking	\$30	\$15	\$45	No studies found; expert opinion
Camping	\$20	\$10	\$50	Bergstrom and Cordell (1991)

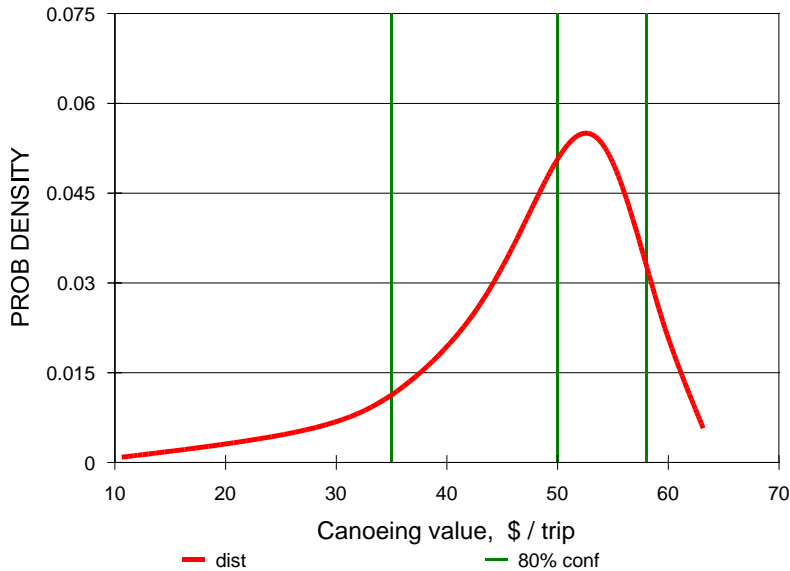
Table 3: Protocol for Value Estimation: *Benefits Transfer Context*

Case	Categories of Available Sources for Value Estimates	Approach Employed to Derive Unit Estimates and Ranges
1	Filtered list of multiple studies which are relevant.	Used multiple study median value and standard deviation.
2	Single relevant study.	Used single estimated value with standard error of estimate.
3	Single relevant study (but no standard errors provided).	Used single estimated value with standard deviation from similar studies.
4	Single relevant study (but no standard errors or related studies with standard deviations).	Used single estimated value and applied + 25 percent to the upper and lower bounds of an 80 percent confidence interval.
5	No relevant study but solicited expert/field opinion.	Used "solicited" value and applied + 50 percent to the upper and lower bounds of an 80 percent confidence interval.
6	No relevant study but applied HLB heuristics along with consultations with domain specialists.	Used "HLB-derived" value and applied + 50 percent to the upper and lower bounds of an 80 percent confidence interval (along with HLB belief on skew of distribution).

Applying the benefits transfer approach described in Table 3, HLB developed an uncertainty range (or confidence interval) around each unit value for all the recreational activities being considered. For each value, lower and higher 10 percent estimates were specified to represent the range within which there exists an 80 percent probability of finding the actual outcome. The greater the uncertainty associated with a value, the wider the range.

As an example, Figure 1 illustrates the degree of uncertainty around the valuation of a canoeing trip in the GCF. There is an 80 percent probability that the average willingness-to-pay unit value, expressed in dollars per trip, lies between \$35 and \$58 with a median value of \$50. Stated another way, there is a 10 percent chance that a canoeing trip is valued at less than \$35 and a 10 percent that it is worth more than \$58.

Figure 1: Recreational Use Valuation: Example - Willingness to Pay for Canoeing trip



Recreational Activity Demand in the GCF Area

This section describes the methodology, information sources and assumptions used to derive base year (2003) demand counts for the principal recreational activities in the GCF. A number of persons/organizations familiar with the GCF area were contacted in an effort to collect the most accurate activity counts.⁴ However, it was found that no systematic tracking of recreational activity counts exists thus making any estimation of base demand a highly challenging exercise.

In deriving activity demand estimates, HLB obtained information on GCF-specific indicators such as the number of moose validation tags available, number of snowmobiling permits issued, and the number of trap lines that fall within the forest. The only metric of activity demand maintained by the MNR is the number of ‘contacts’ made by forest conservation officers in the region. HLB spoke to the MNR supervisor in Kapuskasing, Ken Ukranitz, who was able to supply information on the number of contacts recorded in 2003 as well as provide useful qualitative opinions on recreational activities in the Gordon Cosens Forest.

As part of the previous study, a number of recreational activities were identified to be prevalent in the Romeo Malette Forest⁵ (RMF). A similar determination was made for the GCF and the following activities were found to be significant:

- Moose hunting

⁴ Ministry of Natural Resources (Hearst, Chapleau, Kapuskasing), Kapuskasing Chamber of Commerce, Northern Ontario Tourist Outfitters etc.

⁵ The MNR area enforcement officer provided recreational demand information for the RMF area. ‘Contact’ information was provided for moose hunting, bear hunting and fishing. Qualitative judgments on demand were provided for the other recreational activities.

- Bear hunting
- Small-game hunting
- Trapping
- Sport fishing
- Snowmobiling
- ATVing
- Canoeing
- Camping
- Berry Picking

The following sections detail the approach used to derive base year demand for each of the activities listed above.

Moose hunting

Moose hunting represents one of the most popular activities in the GCF area. The Ontario Ministry of Natural Resources (MNR) maintains information on the number of moose tags available for each Wildlife Management Unit (WMU) in Ontario. The GCF area lies in parts of WMUs 23, 24, 30, 31 and 32. The numbers of tags made available in these WMUs in 2003 were as follows:

WMU 23 – 108
WMU 24 – 289
WMU 30 – 200
WMU 31 – 143
WMU 32 – 132

It is assumed that the GCF area is contained in approximately 75 percent of the above WMUs, thus providing an overall estimate of 654 available tags in the forest. Using MNR data on the proportion of total tags in Ontario issued to individuals versus groups (52 percent and 48 percent respectively) and an assumption of 9 persons per average hunting group (Source: Ken Ukranitz), an estimate of the number of moose hunters came to 3,167. Combining this with an assumed number of hunting days per season per hunter of 8 days (Source: Ken Ukranitz), the overall estimate of moose hunting person trip-days is 25,336.

An alternative approach was also utilized to estimate moose hunting activity in the GCF area, as a 'check'. The MNR conservation officer in Kapuskasing (Ken Ukranitz) was able to provide data on the number of 'contacts' made by his officers in the GCF area in 2003. A 'contact' is an incidence where a conservation officer enters information into their system on persons they encounter during regular patrols of the area. The number of contacts made in 2003 was 6,800.

However it was estimated that officers typically only record contacts for 10-20 percent of all individuals present in the forest area. Of the 6,800 contacts, it was estimated that about 50 percent would likely have been moose hunters, 40 percent would likely have been sport fishers and the remaining 10 percent would have represented individuals present for other activities, such as bear hunting. It was also noted that sport fishers were less likely to be contacted than

hunters since this group generally included children, seniors, etc. which would not necessitate the usual documentation on the part of a conservation officer.

Using this information and the assumption that officers contact 15 percent of all moose hunters in the area generates an estimate of approximately 22,667 moose hunting trip-days. This approach yields a figure fairly close to the one derived directly from tag-based calculations.

Bear Hunting

In terms of person trip-days per year, bear hunting represents a significantly less popular activity than moose hunting in Ontario. To estimate the number of bear hunting trip-days in the GCF area, we apply the proportion of bear hunting days to moose hunting days in the Romeo Malette Forest (around 17 percent) as a reliable proxy measure. Thus the number of bear hunting person trip-days is estimated to be around 4,223.

The alternative approach, which derived an estimate using the number of contacts, resulted in a similar number (approximately 4,533 trip-days a year), thus pointing to consistency in our estimated values.

Small-Game Hunting

A similar approach is adopted to estimate small-game hunting demand in the GCF area. The proportion of small game to moose hunting trip-days in the RMF is around 33 percent. Applying this percentage to the GCF generates an estimate of around 8,445 person trip-days in the base year.

Trapping

A document entitled “Socio-economic Profile - Gordon Cosens Forest” provides the number of partial or full trap lines (102) in the forest. Based on information provided by Ken Ukranitz, groups generally comprised of two persons who may engage in trapping activity once a week through the fall and spring (around 8 months) amounting to approximately 32 days a year. This generates an estimate of about 6,528 person-days in the base year.

Sport Fishing

From the number of recorded contacts (6,800), an estimated 40 percent represented sport fishers in the GCF area. It was assumed that the number of contacts account for only about 7 percent of all sport fishers as opposed to a higher 15 percent of moose hunters. A lower contact-rate was assumed based on the observation that conservation officers are less likely to contact fishers than hunters on their regular patrols. This generated an estimate of 38,857 sport fishing trips in the base year.

Snowmobiling

The document “Socio-economic Profile - Gordon Cosens Forest” contains some information on snowmobiling activity in the GCF area. Approximately 1,700 permits were issued to local residents in 1999. Also, the document estimates there are about 200 tourist snowmobilers between Cochrane and Hearst on any given day during the season (January to March).

Direct conversation with the MNR representative in the area (Ken Ukranitz) pointed to significant declines in snowmobiling activity in recent times, primarily due to higher fuel and insurance costs. Thus we assume a roughly 30 percent reduction in permits issued to locals from 1999 to 2003 and in the number of tourist snowmobilers. A survey of snowmobilers conducted as part of the “Cochrane Timiskaming Snowmobile Safety Campaign” of persons who ride in the Districts of Cochrane and Timiskaming in Northeastern Ontario provided some useful data. In particular, we were able to estimate the average number of snowmobiling trips per year to be close to 27. Combining all this information, the estimate of total snowmobiling trips in the base year is 45,106.

ATVing

Several sources suggested that ATVing is a rapidly growing recreational activity in the GCF area. The gap between the total number of snowmobiling and ATVing trips has been reducing over time. It is assumed that the number of ATVing trips is approximately 75 percent of the number of snowmobiling trips thus totalling around 33,829.

Canoeing

Canoeing is a popular activity on the Missinabi River in the GCF area, mainly among tourists. Sources suggested that the total number of canoeing trips is “in the hundreds” but would likely not be much greater than a thousand.

Camping

Camping is a relatively popular activity in the GCF area, likely combined with other activities such as canoeing, hiking or wildlife viewing. There are no reliable counts of the number of camping person trip-days. As a rough measure, we applied the proportion of camping trips to total recreational activity counts in the Romeo Malette Forest to the GCF area. The estimate of base year camping trip-days is 25,925.

Berry Picking

Berry picking is another relatively popular activity, but no demand data was uncovered for the GCF area. A similar approach was employed as with camping where the proportion of berry picking trips to total activity counts in the RMF was applied to the GCF. The estimate of base year berry picking trips is 12,962.

Estimated Recreational Activity Demand

Table 4 below provides a summary of the median estimated demand for recreational activity in the Gordon Cosens Forest in the base year along with the 80 percent confidence interval bounds. As evidenced from the lack of a systematic activity count tracking method in the GCF, the base demand estimates contain a significant degree of uncertainty as reflected in the probability ranges.

Table 4: Summary of Base Year Recreational Activity Demand Estimates

Activity	Median Number of Person Trip-Days / Trips	Lower 10% Person Trip-Days / Trips	Higher 10% Person Trip-Days / Trips
Moose hunting	25,336	19,002	31,670
Bear hunting	4,223	3,167	5,279
Small-game hunting	8,445	6,334	10,556
Trapping	6,528	4,896	8,160
Sport fishing	38,857	29,143	48,571
Snowmobiling	45,106	33,830	56,383
ATVing	33,829	25,372	42,286
Canoeing	1,000	760	1,266
Camping	25,925	19,444	32,406
Berry Picking	12,962	9,722	16,203

2.2 Assessing the Impact of Varying EFP/Harvest Scenarios on Recreational Activities

Assessing the impact of varying harvest scenarios on recreational activities involves the following five steps:

1. Estimate the unit values for recreational activities relevant to the GCF area through use of relevant studies, expert/field opinion and consultations with domain specialists;
2. Assess the uncertainty in the unit values obtained;
3. Collect information regarding current demand for recreational activities relevant to the GCF area;
4. Assess the uncertainty in demand levels; and,
5. Assess the impact of the EFP scenarios on future demand using “rules of thumb” obtained from local field specialists.

As mentioned previously, valuation is carried out by multiplying unit value estimates of recreational activities by the demand for these activities. The estimates of unit values and baseline demand have been outlined in the preceding sections. Currently there is no literature that addresses a methodology for directly linking changes in recreational activity to EFP measures and harvest practices. Thus, likely or potential impacts were elicited from local field specialists most familiar with the activities of the area. For example, recreation use values for hunting are related to moose population, which is correlated to preferred habitat (an output of the forest planning tool PatchWorks); motorized recreation is driven by access and extent of the transportation network, which is specified for the harvest scenarios considered in the analysis. Table 5 outlines the valuation used and the rationale behind recreational impact measures.

Table 5: Heuristics Used to Assess the Impact of Varying EFP/Harvest Scenarios on Recreational Activity

Recreational Activity	Methodology
Moose hunting	The area of preferred habitat may be considered as an indication of the population dynamics of species within the forest, on which the allocation of tags are based. Thus, valuation of the change in recreational benefits between scenarios is calculated by multiplying the unit value by the change in preferred habit between the two scenarios. It should be noted that this supplies a very rough indicator as the actual population dynamics is much more complex and is based on both site quality for the species as well as the quality of sites for competing populations (predators and prey). This type of valuation inherently assumes that the distribution of tags and hunting demand keeps such population balances in place.
Bear hunting	Use moose habitat as a proxy to the quantity value as this is readily available through PatchWorks output. The valuation methodology is similar to that of moose hunting.
Small-game hunting	The area of preferred habitat may be considered as an indication of the population size of species within the forest. Assuming demand is proportional to species population (the trend in which is assumed to be similar to the trend in preferred habitat area), the change in recreational benefits between scenarios may be calculated by multiplying the unit value by the change in preferred habit between the two scenarios. The sum of small game habitat areas provided by PatchWorks is used as a proxy. Multiply differences in this quantity under the scenarios by the unit value to obtain scenario differences.
Trapping	Assuming the majority of trapping activity occurs around water/lake areas, the effect of varying levels of harvest on trapping should be minimal due to the constraints and buffer zones placed around wetland areas. Thus, for the current pilot study, it is assumed that there is no change in trapping activity between differing harvest/silviculture scenarios.
Sport fishing	The road access network is fairly well established in the GCF. In addition, buffer zones are established around lakes to ensure that effects of harvest on wetland habitat are minimized. Thus we expect little to no change in water/lake recreation and habitat from the marginal increase in harvest and silviculture from one scenario to another.
Snowmobiling	Snowmobilers may benefit from the trails provided by tertiary roads that have been built for harvest but are not currently being used for harvest. Such roads may provide trail access for several years after being built. The metric used for this measure is two-fold. First it is assumed that there is a baseline growth rate that corresponds to the increase in snowmobiling demand in the GCF in its current environment with its already existing trail infrastructure. Then a second growth rate is applied which links the additional roads built over a 5-year period to an increase in snowmobiling demand. This increase in demand in a given period is calculated by multiplying a portion of the baseline annual value by the new tertiary access in the given 5-year period.
ATVing	Same methodology and logic as snowmobiling.

Table 5: Heuristics Used to Assess the Impact of Varying EFP/Harvest Scenarios on Recreational Activity (Cont'd)

Canoeing	Refer to sport fishing – expect little to no change across scenarios.
Camping	Refer to sport fishing – expect little to no change across scenarios.
Berry Picking	The valuation method assumes that demand for berry picking grows at the baseline rate across all scenarios; there is no impact of varying harvest/silviculture regimes on demand.

It should be noted that the valuation methodology described above is not based on complex statistical models which attempt to capture system dynamics, but rather is based on a simplistic rationale which attempts to capture macro trends in benefit quantity that are impacted by EFP and timber-harvest activities.

2.3 Indirect Use Ecosystem Values

Although quantifying the non-timber gains resulting from EFP is challenging and somewhat abstract, there are two potential outcomes resulting from silviculture investment that have an inherent connection with non-timber ecosystem use benefits:

1. An increase in the wood supply available in the forest; and,
2. A decrease in the risk in not obtaining an adequate sustainable wood volume by increasing the yield and exercising control over species composition.

Assuming current harvest levels do not change, the non-timber effects of these outcomes may manifest themselves as follows:

- Since more timber is being grown from the same land-base, silviculture leads to an increase in the residual growing stock (since harvest levels are fixed); as a result of this larger residual stock, enhanced non-timber benefits may be realized in the form of improved watershed services, soil stabilization, air quality, etc.
- Since more timber is being grown from the same amount of harvested area, there may be a case to withdraw some lands for protection (since harvest levels are fixed). These protected areas may provide additional non-timber values through improved wildlife habitat, watershed protection, biological diversity, etc.⁶

The methodology for evaluating environmental “indirect use” impacts is similar to that used for the valuation of recreational effects. Namely, unit value estimates are multiplied by the quantity or supply of environmental by-products where changes in supply are linked to EFP measures and harvest practices through simplistic “rules of thumb” derived from theory, experience and expert knowledge. Table 6 provides a listing and a description of the indirect use values that were

⁶ Although the ability to withdraw additional land for protection is acknowledged as a potential benefit of EFP measures, consideration of such possibilities are beyond the scope of this analysis.

modelled for the Gordon Cosens Forest, as well as the indicators that were used to model the impact of EFP measures and harvest practices on supply. Unit values are provided in Table 7.

Table 6: Indirect Use Ecosystem Values

Indirect Use	Definition/Description	Model Indicators
Soil Conservation / Erosion Control	Retention of soil within an ecosystem. Prevention of loss of soil by wind, runoff, or other removal processes.	Linked to residual growing stock.
Soil Formation	Soil formation process. Weathering of rock and the accumulation of organic material.	Linked to residual growing stock.
Nutrient Cycling	Storage, internal cycling, processing and acquisition of nutrients. Nitrogen fixation, N, P, and other elemental or nutrient cycles.	Linked to residual growing stock.
Water supply	Storage and retention of water.	Linked to residual growing stock.
Waste Treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds. Waste treatment, pollution control, and detoxification.	Linked to residual growing stock.
Biological control	Trophic-dynamic regulations of populations. Keystone predator control of prey species, reduction of herbivory by top predators.	Linked to residual growing stock.
Disturbance Regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations. Storm protection, flood control, draught recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.	Linked to residual growing stock.
Habitat - general wildlife	Biodiversity and general wildlife habitat/environment.	Linked to area of preferred habitat.
Carbon Storage/Sequestration	Sequestering of carbon by terrestrial sinks such as forests and soil, thereby reducing carbon dioxide in the atmosphere.	Linked to volume harvested, growth and yield curves.

The literature on valuing ecosystem services of forests described in Table 6 is very sparse. A paper⁷ by Robert Costanza at the University of Maryland and others was the primary basis for developing the median estimates for most of the values presented in Table 7. The paper identifies a wide range of ecosystem services and estimates the value per unit area of each service for each ecosystem type. HLB extracted the \$/hectare unit values for forest ecosystems and converted them to \$/m³ values (based on a m³ per hectare factor) to link the unit values to residual growing stock in the GCF area.

⁷ The Value of the World's Ecosystem Services and Natural Capital, 1997

Table 7: Indirect Use Ecosystem Service Unit Values

Activity	Median Value (\$/hectare)	Lower 10% Value	Higher 10% Value	Reference Study
Erosion Control	178	89	267	Costanza et al. (1997)
Soil Formation	19	10	29	Costanza et al. (1997)
Nutrient Cycling	400	200	600	Costanza et al. (1997)
Water supply	6	3	9	Costanza et al. (1997)
Waste Treatment	161	81	242	Costanza et al. (1997)
Biological control	7	4	11	Costanza et al. (1997)
Disturbance Regulation	4	2	6	Costanza et al. (1997)
Habitat - general wildlife	87	44	131	Macnab & Brusnyk (1998)
Carbon Storage/Sequestration (value of carbon - \$ / ton)	50*	25*	75*	Loomis & Richardson (2001)

* Unit value is expressed in terms of \$/ton

2.4 Assessing the Impact of Varying EFP/Harvest Scenarios on Ecosystem Values

Assessing the impact of varying harvest scenarios on ecosystem values involves the following three steps:

1. Estimate the unit values for ecosystem services relevant to the GCF area through use of relevant studies, expert/field opinion and consultations with domain specialists;
2. Assess the uncertainty in the unit values obtained;
3. Assess the impact of the EFP scenarios on ecosystem values using “rules of thumb” obtained from local field specialists.

Currently there is no literature that addresses a methodology for directly linking changes in ecosystem values to EFP measures and harvest practices. Thus, likely or potential impacts were elicited from local field specialists most familiar with the activities of the area. Table 8 outlines the valuation used and the rationale behind each of the environmental “indirect use” impact measures considered in this study.

Table 8: Indirect Use Ecosystem Impacts

Indirect Use	Model Indicators
Erosion Control	The valuation of erosion control is calculated by converting the unit value into \$/m ³ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Soil Formation	The valuation of soil formation is calculated by converting the unit value into \$/m ³ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.

Table 8: Indirect Use Ecosystem Impacts (Cont'd)

Nutrient Cycling	Above ground biomass is severely impacted, sometimes almost eliminated, following a clear-cut harvest. Gradually, biomass accumulates and nutrients are restored. In this pilot, residual growing stock will be used as a proxy for the amount of above ground biomass and nutrient cycling within the GCF. The valuation of nutrient cycling is calculated by converting the unit value into $\$/m^3$ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Water supply	The valuation of water supply is calculated by converting the unit value into $\$/m^3$ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Waste Treatment	The valuation of waste treatment is calculated by converting the unit value into $\$/m^3$ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Biological control	The valuation of biological control is calculated by converting the unit value into $\$/m^3$ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Disturbance Regulation	The valuation of disturbance regulation is calculated by converting the unit value into $\$/m^3$ of residual stock and multiplying this value by the volume of residual growing stock within the GCF.
Biodiversity Maintenance / Habitat - general wildlife	It should be noted that biodiversity maintenance depends on many forest attributes such as the vegetative structure of the forest and amount of old growth available, the road access network, etc. It is assumed that such factors are built into the calculation of preferred habitat area as supplied to HLB. The area of preferred habitat is then considered as an indication of the population size and biodiversity of species within the GCF. Valuation of the change in biodiversity maintenance/general habitat benefits between scenarios is calculated by multiplying the unit value by the change in preferred habit between the two scenarios.
Carbon Sequestration	Forests may reduce the amount of carbon dioxide in the atmosphere through increases in biomass and organic matter accumulation. Regenerating forests initially act as net carbon sources but generally become carbon sinks within 10 to 15 yrs due to rapid accumulation. Carbon accumulation continues to increase until stands reach maturity. After this time, net carbon uptake begins to decrease and approach zero (Plantinga and others 1999). Site differences, silviculture, land use practices, all affect carbon sequestration. The valuation of carbon sequestration from one scenario to another is calculated by multiplying the change in annual growth between scenarios by the tonnes of carbon per cubic metre of wood and unit value of carbon ($\$/tonne$). Note that this method of valuation necessarily takes into account the release of carbon from decaying timber products, as decay would be captured by negative growth.

Table 8: Indirect Use Ecosystem Impacts (Cont'd)

<p>Carbon Release in Terrestrial Biomass</p>	<p>Forests may add to the pool of carbon dioxide in the atmosphere through burning of forestlands, deforestation, or decomposition of wood products and by-products. The end use of timber harvested from forests is an important factor in evaluating the contributions of forestry to the global carbon cycle. Carbon is stored in long-term durable goods such as furniture and timber bridges. If the end use is for paper products that are rapidly used and discarded to decay, then the carbon is released into the atmosphere. The release in stored carbon is valued by multiplying the volume of pulp and other non-SPF products by the unit value of carbon (\$/tonne) and tonnes of carbon per cubic metre. A proportion of SPF1 and SPF2 volume harvested also contribute to increase carbon levels through the manufacturing process. This proportion is taken to be 57-60 percent and is multiplied by the volume SPF1 and SPF2 harvested and the unit value to determine the cost of releasing carbon into the atmosphere. (Approximately 40-43 percent of logging results in solid wood lumber; the rest is bark (28percent), wood chips (14 percent) and sawdust (14 percent)).</p> <p>Note that carbon release (i.e. the change in carbon storage in terrestrial biomass) due to harvesting practices was modeled in this study. Thus changes in carbon storage between scenarios are captured. However, the base value of carbon storage in terrestrial biomass was not included in the valuation of the GCF ecosystem.</p>
<p>Carbon Storage in Terrestrial Soils</p>	<p>Approximately 50 to 60 percent of the carbon in temperate forest ecosystems is found in the soil organic matter (US Dept. of Energy). Land management practices and land use changes can directly affect the ability of soils to sequester carbon. Timber harvesting followed by forest re-growth does not necessarily reduce soil carbon storage and subsequent loss of soil organic matter (SOM). When followed by erosion and subsequent loss of SOM, however, harvesting does result in substantial losses of soil carbon and fertility. For the purpose of this study, we are assuming that harvesting and regeneration practices are such that soil carbon storage does not change from one scenario to another. It should be noted that the base value of carbon storage in terrestrial soils was not captured in this study.</p>

As shown in the table above, residual growing stock has been used as a key indicator of the impact of varying EFP-harvest scenarios. This is supported in the literature as illustrated by the following reference:

"In forest ecosystems, post-disturbance biomass accumulation provides an index of carbon sequestration and the establishment of biological control over a variety of ecosystem processes, including those controlling water and nutrient cycles and losses. Thus, the rates and controls on biomass accumulation in aggrading secondary successional forests have implications when refining forest growth and nutrient cycling models." (Elliot et al., 2002)

3. SOCIO-ECONOMIC IMPACT ANALYSIS

As part of the business case study for EFP measures within the Gordon Cosens Forest (GCF) area, a review of the socio-economic profile of the GCF was conducted. This review was based on the analysis included in the 2000 Gordon Cosens Forest Management Plan (FMP) that was supplied to HLB by the Ontario Ministry of Natural Resources. This section provides an overview of the socio-economic meta-model that was developed using the Provincial Socio-Economic Impact Model (SEIM) input and output values.

3.1 SEIM Overview

The profile provided by the MNR included communities which are within the bounds of the GCF, or which contain mills which obtain more than 10 percent of their fibre supply from the GCF. These communities included:

- Kapuskasing
- Hearst
- Timmins
- Kirkland Lake

These communities depend on the forest industry to varying degrees; the impact of EFP alternatives varies from district to district and depends on the distribution of wood supply. Within a *given* district the level of impact is in *direct* proportion to the wood supply.

The employment and GDP figures presented in the socio-economic FMP report include direct, indirect, and induced impacts of the processing of the wood supply. Direct impacts include jobs in the mills and lumber sales. Indirect impacts are, for example, expenditures on logging equipment and jobs in manufacturing it. Induced impacts are those that arise when employees spend their paycheques. The FMP Gordon Cosens analysis looks at the benefits derived only from wood that comes from the Gordon Cosens Forest. The main socio-economic impact of EFP measures relates to local employment; the fiscal impact is measured by changes in GDP.

3.1.1 Distribution to the mills

The following outlines the distribution of timber from the GCF to local communities based on the 2000 Gordon Cosens Forest Management Plan (FMP).

Hearst & Kapuskasing Area:

- Spruce Falls Studmill: The MNR has licensed the Spruce Falls Studmill for a maximum of 750K m³/yr; however timber with a diameter >26cm is to be made available to area sawmills. It was predicted that this might direct approximately 20 percent of the timber; actual figures have been approximately 25-29 percent. Area sawmills are required to return the equivalent volume of chips to Spruce Falls.

- Hearst Area Sawmills: Receive 75 percent of the excess SPF volume (above the 750K limit to the Spruce Falls Studmill) + 75 percent of the timber above 26cm; and,
- Levesque Plywood: Receive 10 percent of the Poplar.

Timmins Area:

- Malette Timmins Sawmill: Receive 25 percent of excess SPF volume (above the 750K limit to the Spruce Falls Studmill) + 25 percent of the timber above 26cm; and,
- Grant - Timmins OSB: Receive 48.6 percent of the Poplar.

Kirkland Lake:

- Grant - Englehart OSB: Receive 41.4 percent of the Poplar.

3.2 The SEIM Meta-Model

Within a given district, the degree of impact resulting from harvest practices is in direct proportion to the wood supply by product type. Thus, the impact of various EFP scenarios on local GDP can be estimated using a multiple linear regression model where GDP is a linear function of the product volumes and the model coefficients are district specific. That is, model coefficients depend on the conditions of the district such as the regions ‘dependency ratio’, labour force characteristics, local industry/business, etc.

In order to conduct the socio-economic analysis presented in the 2000 Gordon Cosens FMP, local conditions were entered into SEIM. Based on the product volume inputs and GDP outputs presented in the FMP socio-economic profile, HLB was able to derive the model coefficients that the SEIM model used to estimate the impact of wood supply on GDP for the Gordon Cosen communities. These multiple regression models were used to estimate the socio-economic impact of the various EFP scenarios selected for this study. Note that, since the socio-economic meta-model presented in this report is founded on SEIM input and output data, all assumptions used in the SEIM analysis that was submitted with the 2000 GCF FMP are underlying assumptions in the current analysis as well. The results of this SEIM “meta-model” are presented in Appendix A.

3.3 Socio-Economic Impact of GCF EFP Scenarios

Since the impact of EFP alternatives impact is in direct proportion to the wood supply within a given district, scenarios that include greater annual harvest levels result in positive socio-economic gains for the region. Whether or not these gains offset the negative environmental impact associated with increased harvest volume depends on both the magnitude of the harvest increase and the amount of silviculture investment (all other factors assumed constant).

4. EFP SCENARIO DEVELOPMENT: FINDING A WIN-WIN SOLUTION

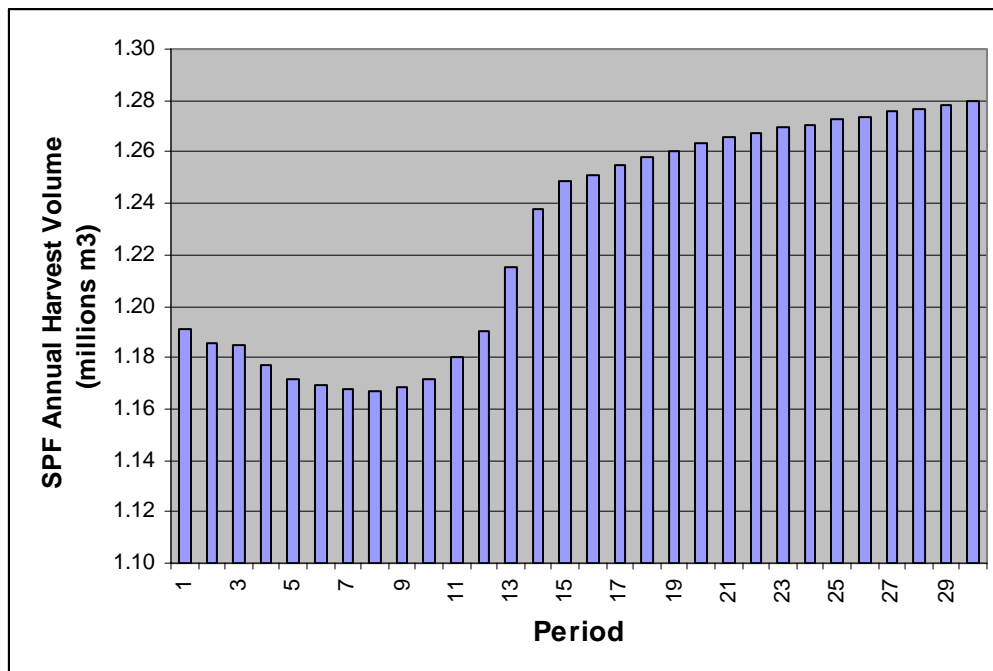
A feasible EFP partnership between industry and the government lies in balancing the objectives of the two parties such that an increased silviculture investment results in *both* a viable increase in AAC in a foreseeable time horizon and a net gain in social values. In order to find that balance between silviculture investment and harvest level, it is necessary to develop scenarios that allow us to evaluate the effect of increased harvest levels on regional socio-economic conditions, recreational activity and other non-timber benefits and to develop scenarios that allow us to evaluate the effect of silviculture investment on long-term social benefits.

This section presents the base case parameters and alternative scenarios that will aid in the development of viable government-industry EFP partnering options.

4.1 Developing the “Base Case”

The base case usually represents current or best planned forest prescriptions in the forest area under current budget allocations. The analysis conducted by SPS indicated, however, that under the current FMP guidelines the current OFAAB base level of 1.325 million m³ SPF per annum was neither attainable nor sustainable over the 30-period analysis horizon even with a sizeable annual silviculture budget of \$4.3 million. In fact, the harvest schedule modeled by SPS indicated that attainable SPF harvest levels fall under 1.2M m³ for the first 12 periods, as shown below in Figure 2.

Figure 2: Annual SPF Harvest Flow: OFAAB target



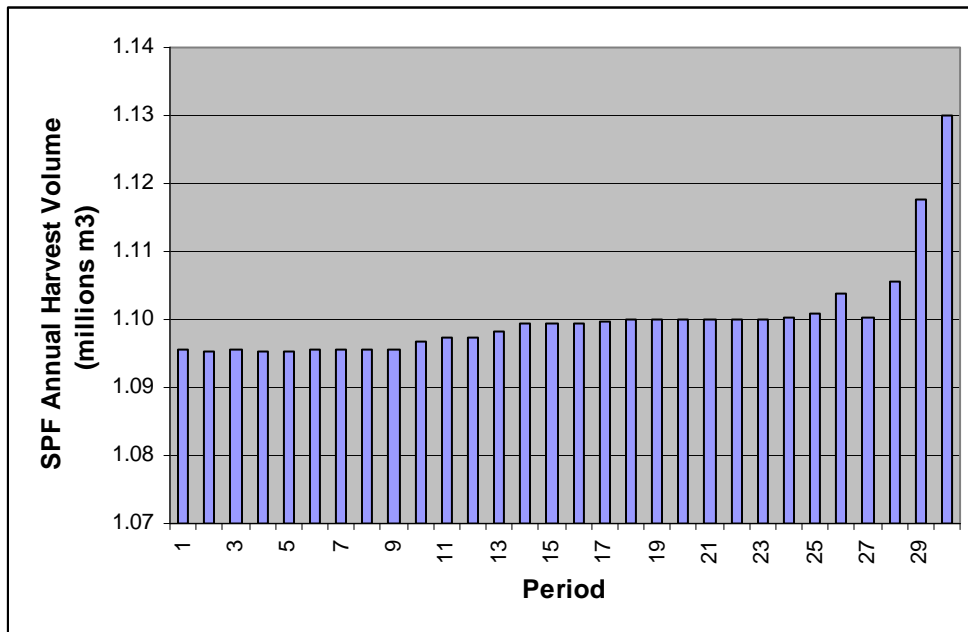
Given the strain created by the current OFAAB harvest level, a base harvest level target of 1.1 million m³ SPF per annum was chosen for the base case with a fixed annual silviculture expenditure of \$3 million (the budget necessary to sustain the base harvest level for a 150-year (30-period timeframe)).

Base Case Summary:

- Harvest Level: 1.1M m³ SPF per annum (see Figure 3 below);
- Silviculture Expenditure: \$3 million annually; and,
- Remaining Model Specifications: Based on the guidelines and regulations specified in the current Forest Management Plan (FMP).

The base case scenario, as summarized above, allows us to assess the impact of moderate increases (5-10 percent) in harvest level without compromising harvest level sustainability.

Figure 3: Annual SPF Harvest Flow: Base Case



4.2 Scenario Description

A compromise between industry and government objectives would involve investing in silviculture so that a greater harvest level can be sustained and then harvesting somewhat below this harvest level but above the current base level (ideally the base level would be the current AAC level, however, as shown in the previous section this may not be feasible). For example, one possible scenario may be to invest in enough silviculture so that a 1.3M m³ SPF harvest level could be sustained, but then only harvest at the 1.15M m³ or 1.2M m³ level. In harvesting a lesser volume than that possible due to the increased silviculture, it may be possible to realize some of the social values accruing from the increased silviculture expenditure.

Given the complex dynamics involved, the relationship between social well-being with silviculture investment and harvest level may be non-linear. Thus, the following two types of regimes should be considered:

- i. In order to evaluate the effect of increased harvest levels on regional socio-economic conditions, recreational activity and other non-timber benefits such as wildlife and indirect use environmental values, it is prudent to choose scenarios where SPF harvest levels vary while silviculture expenditure remains fixed; and,
- ii. To evaluate the effect of silviculture investment on long-term social benefits outcomes it is important to compare scenarios in which EFP investment levels vary while harvest levels remain fixed.

Together, the scenarios created under these regimes allows us to test the impact of silviculture investment and harvest level on long-term social benefits as well as their interaction. That is, they allow us to test the impact of increased silviculture expenditure at various harvest levels and to examine whether increased silviculture activity above that required for sustainability depends on the current harvest level.

The following harvest level/silviculture scenarios were chosen as a basis for the EFP business case analysis within the Gordon Cosens Forest area:

Table 9: Scenario Specifications

<p>1. Target SPF Harvest Level: 1.1 million m³/year</p> <ul style="list-style-type: none">a. Silviculture Expenditure: \$3M/yr for all years (Base Case)b. Silviculture Expenditure: \$4M/yr for all years
<p>2. Target SPF Harvest Level: 1.15 Million</p> <ul style="list-style-type: none">a. Silviculture Expenditure: \$3.5M/yr for all yearsb. Silviculture Expenditure: \$4M/yr for all yearsc. Silviculture Expenditure: \$4.5M/yr for all years
<p>3. Target SPF Harvest Level: 1.2 Million</p> <ul style="list-style-type: none">a. Silviculture Expenditure: \$4M/yr for all years

Note that for all scenarios, silviculture expenditure is set at or above the amount required to sustain harvest volume over the 30-period planning horizon. In addition, silviculture expenditure is fixed at an even investment amount for all 30-periods. All other factors/conditions remain fixed across scenarios and are set equal to the conditions specified in the base case scenario.

4.3 Base Case Simulation Results

Table 10 provides a rough estimate of the present value (PV) over a 150-year analysis period, of the non-timber and socio-economic benefits of the Gordon Cosens Forest area under EFP and harvest operations specified in the base case scenario. The 80 percent confidence interval for the present value of total social benefits is \$9.3 billion to \$36.2 billion. Note that the sizeable uncertainty in social benefits is mainly driven by the non-timber valuation (the 80 percent confidence interval for the present value of non-timber benefits is \$6.6 billion to \$33.7 billion). This reflects the large variation in unit values depicted in the literature and the confidence regarding the demand function.

The uncertainty in the socio-economic benefits (80 percent confidence interval for the present value is \$2.2 billion to \$3.3 billion) is mainly due to the variation about the expected timber volume in the harvest plan area selected under the SPS PatchWorks analysis; this uncertainty was derived using the growth and yield curves developed by Margaret Penner, a forest biometrician with Forest Analysis Ltd.

Table 10: Base Case Valuation

Base Case: Scenario 1	
1.1 million m³ SPF annual harvest level, \$3 million annual silviculture budget	
Timber Harvest	1.1 million m ³ SPF per annum
Non-Timber Benefits	\$12.95 billion (30 period PV*)
Socio-economic Benefits	\$2.63 billion (30 period PV**)
Total Social Benefits	\$15.57 billion (30 period PV)
Silviculture Costs	\$60.28 million (30 period PV)

* Present value for non-timber benefits is based on a net discount rate 1.5percent

** Present value for socio-economic and timber product values is based on a net discount rate of 5 percent (i.e. net discount rate = discount rate minus inflation)

Figures 4 through 6 depict the non-timber benefit stream, the socio-economic benefit stream, and the total social benefits over the 150-yr analysis period, respectively. Note the fairly wide confidence bounds indicating the degree of uncertainty around the estimated annual values.

Figure 4: Non-Timber Benefits by Period: Base Case

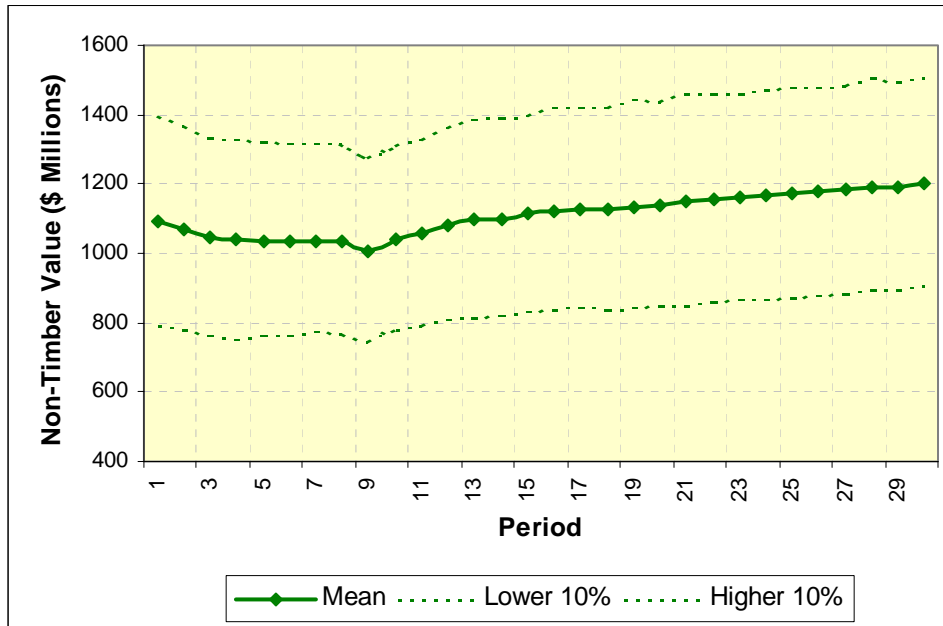
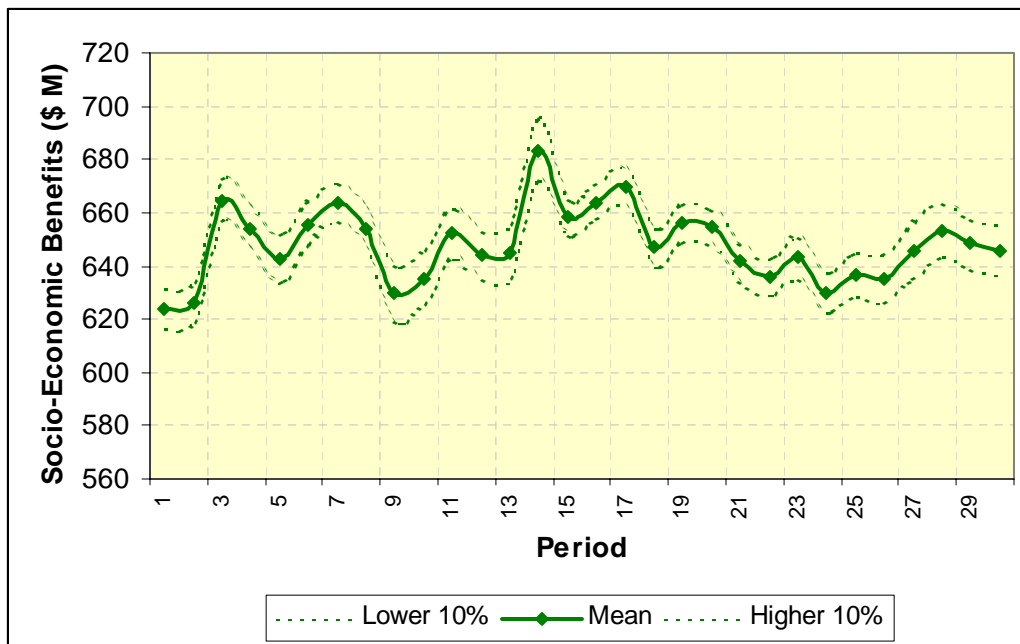


Figure 5: Socio-Economic Benefits by Period: Base Case



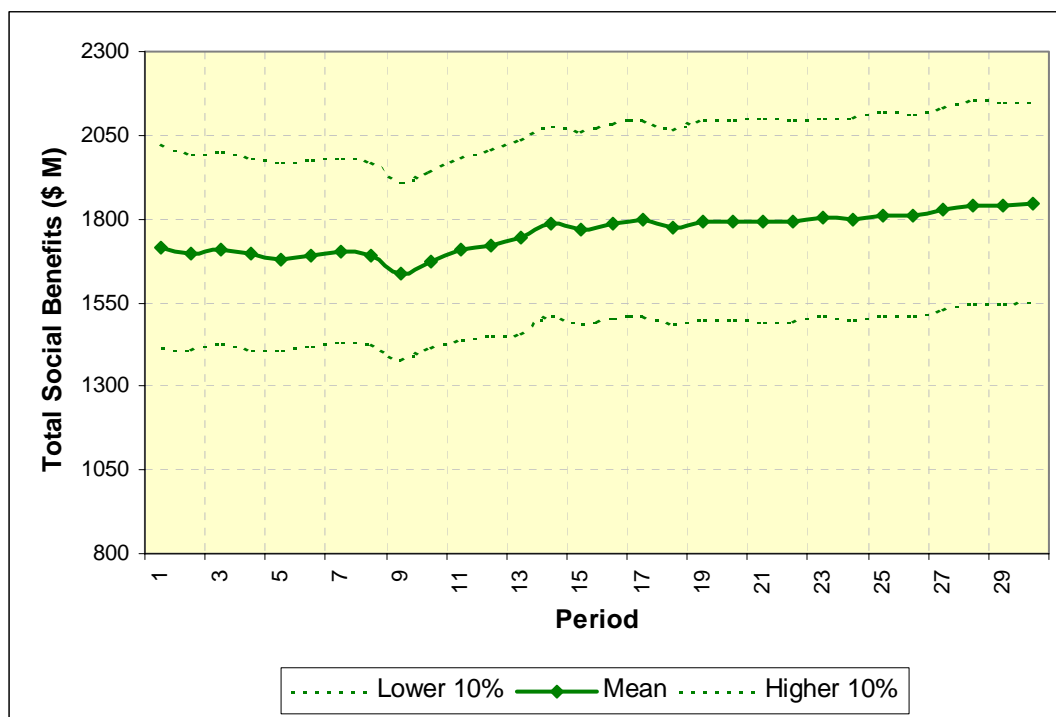
Note that the confidence band depicted in Figure 5 is fairly tight. Although the uncertainty depicted in Figure 5 captures the variation about the expected timber volume in the harvest plan area, it does not capture the uncertainty in the forest inventory nor does it capture the variation in product prices. When examining Figure 5, the following should be kept in mind:

- The uncertainty in the forest inventory has not been captured;

- Product prices and product proportions distributed to local communities within the bounds of the GCF are assumed constant over time;
- Post treatment succession and natural disturbances were not accounted for in the SPS PatchWorks analysis and the bias and uncertainty created by these restrictions has not been captured in ForestRAP.

These added sources of risk would result in the confidence band widening over time. However, in practice it is likely that, if the future yield in a selected area falls considerably short of expectations, another area would be chosen for harvest in its place.

Figure 6: Total Social Benefits by Period: Base Case



As outlined earlier, the ForestRAP model incorporates the harvest plan (including annual harvest volumes, annual transportation costs, and annual silviculture expenditure) that is developed using an independent forest-planning tool. For this study, PatchWorks software developed by Spatial Planning Systems (SPS) was used as the forest-planning tool. The scenarios run by SPS were based on guidelines and regulations set out in the current Forest Management Plan (FMP). Harvest areas were chosen to maximize net timber value (product revenue minus all costs) *to the mill* under the specified harvest and silviculture scenario constraints. A lower limit of \$1M net value each year was used as a practical fiscal constraint.

Figure 7 illustrates the annual timber product value to the mill gate under the base case; note that the wide confidence bounds are due to the fluctuation in product unit prices and the variation about the expected timber volume in the harvest plan area. Figure 8 shows the timber value stream net of all operational costs. As seen from the plot, net timber value to the mill is very

small, hovering about the break-even point. Since much of the profit in harvested timber is realized in the manufacturing of long-term durable goods and paper products, limiting the analysis to the net value at the mill gate does not represent the true gain that EFP measures bring to industry. Thus, for this analysis, the industry benefit will be measured by the increase in harvest level that is possible through increased silviculture expenditure as opposed to usual business case measures such as net present value and rate of return on the investment.

Figure 7: Timber Product Value (to the mill)

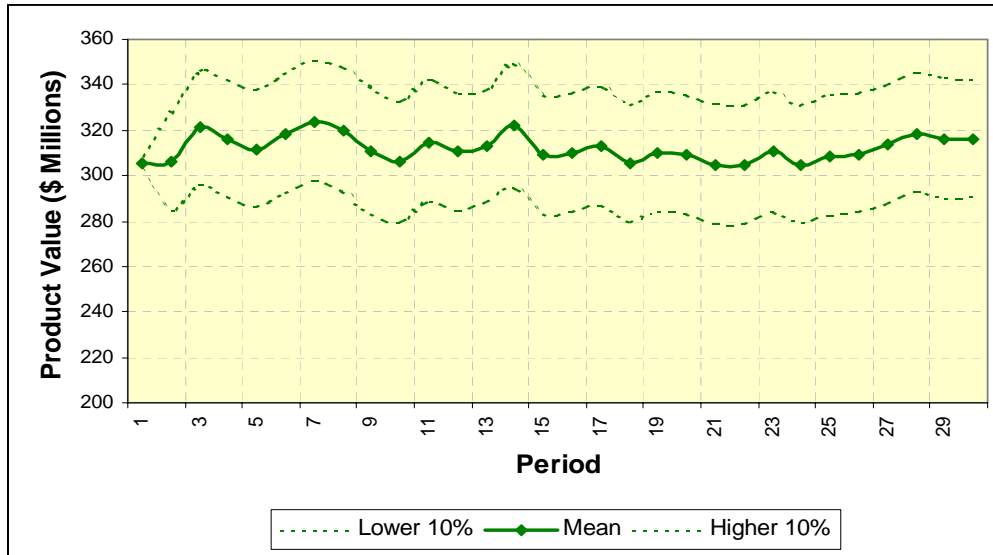
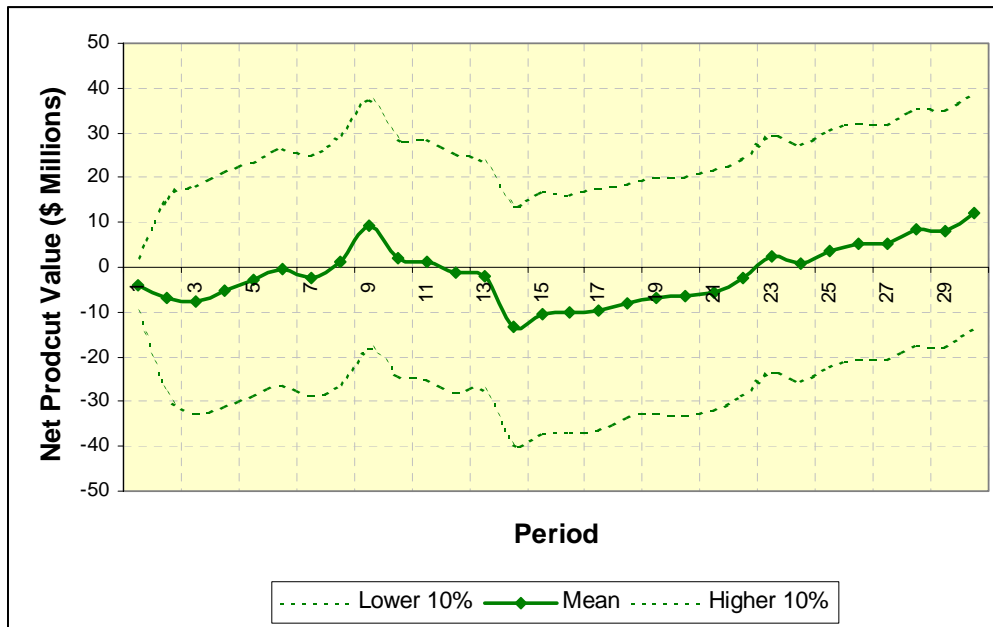


Figure 8: Net Timber Product Value (to the mill)



4.4 Scenario Comparison

Table 11 compares the change in the non-timber and socio-economic benefits derived from the Gordon Cosens Forest area under varying harvest levels and silviculture investment. Since the impact of the EFP scenario options on regional socio-economic impact increases with wood supply, scenarios that include greater annual harvest levels result in positive socio-economic gains for the region. However, whether these gains offset the negative environmental impact associated with increased harvest volume depends on both the magnitude of the harvest increase and the amount of silviculture investment (all other factors assumed constant), as shown in Table 11.

Table 11: Scenario Comparison (Difference from Base Case, 30 Period Present Value, Median Estimates)

Scenario	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Target Percent Annual Increase in SPF Harvest Level	0	4.5%	4.5%	4.5%	9.1%
Overall Percent Increase in <u>SPF</u> Product Volume	0.5%	3.8%	3.8%	3.6%	7.2%
Overall Percent Increase in <u>Total</u> Product Volume	0%	2.9%	2.5%	2.1%	4.4%
Annual Percent Increase in Total Product Volume	-1.9%-2.4%	-0.6%-5.6%	-1.0%-5.8%	-0.2%-4.3%	0.1%-9.0%
Increase in Non-Timber Benefits	\$61.4M	-\$94.6M	-\$40.3M	-\$20.6M	-\$157.5M
Increase in Regional Socio-economic Benefits	-\$3.6M	\$89.1M	\$82.3M	\$52.7M	\$143.8M
Net Increase in Social Benefits	\$57.8M	-\$5.5M	\$42.0M	\$32.0M	-\$13.7M
Increase in Silviculture Costs	\$20.4M	\$10.6M	\$20.5M	\$30.6M	\$21.2M

In the above table, the target percent annual increase in SPF harvest level refers to the target levels specified as a model constraint during the SPS scenario development using PatchWorks. In each of the scenarios considered, the overall increase in SPF harvest volume over the 30-period timeframe falls short of the target, likely due to other constraints imposed by the regulations and guidelines set forth in the current FMP. Note that the annual percent increase in product volume is not constant across periods but varies depending on the harvest schedule resulting from the SPS analysis. In fact, for all scenarios under consideration, the annual target levels are not met until period 14, with only a partial increase in harvest level in the early periods; refer to Appendix B for plots depicting annual harvest flow for each of the scenarios presented in Table 11.

For all silviculture investment scenarios considered, increasing the harvest level above those specified under the base case results in a loss in non-timber benefits over the 30-period analysis horizon. This is mainly because increased timber production resulting from silviculture

investments takes a considerable amount of time to be realized. Thus, an immediate increase in harvest level by even a modest amount quickly erodes any gains in non-timber benefits that would be felt by moderate to large increases in silviculture expenditure.

As discussed in Section 3, scenarios that include greater annual harvest levels generally result in positive socio-economic gains for the region. It should be noted, however, that there is some dispute concerning whether these gains are truly incremental from the ministry's perspective or whether they simply result in a regional transfer of economic resources with a net neutral socio-economic impact for the province⁸.

For the GCF region, there has been some support in favour of an incremental assessment of the socio-economic impact of forestry activity. Considering the historical population decline in regional jobs, that may be attributable to a decline in forest employment, and the lack of other jobs for anyone laid off (as described in the socio-economic profile in the FMP⁹), there is a need to stabilize regional employment. Although the importance of the socio-economic benefit of the GCF to local towns has been recognized in the Ministry of Natural Resources' Ontario Living Legacy – Ontario Forest Accord, currently the ministry does not regard these gains as incremental and they do not consider such benefits when conducting EFP business case analysis. This should be noted when examining the results presented in this report, which treat socio-economic changes as incremental.

One striking observation from Table 11 is that the impact of increased silviculture investment for Scenario 5 (1.15M m³ annual harvest level with an annual \$4.5 million silviculture budget) results in comparatively less non-timber and socio-economic gains than Scenario 4. The lower than expected gain in social benefit from the silviculture investment is in part due to the programming objectives specified during the development of the SPS harvest scenario plans. More specifically, harvest plans were developed with the objective of maximizing net timber benefit to the mill with SPF harvest levels and silviculture levels specified under the six scenarios considered. Although each model run was subject to the regulations and guidelines set forth in the current FMP, the objective function did not contain provisions for desired non-timber or socio-economic levels. For example, once the desired SPF harvest level was attained, there was no incentive for the model to invest the remaining silviculture budget on a strategy that would maximize residual growing stock which would increase overall wood supply and increase non-timber benefits. In fact, because the objective function for the PatchWorks model had no incentive for investing in silviculture levels above those required to sustain harvest levels, the \$4.5 million annual expenditure target was barely met since investing more dollars in an

⁸ The Ministry would not consider the employment related to the silviculture investments to be a benefit unless it represented a net increase in jobs for the province. Unless there is regional unemployment for individuals with the skills to fill these jobs, the increase in employment would not be considered a net economic benefit to the province but rather a transfer of resources from one region to another. However, if there is unemployment amongst workers with the skills for these jobs, then the silviculture investment and the associated jobs should be considered as an economic benefit.

⁹ As outlined in socio-economic profile in the FMP, the Hearst District is almost completely dependent on the forest industry. The industry accounts for 54 percent of person-years of employment, while indirect and induced "spin-off" employment accounts for the remainder. In addition, approx. 47 percent of the adult population in the Hearst and Kapuskasing area have not graduated from high school, thus limiting employment opportunities if laid off.

“unnecessary” item is in direct conflict with the objective of maximizing net profit. Also, in order to maintain the net value lower limit constraint of \$1M per annum, the increase in silviculture expenditures had to be offset by an increase in revenue or a decrease in other expenditures. For Scenario 5 the increase in revenue was not likely to happen, because all other scenarios had pushed this to the maximum. As a result less wood was harvested in the initial periods, more than likely eliminating the harvest of more expensive wood and non-SPF timber once the SPF harvest targets were reached. Thus, less wood is harvested overall, limiting the regional socio-economic gain. These observations demonstrate the need to incorporate social targets into the program objective function when developing a harvest plan under a private-public partnership.

Of the scenarios considered in this study, Scenario 4 offers the best balance between government and industry objectives, providing a moderate increase in annual harvest level as well as a net gain in social benefits of approximately double the silviculture investment over a 30 period horizon. Under this scenario, the annual SPF harvest level is initially raised by approximately 3.1 percent and annual silviculture expenditure is set at \$4M per annum (roughly \$0.5M more than that required to sustain harvest levels). By period 14 SPF harvest levels increase to approximately 4.5 percent above base case level of 1.1 million m³.

Figures 9 through 13 depict the present value of the difference in social benefits and the difference in harvest volume between Scenario 4 and the base case over the 30-period analysis horizon.

Figure 9: Difference in Present Value of Non-Timber Benefits (Scenario 4 – Base Case)

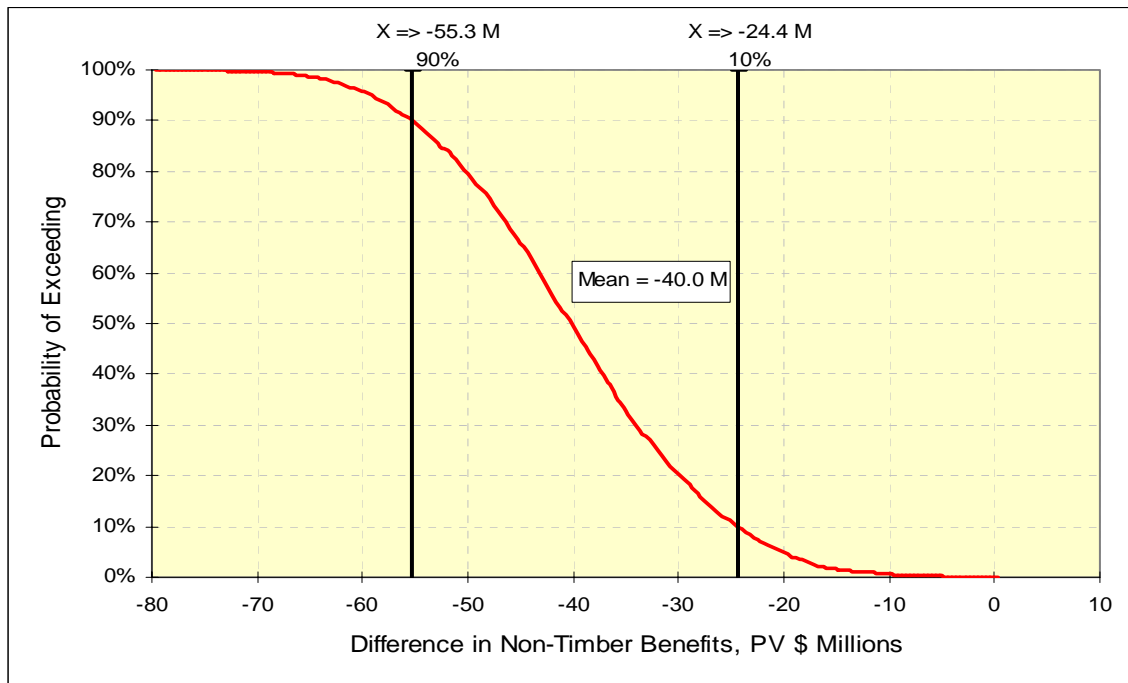


Figure 9 shows that there is a 90 percent probability that the present value of non-timber benefits derived in Scenario 4 will be lower than the base case scenario by at least \$24.4 million and a 10 percent probability that they will be lower by \$55.3 million. There is a 50 percent chance that

non-timber benefits resulting from Scenario 4 will be below the base case by at least \$40.3 million.

Figure 10: Difference in Present Value of Socio-Economic Benefits (Scenario 4 – Base Case)

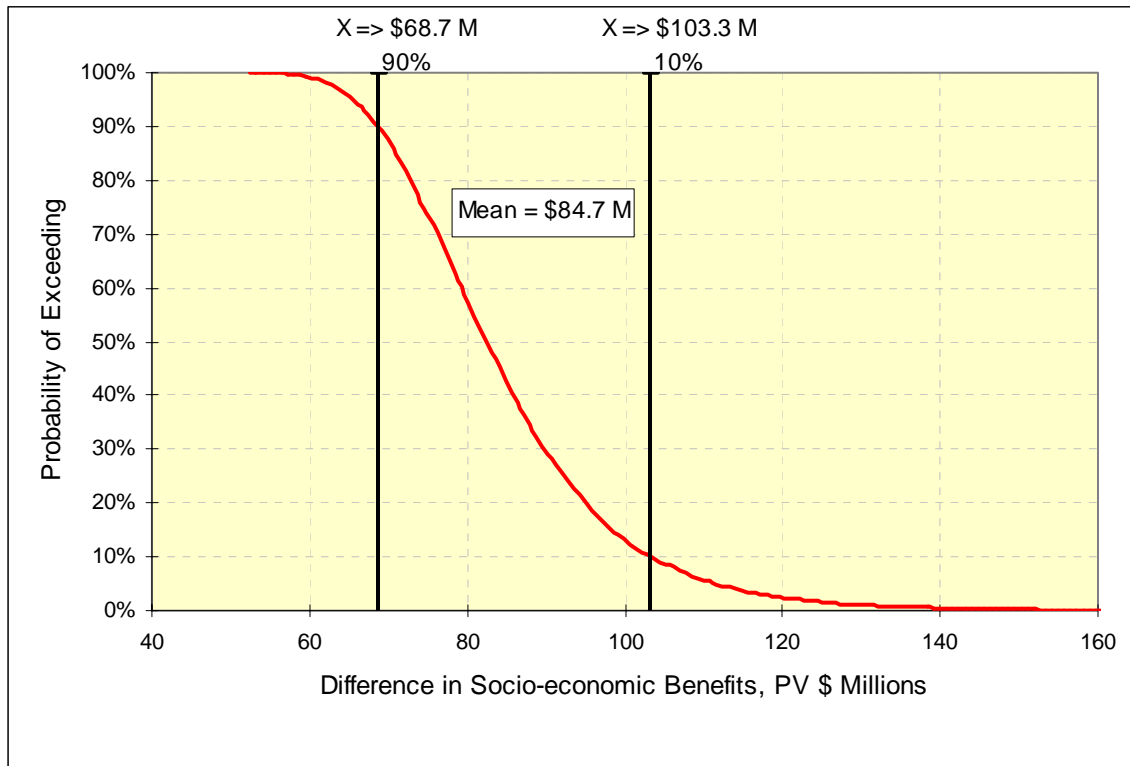
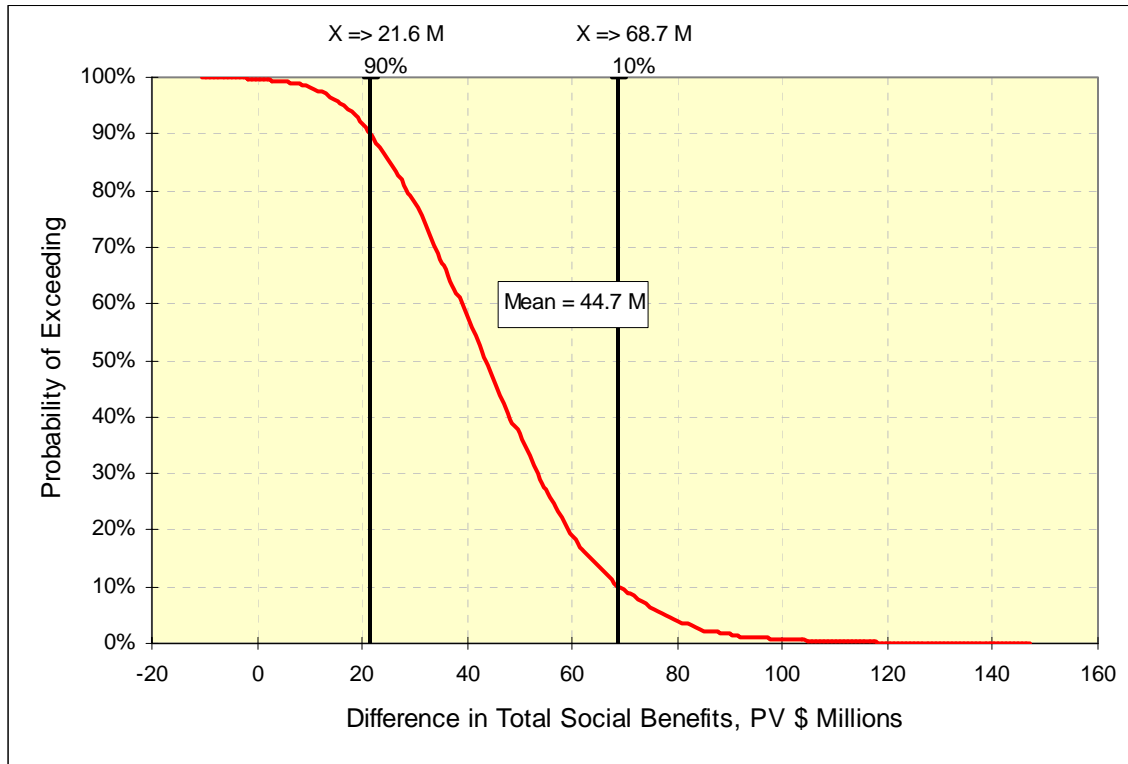


Figure 10 shows that there is a 90 percent probability that the present value of socio-economic benefits derived in Scenario 4 will be at least \$68.7 million higher than the base case scenario and a 10 percent probability that the difference will exceed \$103.3 million over the 150-year analysis period.

Figure 11: Difference in Present Value of Total Social Benefits (Scenario 4 – Base Case)



Total social benefits are defined as the sum of total non-timber and socio-economic benefits. As demonstrated by Figure 11, there is a greater than 99 percent probability that the present value of total social benefits derived in Scenario 4 will be higher than the base case scenario; there is a 10 percent probability that they will be at least \$68.7 million higher. Note that the confidence bands for the difference in scenario outcomes are much narrower than those for the individual scenarios themselves. This is due to the fact that some of the uncertainty in the scenario results would act the same across scenarios and are thus “netted out” when differences are considered.

From the industry perspective, the benefit of EFP measures is measured by the increase in harvest level that is possible through increased silviculture. As shown in Figure 12, Scenario 4 provides a 90 percent chance that the overall increase in SPF harvest volume over 30-periods will be at least 3.7 percent higher than the base case scenario, with an expected increase in total harvest of 2.5 percent over the 30-period time horizon. Note, however, that this risk assessment is subject to the model limitations discussed in Section 4.3; that is, the uncertainty in the forest inventory, post-treatment succession and natural disturbances are not incorporated into this risk assessment.

Differences in SPF and total harvest volume between Scenario 4 and the base case are shown in Figure 12 and Figure 13 respectively.

Figure 12: Difference in SPF Harvest Volume over 30 periods (Scenario 4 – Base Case)

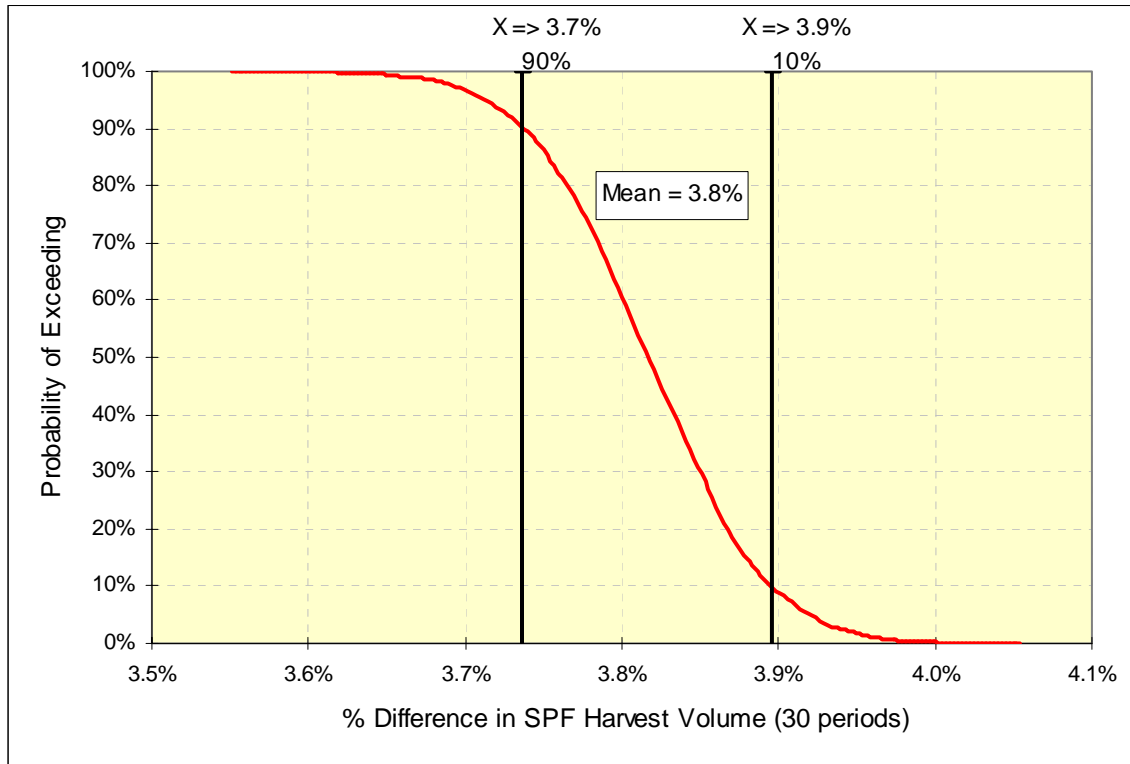
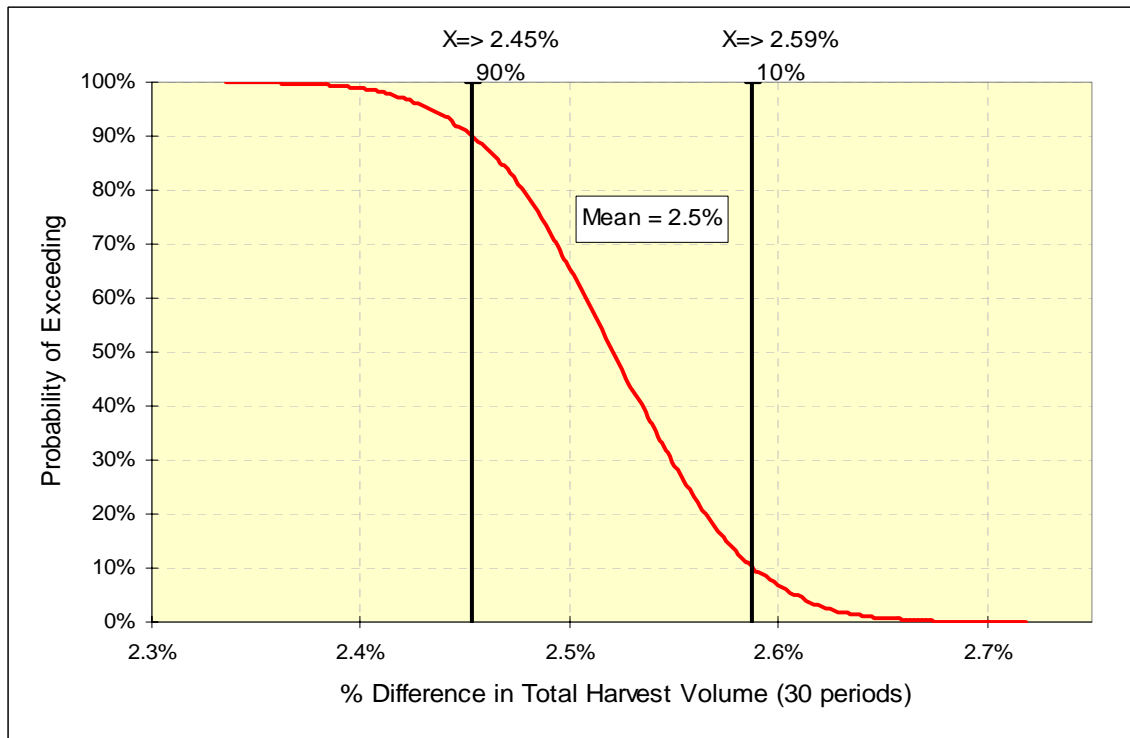


Figure 13: Difference in Total Harvest Volume over 30 periods (Scenario 4 – Base Case)



4.5 Developing a Cost-Sharing Strategy

As was shown in Table 11, if the government were to invest an extra \$20.4M in total silviculture expenditures (above that required for sustainable operations, i.e. Scenario 2) over the next 30-periods without increasing the SPF harvest level above 1.1M cubic metres annually, it would result in an estimated net increase of roughly \$57.8M in social benefits, assuming that regional socio-economic gains are truly incremental. This increase would be solely realized through gains in non-timber benefits. The same investment combined with a modest increase in annual harvest levels as specified in Scenario 4 would result in an estimated net social gain of approximately \$42.0 million; this would be due to an increase of about \$82.3 million in regional socio-economic benefits and a loss of about \$40.3 million in non-timber conditions.

To offset the reduction in social values due to the increase in harvest volume, industry would share in the silviculture investment. Since an estimated \$10.6 million in additional funds would be required to sustain harvest operations at the increased level with no net gain to social benefits, industry's share of the \$20.4M investment would have to be greater than \$10.6M in order for the government or society to receive any benefit from the partnership. Under a partnership in which industry is granted an increase in allowable cut in the short-term for its contribution to silviculture costs, the government entity takes on the majority of the risk; thus, any cost-share arrangement should make appropriate provisions for the transference of risk.

As demonstrated by Figure 11, there is a greater than 99 percent probability that the present value of total social benefits derived in Scenario 4 will be higher than the base case scenario. The expected gain in net social value over the 30-period time horizon is roughly \$44.7 million. Since the expected value does not take into account the increased risk to the government, the risk-adjusted value of \$28.5 million in gains would form a more suitable basis on which to derive a cost-share strategy. That is, there is an 80 percent probability that net social benefit would be increased by at least \$28.5 million under Scenario 4. Under this scenario, the government would accept a moderate loss in non-timber benefits in exchange for increased regional socio-economic benefits.

Based on an extrapolation of the results presented in Table 11 Scenario 2, the government would have to invest approximately \$10 million in silviculture above the base case amount over a 30-period horizon to realize a net gain to social benefits in the order of \$28.5 million, with the gain stemming solely through increased non-timber benefits. That is, if there were no increase in harvest volume, then the expected payoff to the public sector would be \$28.5 million if a \$10 million investment in silviculture was made over a 30-period horizon. Thus a win scenario for the government would occur if industry contributed to some of this cost. Thus, a possible cost sharing strategy would be one in which:

- Total increased silviculture over the 30 period horizon = \$20.5 million, where:
 - Industry contributes \$10.6-\$20.5 million in increased silviculture;
 - Government contributes \$0-10.0 million in increased silviculture; and,
- Silviculture expenditure and harvest level follows the schedule set forth in Scenario 4.

For example, if the government and industry were to consider a 50-50 cost share in the cost for the increased gain in social benefit then the government would contribute \$5 million to EFP silviculture and industry would contribute \$15.6 million in exchange for a modest increase in harvest volume. In order to determine the true value of this cost-share strategy from an industry perspective, the value of increased volume beyond the mill gate would need to be quantified. For example, the present value of the extra harvest to the mill gate is \$35.1 million without considering the extra harvest cost (which almost completely erodes this gain). Consideration would have to be given to the amount of profit that would be gained through this increased gain in harvest during the manufacturing process.

5. CONCLUDING REMARKS

In agreeing to invest in silviculture, which generates increased social value for the government and the community, industry demands benefits in the form of an increase in the allowable harvest level *in the current period*. However, from the government's perspective, it can be convincingly argued that increasing current harvest levels will reduce non-timber values (recreation use, passive use, etc.), although increased benefits may be realized through local employment opportunities.

Thus the trade-off is as follows: increasing silviculture may lead to enhanced social values for the government; to entice industry to undertake this investment an increased harvest level may be granted in the short-term to justify initial treatment costs. This increased harvest level, however, negatively affects non-timber values. Thus, this harvest level must be chosen in such a way as not to erode all the social values accruing from the increased silviculture.

Several harvest scenarios were examined for the GCF area to assess the impact of varying harvest levels and silviculture expenditure on timber, non-timber, and socio-economic values. The main findings indicate that:

- When the amount of silviculture investment is chosen to satisfy an increased harvest target without consideration for the impact on social or environmental values, then the net change in social values is negative. That is, the loss in non-timber benefits is not offset by the increase in socio-economic benefits; however, there is a gain to industry in terms of increased harvest levels.
- When silviculture investment is increased while harvest level remains fixed, the gain in long-term non-timber benefits greatly out-weighs the incremental silviculture expenditure.
- Since the increased timber production resulting from silviculture investments take a considerable amount of time to be realized, immediate increases in harvest level by even a modest amount quickly erodes any gains in non-timber benefits that would be felt by moderate to large increases in silviculture expenditure. However, as there are socio-economic benefits associated with increased harvest levels, it is possible to meaningfully increase harvest levels at a gradual rate and still produce a gain in net social value (non-timber benefits + socio-economic benefits).
- Based on the joint analysis conducted using the SPS forest planning software and the HLB ForestRAP model, increasing the SPF harvest level in the GCF area by 3.8 percent above the base level of 1.1M cubic meters per annum while increasing silviculture from \$3M per year (the level required to sustain harvest at 1.1 million m³ per annum) to \$4M per year (a 33 percent increase) produces a net gain in social benefits over a 150-year planning period. The non-timber benefits, however, drop somewhat.
- Analysis conducted by the SPS team indicate that the current OFAAB base harvest level of 1.325M m³ SPF per annum is not sustainable over a 30-period time horizon.

Key Sources of Risk: Industry

The immediate concerns to industry include short-term costs and available volume (annually allowable cut, AAC). However, mid-term business plan considerations, such as maintaining adequate harvest levels 30 to 60 years into the future, are also key issues when developing a viable harvest plan. From an industry perspective, investment risk stemming from an EFP partnership with the government has two main components. One, there is risk involved in the timing of the investment return and two, there is risk in the actual wood supply available in future periods:

- **Timing:** The longer it takes for industry to realize gains from its investment, the more risky the venture. The government sets the forest management regulations, and thus has ultimate control over current and future harvest activity. Thus from an industry perspective there is concern that any investment industry makes now may be thwarted in the future if regulations change;
- **Sustainable Harvest:** There is a great deal of uncertainty about the amount of wood supply in the mid- to long-term. There is always risk of natural disturbances (which are not accounted for in the current analysis) as well as uncertainty in the growth and yield of forest units and the effect of EFP measures. Industry may push for a fairly immediate increase in allowable cut in the short- to mid-term with a contingency for more moderate sustainable harvest levels later, rather than the reverse, arguing that the investment period should match the return period; and,
- **Choosing the baseline harvest level** from which to start negotiations. The current OFAAB harvest level may not be feasible; that is, if this limit is already set too high then increasing levels above this amount could accentuate industry problems downstream (more details below).

Key Sources of Risk: Government

Since the government is interested in long-term benefits in exchange for fairly short-term gains to industry, the overall risk to the government is bound to be higher than that to industry. This increased risk to the government is compounded given the stage of the science used in estimating timber conditions such as growth and yield curves, succession, response to silviculture, natural disturbances, etc. Main risk factors include:

- **Timing:** Industry desires an increase in allowable cut in exchange for silviculture investment. Given the amount of time it takes for silviculture benefits to be realized and the negative impact of harvest on non-timber social values, the further out the government can push increases in harvest level, the lower its investment risk.
- **The current OFAAB base level:** SPS analysis of the Gordon Cosens Forest area suggests that the current OFAAB base harvest level is not sustainable. As a result, the base case harvest level for this analysis was set at 17 percent below the current OFAAB base level. Increasing harvest levels above the current OFAAB level may not even be possible without adversely impacting both non-timber and socio-economic conditions in the mid- to long-term.
- **Choosing the baseline harvest level:** It is of utmost importance to choose a feasible baseline harvest level from which to start negotiations. Harvesting above sustainable levels in the short-term may result in harvesting below the minimal required levels later,

which may result in shutting down some mill operations completely thus *accentuating* the negative socio-economic impact of reduced harvest levels downstream. This scenario was not run in the analysis presented here.

- Currently the Ministry does not regard changes in socio-economic conditions resulting from EFP investment as truly incremental but simply a regional transfer of economic resources with a net neutral socio-economic impact for the province. As such, the Ontario Ministry of Natural Resources does not consider such benefits when conducting EFP business case analysis. This should be noted when examining the results presented in this report, in which socio-economic changes were treated as incremental.
- Social valuation of EFP practices is in its infancy, resulting in a great deal of uncertainty in expected outcomes.
- Uncertainty in post-treatment succession, natural disturbances, and changing forestry conditions has not been accounted for in the analysis presented in this report. The risk of these factors comes into play in the mid- to long-term timeframe.
- Biases in model specifications (more details below).

Model Calibration and Testing of Forest Planning Software

SPS analysis of the GCF area indicates that the current annual OFAAB base harvest level of 1.325M m³ SPF is not sustainable even under a fairly substantial annual silviculture investment. This appears to be in contrast to the analysis presented in the current Forest Management Plan (FMP), which utilized the SFMM forest-planning tool. Because of the importance of starting with a feasible baseline harvest level, we recommend investigating the reason behind the discrepant results. Also, the pilot studies conducted on both the RMF and GCF areas indicate that the SPS forest planning software (PatchWorks) is in a relatively early stage of testing; as such we stress the need for improved quality assurance testing and consistency checks across summary output tables.

Based on the EFP business case pilot studies conducted for the RMF and GCF areas, the items listed below have been identified as essential follow-up activities if PatchWorks software (or any new forest planning software) is to be used to develop optimal harvest plans:

- Need calibration with SFMM (it may be necessary to reconsider current OFAAB levels);
- Need quality assurance testing for SPS (consistency across summary output tables should be standard practice; many of the initial scenario runs did not meet this basic testing requirement);
- Need to consider industry profit of increased harvest levels after mill gate (conversion factor);
- Need to incorporate social targets into the objective function when forming a partnership;
- Need to investigate how changes in the objective function alters harvest schedule and what this means to timber, non-timber, and socio-economic conditions;
- Need to standardize model parameters: In order to conduct a fair comparison between scenarios it is necessary to develop a standard set of model parameters to be used across scenarios (i.e. these should not change but remain fixed from scenario to scenario). It has been found that changing parameters of secondary importance could have a profound affect on the results, which may bias the analysis. Examples of such parameters include: habitat

targets/constraints, non-SFP yield targets, species composition parameters, cost constraints (such as transportation), constraints on net value, etc.

- Unit value validation: Unit costs such as those used for transportation may vary greatly from one forest area to another. For example, unit values used for loading costs in the GCF business case analysis were set at twice those used in the RMF analysis.

Other Considerations:

The business case analysis quantifies the risks associated with EFP investment in terms of NPV and other economic variables. It also provides an initial risk assessment of the attainable increase in AAC under such an investment. The assessment, however, is dependent on the assumptions used in both the PatchWorks tool and the ForestRAP model. Part of the risk assessment involves the validation of input assumptions and the identification and resolution of possible biases. At the current stage of the analysis, many input assumptions have been validated via background research, consistency checks, and expert opinion. However, possible sources of bias and additional sources of uncertainty have been identified during the RMF and GCF pilot studies that may significantly impact the results. These include:

- Upward Bias in Yield:
 - Post-treatment succession are not accounted for (i.e. the probability that a forest unit converts to a different type of forest unit is assumed to be zero following harvest intervention and silviculture treatment);
 - Natural disturbances are not modeled;
 - Extrapolation of G&Y beyond 100-years is subject to greater uncertainty; and,
 - The treatment of protected areas (such areas should be omitted from the analysis for the entire analysis period even if they are to become available prior to the end of the analysis period, otherwise it may misleadingly lower required silviculture investment).
- Downward bias in short-term silviculture investment:
 - Gap areas not yet identified;
 - Harvest costs fixed over product size (SPF1-2-3);
 - Post-treatment succession not considered;
 - Natural disturbances are not modeled;
 - Without an even investment constraint, the forest planning algorithm decreases the silviculture investment beyond 75 years due to the model horizon and the time required for silviculture benefits to be realized (note: an even investment condition was imposed in this analysis to eliminate this problem); and,
 - Decline in residual growing stock as present levels of excess wood supply are being depleted. Past and present conditions allowed a relatively low investment in silviculture as there was more than adequate wood supply to sustain harvest levels for many periods. That is, the large wood supply was in excess of what was needed for sustainability. However, the residual growing stock has been steadily decreasing in forest areas such as the RMF. Thus, future generations will have to invest more heavily in silviculture to receive the same or less timber harvest than those bestowed upon past and present generations.

For the government, the uncertainty associated with long-term projections may be reduced by investing in yield curves (PSP program), tree improvement, modeling, and monitoring activities. Although reliability of yield curves are central to an equitable government-industry business arrangement, it is the use of those curves, the validity of model assumptions (such as those pertaining to natural and post-treatment succession, available land-base etc.), and the selection of an appropriate base case, that have a large impact on the business case results upon which decisions are made and partnerships are formed.

APPENDIX A: SEIM META-MODEL

As shown in the regression output below, within a given district the SEIM model assumes the level of impact of various management alternatives on GDP is in direct proportion to the wood supply and product type.

1. Kirkland Lake

Model Summary^{c,d}

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	1.000 ^b	1.000	1.000	.02911

- a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.
- b. Predictors: Poplar or Paper
- c. Dependent Variable: GDP
- d. Linear Regression through the Origin

ANOVA^{c,d}

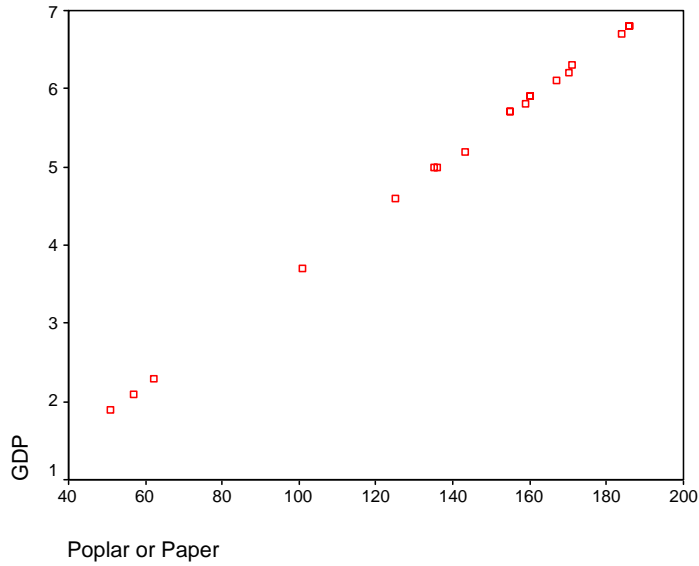
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	592.374	1	592.374	698894.6	.000 ^a
	Residual	.016	19	.001		
	Total	592.390 ^b	20			

- a. Predictors: Poplar or Paper
- b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.
- c. Dependent Variable: GDP
- d. Linear Regression through the Origin

Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Poplar or Paper	.037	.000	1.000	835.999	.000

- a. Dependent Variable: GDP
- b. Linear Regression through the Origin



2. Timmins

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000 ^a	1.000	1.000	.28176

a. Predictors: (Constant), Poplar or Paper, SPF_1

b. Dependent Variable: GDP

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4425.800	2	2212.900	27874.668	.000 ^a
	Residual	1.350	17	.079		
	Total	4427.150	19			

a. Predictors: (Constant), Poplar or Paper, SPF_1

b. Dependent Variable: GDP

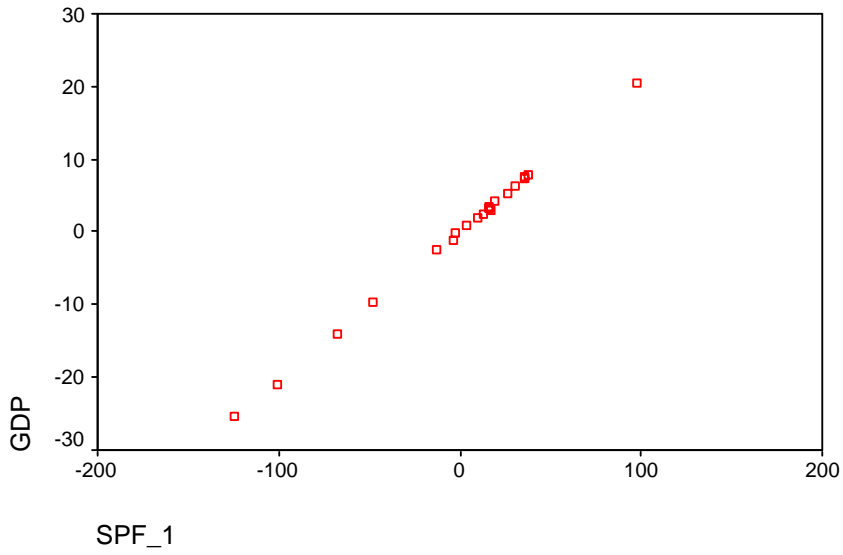
Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.594	.229		120.559	.000
	SPF_1	.207	.001	.867	162.991	.000
	Poplar or Paper	.060	.002	.198	37.189	.000

a. Dependent Variable: GDP

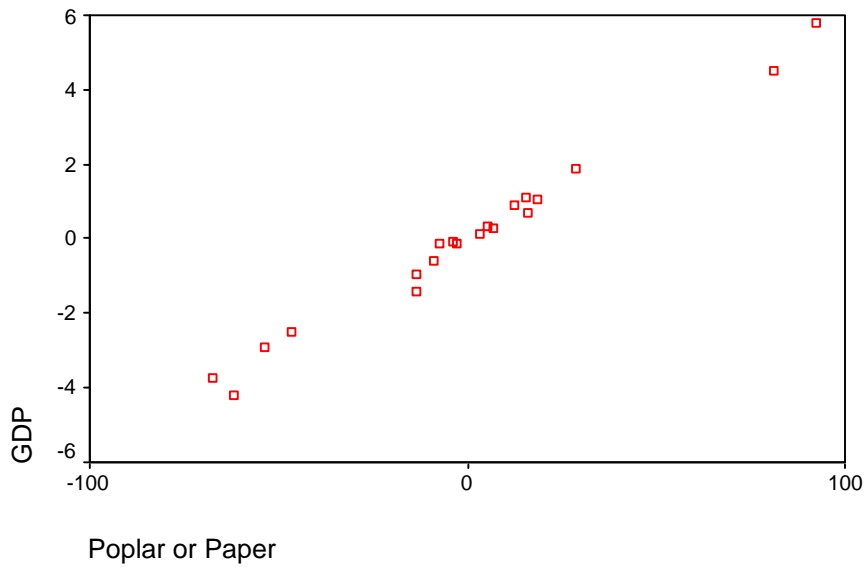
Partial Regression Plot

Dependent Variable: GDP



Partial Regression Plot

Dependent Variable: GDP



3. Hearst & Kapuskasing

Model Summary^{c,d}

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	1.000 ^b	1.000	1.000	.24777

a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.

b. Predictors: VENEER, SPF_1, SPF_2

c. Dependent Variable: GDP

d. Linear Regression through the Origin

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	81150.816	3	27050.272	440627.6	.000 ^a
	Residual	1.044	17	.061		
	Total	81151.860 ^b	20			

a. Predictors: VENEER, SPF_1, SPF_2

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: GDP

d. Linear Regression through the Origin

Coefficients^{a,b}

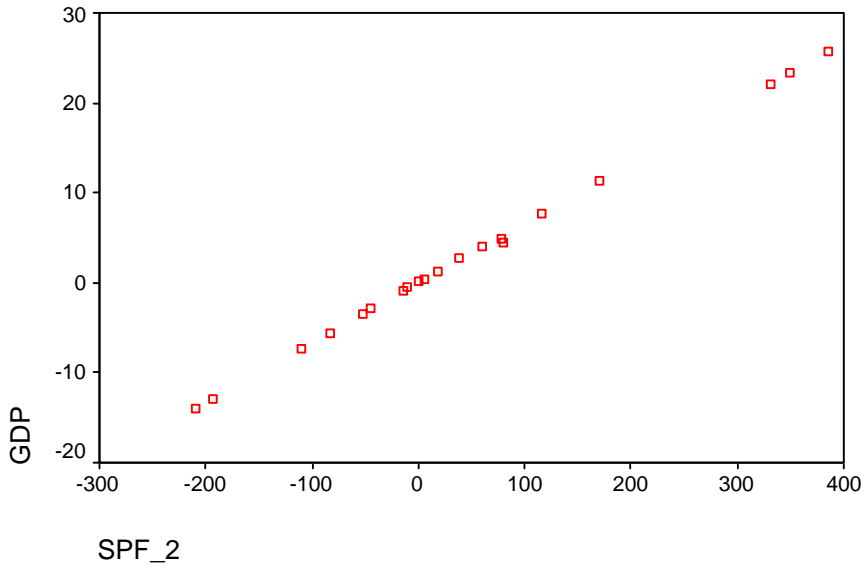
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	SPF_2	.067	.000	.627	198.598	.000
	SPF_1	.081	.000	.391	210.692	.000
	VENEER	.054	.007	.031	7.951	.000

a. Dependent Variable: GDP

b. Linear Regression through the Origin

Partial Regression Plot

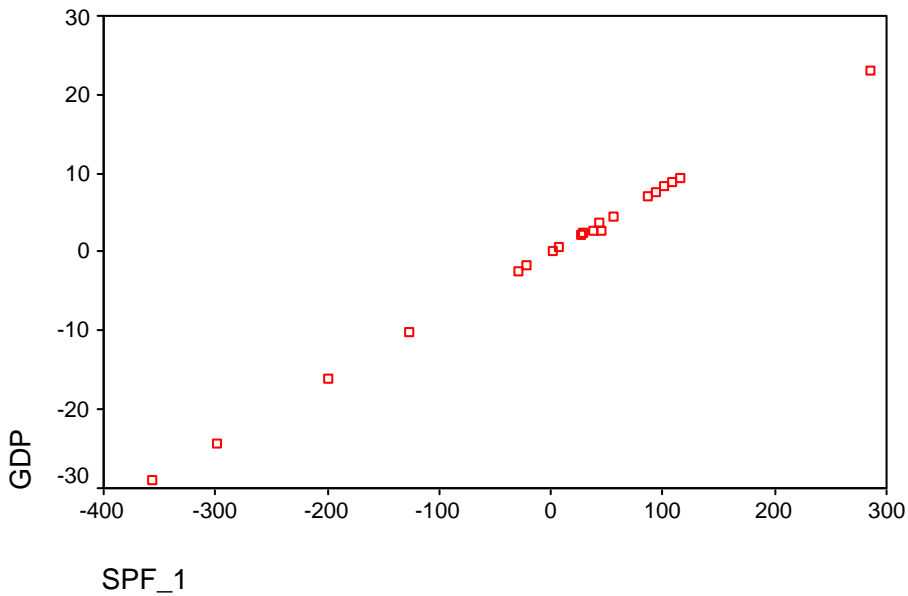
Dependent Variable: GDP



SPF_2

Partial Regression Plot

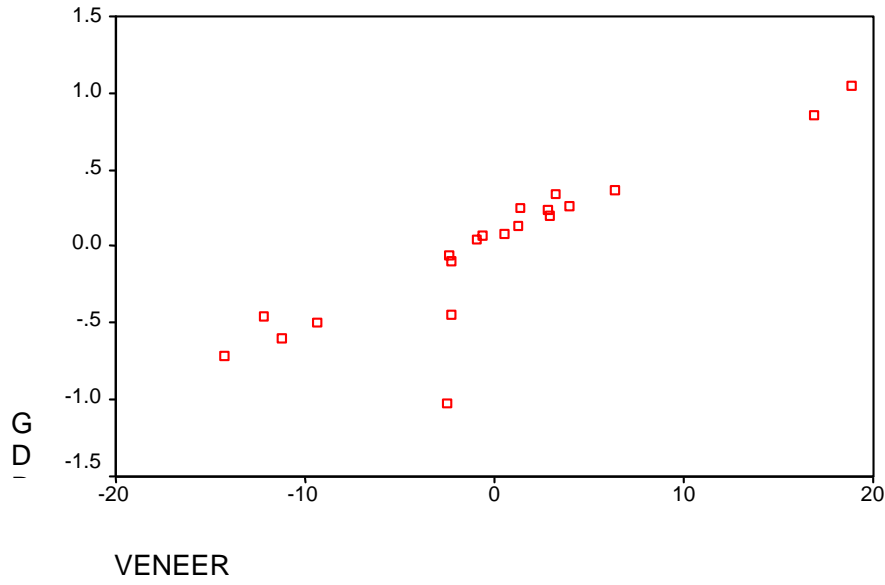
Dependent Variable: GDP



SPF_1

Partial Regression Plot

Dependent Variable: GDP (*Note GDP rounded to \$0.1 million)



APPENDIX B: SCENARIO COMPARISON TABLES

This appendix provides a summary comparison between all six scenarios under consideration. The tables below present the difference in present value over 30-periods for the following:

- Non-timber benefits;
- Socio-economic benefits;
- Total social benefits; and,
- Silvicultural costs.

Table B1: Scenario Comparison (Difference From Base Case, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	\$0.0	\$61.4	-\$94.6	-\$40.3	-\$20.6	-\$157.5
Increase in Socio-economic Benefits	\$0.0	-\$3.6	\$89.1	\$82.3	\$52.7	\$143.8
Net Increase in Social Benefits	\$0.0	\$57.8	-\$5.5	\$42.0	\$32.0	-\$13.7
Increase in Silviculture Costs	\$0.0	\$20.4	\$10.6	\$20.5	\$30.6	\$21.2

Table B2: Scenario Comparison (Difference From Scenario 2, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	-\$61.4	\$0.0	-\$156.0	-\$101.7	-\$82.0	-\$218.8
Increase in Socio-economic Benefits	\$3.6	\$0.0	\$92.7	\$85.9	\$56.3	\$147.4
Net Increase in Social Benefits	-\$57.8	\$0.0	-\$63.3	-\$15.8	-\$25.7	-\$71.4
Increase in Silviculture Costs	-\$20.4	\$0.0	-\$9.8	\$0.0	\$10.2	\$0.7

Table B3: Scenario Comparison (Difference From Scenario 3, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	\$94.6	\$156.0	\$0.0	\$54.3	\$74.0	-\$62.8
Increase in Socio-economic Benefits	-\$89.1	-\$92.7	\$0.0	-\$6.8	-\$36.4	\$54.7
Net Increase in Social Benefits	\$5.5	\$63.3	\$0.0	\$47.5	\$37.5	-\$8.1
Increase in Silviculture Costs	-\$10.6	\$9.8	\$0.0	\$9.8	\$20.0	\$10.5

Table B4: Scenario Comparison (Difference From Scenario 4, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	\$40.3	\$101.7	-\$54.3	\$0.0	\$19.7	-\$117.1
Increase in Socio-economic Benefits	-\$82.3	-\$85.9	\$6.8	\$0.0	-\$29.7	\$61.5
Net Increase in Social Benefits	-\$42.0	\$15.8	-\$47.5	\$0.0	-\$10.0	-\$55.7
Increase in Silviculture Costs	-\$20.5	\$0.0	-\$9.8	\$0.0	\$10.2	\$0.7

Table B5: Scenario Comparison (Difference From Scenario 5, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	\$20.6	\$82.0	-\$74.0	-\$19.7	\$0.0	-\$136.8
Increase in Socio-economic Benefits	-\$52.7	-\$56.3	\$36.4	\$29.7	\$0.0	\$91.1
Net Increase in Social Benefits	-\$32.0	\$25.7	-\$37.5	\$10.0	\$0.0	-\$45.7
Increase in Silviculture Costs	-\$30.6	-\$10.2	-\$20.0	-\$10.2	\$0.0	-\$9.5

Table B6: Scenario Comparison (Difference From Scenario 6, 30-Period Present Value)

Scenario	Scenario 1: 1.1M cut, \$3.0M silv	Scenario 2: 1.1M cut, \$4.0M silv	Scenario 3: 1.15M cut, \$3.5M silv	Scenario 4: 1.15M cut, \$4.0M silv	Scenario 5: 1.15M cut, \$4.5M silv	Scenario 6: 1.2M cut, \$4.0M silv
Increase in Non-Timber Benefits	\$157.5	\$218.8	\$62.8	\$117.1	\$136.8	\$0.0
Increase in Socio-economic Benefits	-\$143.8	-\$147.4	-\$54.7	-\$61.5	-\$91.1	\$0.0
Net Increase in Social Benefits	\$13.7	\$71.4	\$8.1	\$55.7	\$45.7	\$0.0
Increase in Silviculture Costs	-\$21.2	-\$0.7	-\$10.5	-\$0.7	\$9.5	\$0.0

Figure B1: Annual SPF Harvest Flow: Base Case

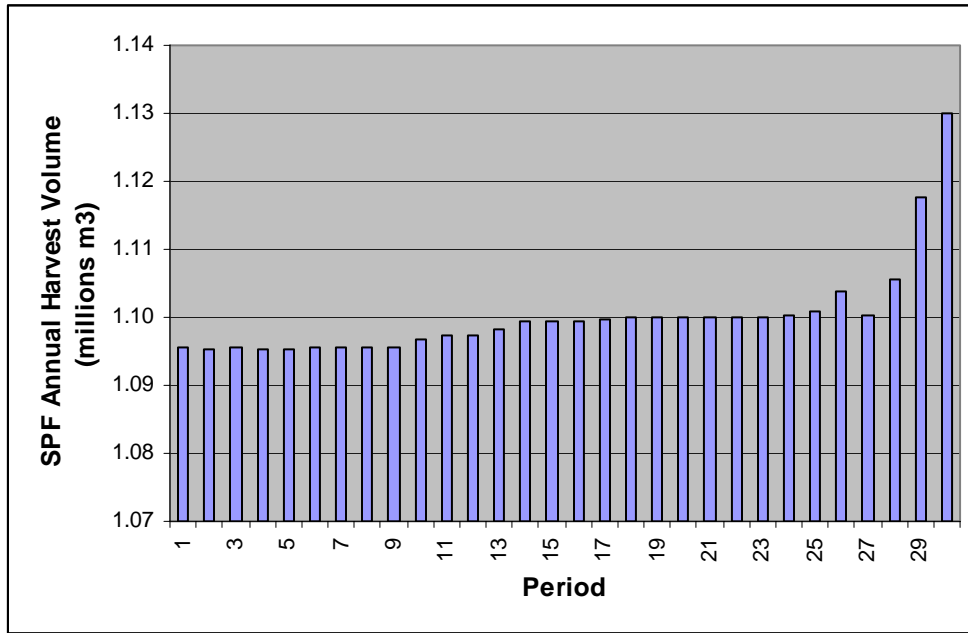


Figure B2: Annual SPF Harvest Levels, Scenario 2

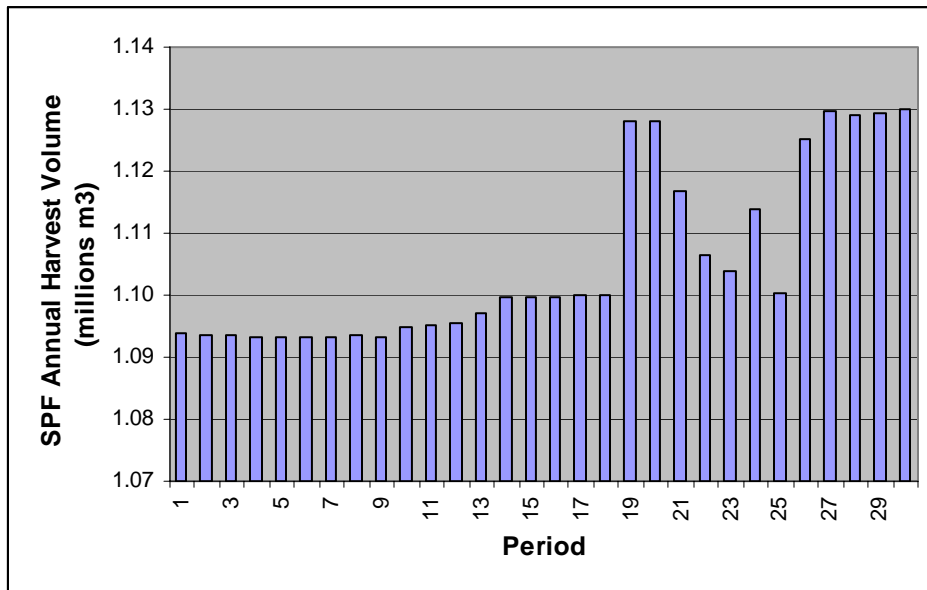


Figure B3: Annual Total Harvest Levels, Scenario 2

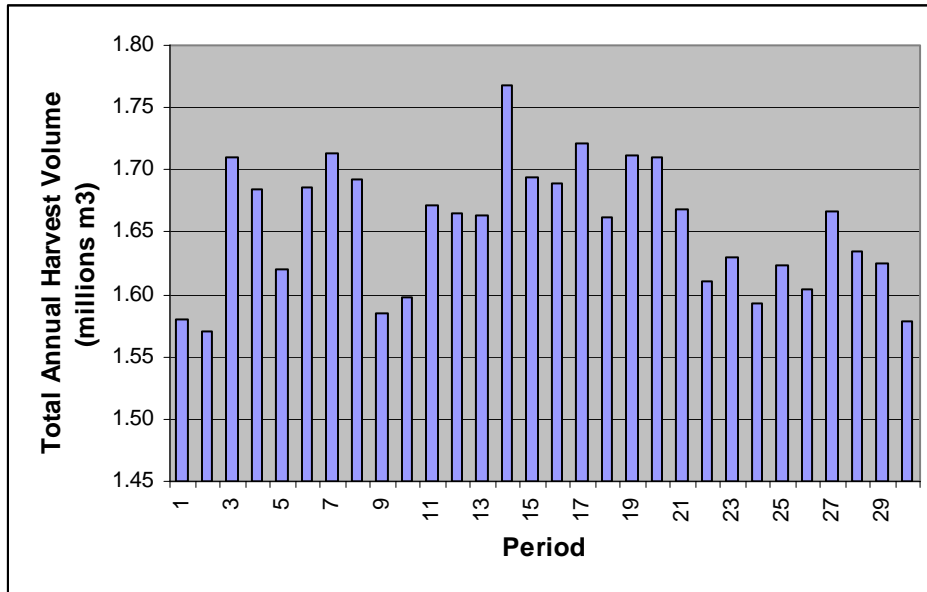


Figure B4: Annual SPF Harvest Levels, Scenario 3

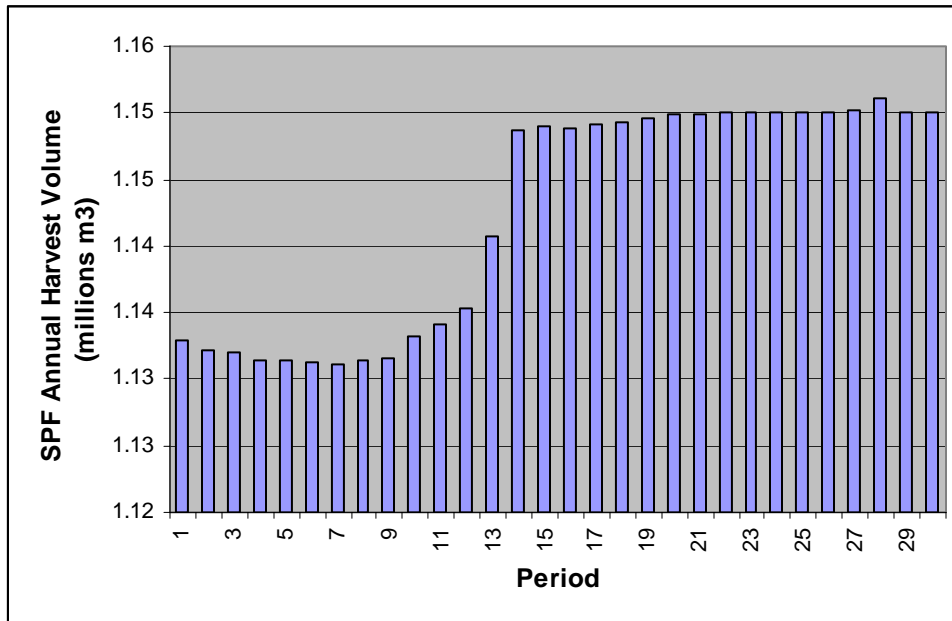


Figure B5: Annual Total Harvest Levels, Scenario 3

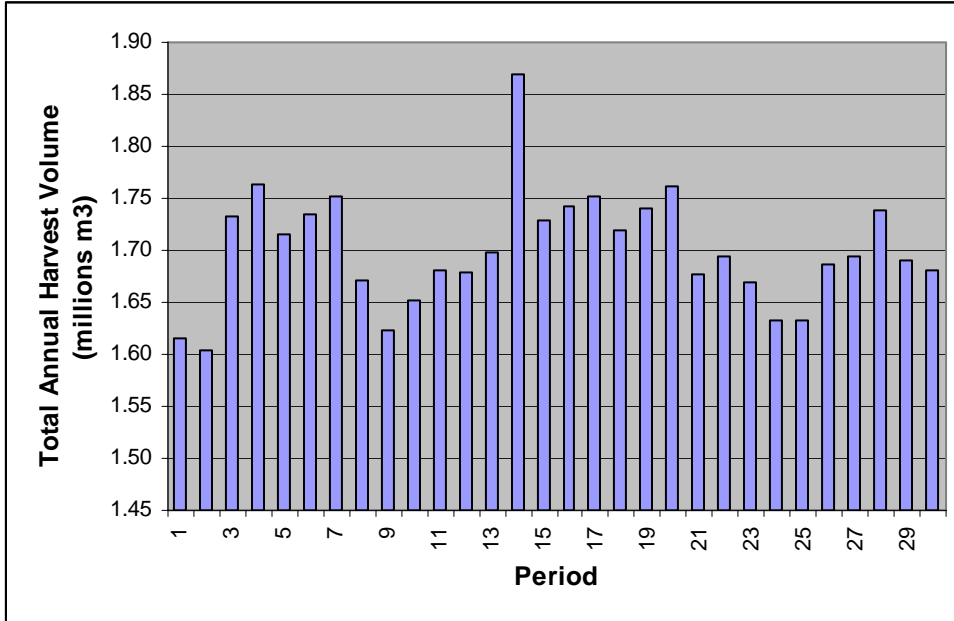


Figure B6: Annual SPF Harvest Levels, Scenario 4

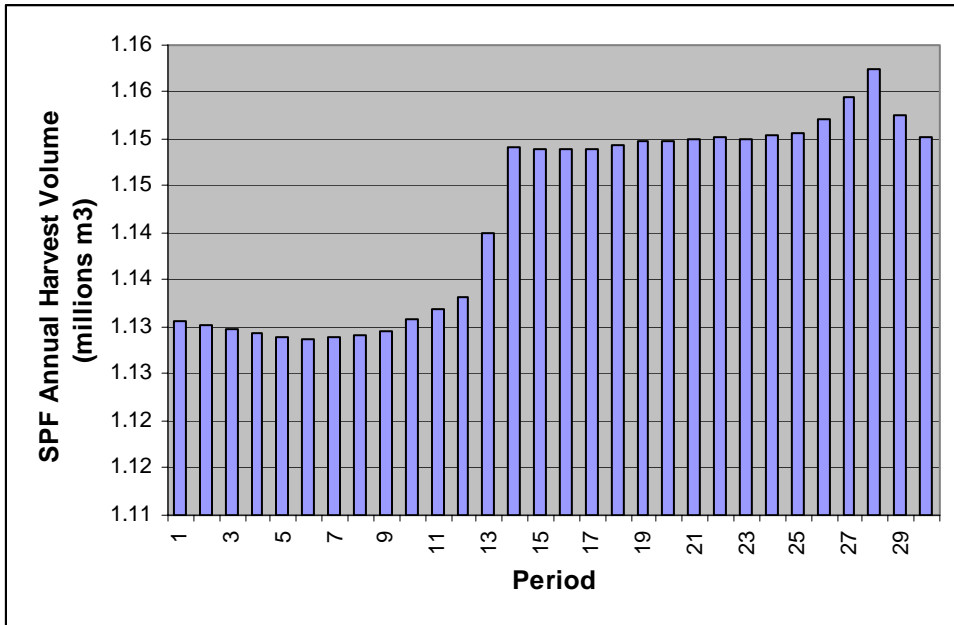


Figure B7: Annual Total Harvest Levels, Scenario 4

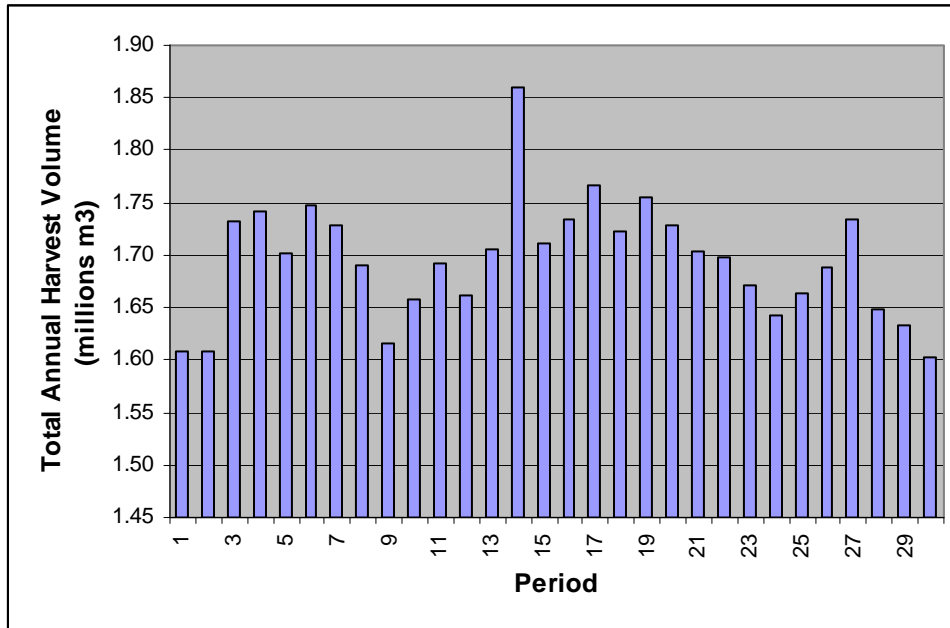


Figure B8: Annual SPF Harvest Levels, Scenario 5

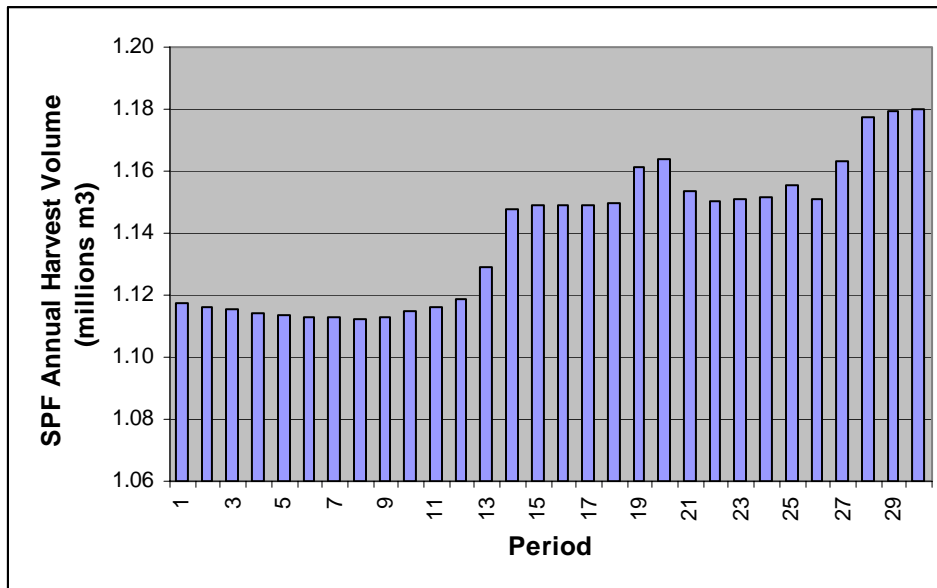


Figure B9: Annual Total Harvest Levels, Scenario 5

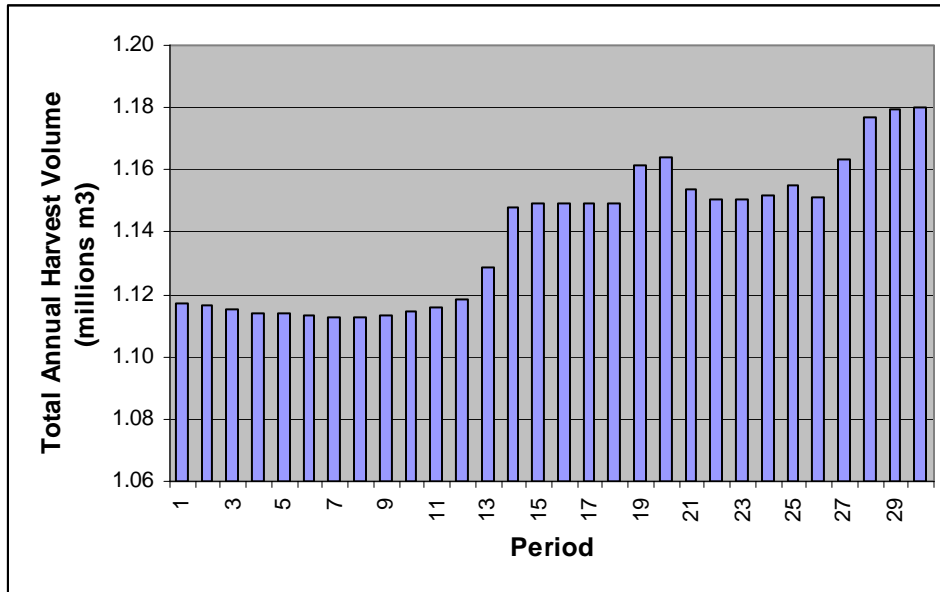


Figure B10: Annual SPF Harvest Levels, Scenario 6

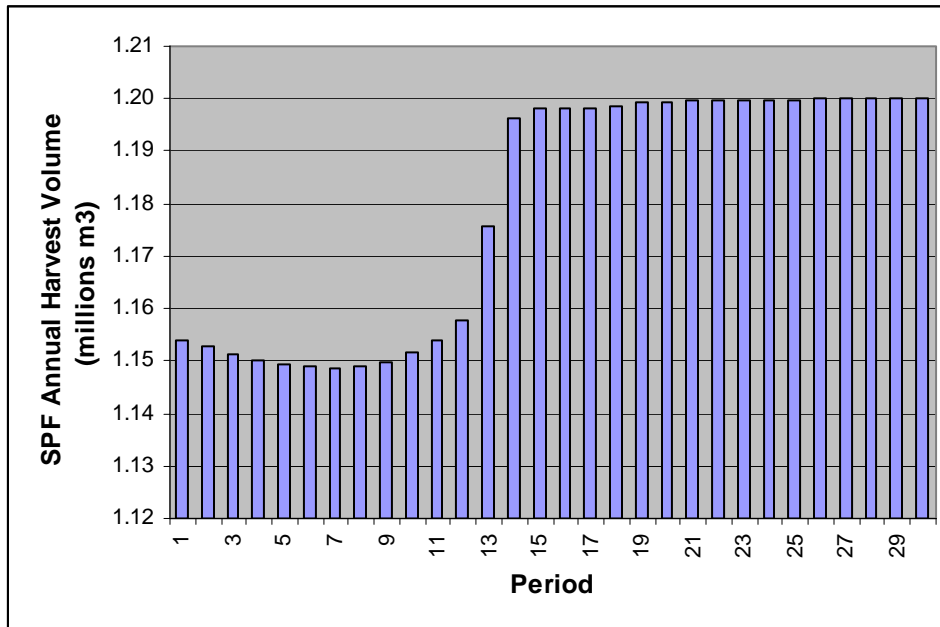


Figure B11: Annual Total Harvest Levels, Scenario 6

