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Incremental Silviculture Strategy For British Columbia

Working Paper 5: Proposed Financial and Socio-economic Analysis Framework

PREPARED FOR

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Ministry of Forests,

Province of British Columbia

This document has not had expert review and may be subject to extensive revision.
In its present form it should be regarded as a concept/discussion document only.

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Incremental Silviculture Strategy For British Columbia

This document is one of seven working papers prepared as background to the preparation of an incremental silviculture strategy for British Columbia.

The Working Papers are individually subtitled as follows:

- *Working Paper 1: Project Information, References*
- *Working Paper 2: Concepts of Strategy and Planning, Proposed Planning Framework*
- *Working Paper 3: Government's Goals, Proposed Guiding Principles*
- *Working Paper 4: Proposed Log Quality Framework, Timber Supply and Demand*
- *Working Paper 5: Proposed Financial and Socio-economic Analysis Framework*
- *Working Paper 6: Summary of TSA Basic Data*
- *Working Paper 7: Review of TSA Issues and Planning Processes*

This report contains a proposal for a framework for the use of financial and socio-economic analysis in incremental silviculture planning.

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1. Introduction

1.1 Terminology

To the uninitiated, and sometimes even within professions, terminology can be confusing. To avoid this state, a few definitions are offered here.

In this paper, the term *economic* is used in the broad, all-inclusive sense, similar in meaning to that a person would give the term "the economy." To differentiate economic analysis methodologies for incremental silviculture, these are divided into two primary categories, financial analysis and socio-economic analysis. A *financial analysis* is an examination of only the monetary costs and benefits of a proposed program or project, in contrast with a *socio-economic analysis* which includes all costs and revenues (benefits), whether measured in monetary or other terms (Gregory, 1987:294). The broader socio-economic analysis considers externalities (e.g., costs or benefits to third parties) and provides a structure to aid analysis as to whether society as a whole is better or worse off in association with each alternative. A socio-economic analysis may include a financial analysis of those elements that lend themselves to it. However, the reverse does not hold; that is, a financial analysis does not extend beyond the boundaries of monetary costs and benefits to include non-monetary aspects.

Although many economists consider the terms *socio-economic* and *economic* to mean the same thing, the more specific term *socio-economic* is used to differentiate this aspect from the purely financial aspects of economics.[1] This is necessary because the term *economic* is often used in the literature to mean *financial.*

Within the two categories of financial and socio-economic analysis are a number of specific analysis methodologies. A brief description of those that are relevant to publicly funded incremental silviculture follows. The majority of these are socio-economic analysis methodologies. The only strictly financial analysis methodologies described are net present value (NPV) analysis

[1] The same terminology discipline, of course, cannot be maintained within quotes from the literature. Hopefully, the intended meaning of terms will be clear.

(as noted above, it can also be part of a socio-economic analysis) and internal rate of return (IRR) analysis. Cost-effectiveness analysis typically is a form of financial analysis, but may take on the aura of a socio-economic analysis if some social indicators are included.

benefit-cost analysis: "an analytical technique that estimates the net benefits of a management option using social (non-market) costs and benefits as well as financial (market) costs and benefits." (British Columbia, 1992:41) Where possible, benefits and costs are measured in monetary terms and a benefit-cost ratio determined for each option. Intangible impacts which cannot be translated into monetary terms are also recorded for each option. (Field & Olewiler, 1995: 113-114)

economic impact analysis: "an analytical technique that estimates the impacts of a management option on income and employment within specific communities, regions or the province." (British Columbia, 1992:41)

multiple accounts analysis: "…an analytical technique that specifies a framework of evaluation accounts under which management options can be systematically assessed in terms of their social and economic impacts." (British Columbia, 1992:41-42) No attempt is made to reduce impacts to a single common denominator (such as $ values), nor is a 'net' impact determined.

social impact analysis: "…an analytical technique that identifies and assesses demographic, local government and community concerns." (British Columbia, 1992:41-42)

cost-effectiveness analysis: "…an analysis…in which we look for the way of achieving the greatest improvement in some environmental target for a given expenditure of resources." Put another way, it "…essentially takes the objective as given, then costs out various alternative ways of attaining that objective." (Field & Olewiler, 1995: 17, 109)

net present value (NPV) analysis: an analytical technique which determines whether future income from a project is greater than the costs incurred to generate the income (including the cost of capital) by discounting both income and costs to a single net present value. NPV analysis is one of the most commonly used forms of financial analysis in silviculture investment decision-making. It is discussed in greater detail on page 4.

Internal rate of return (IRR) analysis: determines "the rate [of interest] earned on all project costs by the anticipated revenues." It is the rate of interest that makes "…the sum of all discounted project costs exactly equal to the sum of all discounted project revenues, which means it is the discount rate that makes the net present value of a project equal to zero." (Gregory, 1987:250)

1.2 Why is a Framework Necessary?

The *Ministry of Forests Act* (s. 4) directly charges the ministry to "manage, protect and conserve the forest and range resources of the government, having regard to the **immediate and long term economic and social benefits** they may confer on British Columbia." (Bold added for emphasis.) A framework for the financial and socio-economic analysis of possible ministry management, protection and conservation options is necessary to properly fulfill this responsibility.

Less directly, the literature review conducted under the wider aspects of this project uncovered a number of items that also indicate the need for a financial and socio-economic analysis framework. These are:

1. Some documents reviewed encourage or imply rigid application of stand level net present value analysis to incremental silviculture treatment decisions. For example, one draft manuscript considered investments that do not indicate a positive NPV at a 4% discount rate to be 'irresponsible.'[2] Such a statement implies that there can be no other valid reason to consider the treatment.
2. The Ministry of Forests' *Silviculture Manual* acknowledges that other values need to be taken into account in a 'financial' analysis, but provides little guidance as to how this may be done.
3. Lastly, the management literature indicates the potential exists for the rigid application of capital budgeting criteria (nearly always involving a financial analysis) at lower organizational levels to "…destroy any strategic patterns top management may have selected earlier." (Mintzberg, 1996: 131-132)

It is evident from the BC forestry literature that there is some confusion over the respective roles and uses of financial and socio-economic analysis methodologies, especially in a public funding environment. This is likely because, as will be seen, there are neither financial analyses of management unit level effects of incremental silviculture nor socio-economic analyses at this or higher levels.

The following quote from Brumelle contrasts with the simplistic approach to forest investment decision-making demonstrated in item 1, above.

> "Unstructured or unprogrammable problems have been called 'wicked', because they resist our attempts to solve them using conventional analytical tools. Wicked problems are both complex and organized. The silvicultural investment problem is one such wicked decision problem. It is complex because the underlying forest management system must consider many interacting ecological and economic subsystems, and constitutes a prime component of the general fabric of our political and social system. The problem is also organized, since these subsystems are interdependent and are connected by strong feedback loops, so that an action in one component also affects the behaviour in other components. (1991:804)

Another often overlooked factor is that a financially efficient stand level treatment program is not necessarily *dynamically efficient.* Attaining dynamic efficiency requires management unit level analysis, looking at the effects of a program over time and in the context of the whole unit and its sustainable harvest flow as well as other objectives.

Intertwined with the evident confusion between stand level financial and higher level socio-economic evaluation methodologies, is the confusion between stand level and forest level (management unit) management. Baskerville states,

> Contemporary discussion in BC confuses *stand* silviculture, and *forest* management. In context of forest level management, silviculture is a tactical tool used to manage local stand composition and structure with the intent of creating a future stand composition or structure *that has context in a strategic goal of managing the pattern of stand types and stages of stand development across a whole forest*. (1998:3)

[2] BC MoF, 1997f. The document was in early draft form when reviewed and has since been changed.

The outcome of stand level financial analysis should **never** be interpreted as a strategy in itself. Although a silvicultural treatment may be highly cost-effective at the stand level, it could be exactly the opposite at the forest level. For example, commercially thinning a particular type and age of stand might be indicated by a stand level financial analysis to be an appropriate action. The CT would partially recover the cost of stand establishment and changes an otherwise negative net present value, indicating the establishment to be a "poor" investment, to a positive one. However, this early commercial harvest might be shown at the forest level to be unwise, for it reduces future volume from a critically short age class, making a significant harvest flow problem twenty years down the road even worse! This wouldn't be known without forest level analysis. In this hypothetical situation, what is indicated to be a sound financial move at the stand level proves just the opposite at the forest level.

The foregoing discussion indicates the need for a financial and socio-economic analysis framework that will:

- provide foundation and structure to incremental silviculture investment decision-making at all levels, particularly at the management unit level;
- provide a perspective that incorporates government strategy and values in the allocation of funds and selection of incremental silviculture treatments;
- support the most efficient use of available public silviculture funding within the constraints set out by government or a public funding agency; and
- indicate the gaps in knowledge and methodology that need further research and development action to fill.

A financial and socio-economic analysis framework is essential to support both the continuing evolution of new strategy as well as the economically efficient delivery of existing strategy.

1.3 Financial Analysis - The Silvicultural Context

As previously noted, net present value (NPV) analysis is the most commonly used form of financial analysis of incremental silviculture projects. Because of its central role, this section describes NPV analysis in greater detail.

Due to the long term nature of most silvicultural investments, foresters often use net present value (NPV) analysis to assist in the decision process for stand level silvicultural treatments. This methodology handily reduces sets of stand and stock tables, costs, potential products, and future income streams, which are awkward to compare between alternatives, to single net present values which are easy to compare. Based on the assumptions employed, NPV analysis points to which are the 'best' investments.

In the private sector, NPV analysis is most often associated with capital budgeting, with a discount rate chosen to represent the cost of capital along with a risk premium reflecting the riskiness of an individual project and/or an entire industry sector.[3] In the public sector, NPV analysis is often associated with benefit-cost analysis and cost-effectiveness analysis, with a *social discount rate*

[3] Inherent with the use of discounting methodologies is probably acceptance of the implied theorem that risk and uncertainty increase exponentially over time, rather than increasing at some constant rate.

being used primarily as a measure of society's willingness to sacrifice present consumption for future benefits.

Planners calculate a net present value by estimating the timing and cost of silvicultural treatments, the timing and amounts of net income from harvests (that is, the income after harvesting costs are deducted), and discounting all of these to a single net present value. Management costs incurred over the life of the investment may also be discounted.

A *site value* is the net present value of an infinite number of successive rotations on a site managed under the same regime. Site value takes into account the delay between harvesting and regeneration. It is most often used in land valuation. It can also be used for comparing different silvicultural treatment options having different payback periods. For simplicity, this discussion only addresses the net present value of a single rotation.

The primary application of NPV calculations is to compare the results of one or more treatment possibilities on the same stand. Using computer models, planners grow both the treated and untreated stand to a series of harvest ages, usually at ten year intervals. They then determine net income from each harvest either at the log or forest product level. This requires inputs of anticipated future logging, transportation and manufacturing costs, as well as log or product prices. Net income at each harvest age is discounted to the present at a specified discount rate. For the treated stand, this discounted net income is subtracted from the cost of the treatment.[4] The harvest age which yields the highest NPV is the *financial rotation age*. The net present value of the treated stand at financial rotation is compared with that of the untreated stand. Generally, if the NPV of the treated stand is positive and is greater than that of the untreated stand, planners consider the treatment to be a desirable investment.

One or more treatment options may yield a negative NPV, even at its financial rotation age. This indicates future net income is not sufficient to offset the cost of the treatment at the discount rate used. However, this does not necessarily mean that a loss will be directly incurred. Rather, it means that a positive return cannot be expected at the discount rate used. For example, if a 4% discount rate is used, a negative NPV means a 4% interest on the investment will not be achieved. In a public policy context, depending on other factors, such as an objective of creating employment, this may not be as important as which treatment option yields the highest, or least negative, NPV. In the private sector, if 4% were the actual cost of borrowed capital, then this cost would not be covered and a loss would indeed occur. If the capital was not borrowed but rather came from equity, then the failure to earn a 4% return would be considered an inefficient use of the equity capital as other opportunities could (theoretically) have provided a greater return.

The choice of discount rate is often critical to the result. Generally, the higher the discount rate and the further out in time until final harvest, the less likely an NPV is to be positive; that is, the less likely that the cost of the treatment can be recovered at the rate of interest (the discount rate) used. Thus the choice of discount rate is central to the use of NPV analysis for incremental silviculture. Discounting is discussed in detail on pages 18 - 27.

[4] If the treatment is applied at other than year 0, its cost would also be discounted - in this case it is assumed to be at year 0.

2. The Current Status in BC

This section contains a brief review of existing financial and socio-economic analysis models and information for incremental silviculture at the stand, management unit, regional and provincial levels.

2.1 Stand Level

Stand level refers to treatments applied to individual forest stands. Financial analysis is normally the only analysis methodology used at this level.

Despite what the term might imply, stand level financial analysis is appropriately applied to classes of stands rather than individual stands. The US Forest Service manual (1990) states, "When using economic analysis to help set priorities, do not analyze each stand individually. Analyze representative types of stands and treatments, then apply the analysis results to similar types of stands."[5]

In British Columbia, a reasonable body of NPV financial analysis work exists at the stand level. The Ministry of Forest's *Silviculture Manual* (no longer in print) contains a substantial set of NPV tables (Section 9.2) for juvenile spacing by various pre- and post-spacing densities by region (coast, northern interior and southern interior), species and site class. A number of other reports containing stand level analyses are available (for example: Lang & McCullock, 1993[6]; Massie, 1995; McWilliams & Carter, 1998; Stone 1993 & 1996).

A financial analysis module is included as part of the latest release of the ministry's Table Interpolation Program for Stand Yields (TIPSY) program. This module allows comparing NPV's for spaced and unspaced stands only. Today's spreadsheet programs make undertaking a custom analysis for any silvicultural treatment a relatively simple task. However, the limited availability of growth and yield data affects the usefulness of such tools. This is discussed further in "Data," page 27.

2.2 Management Unit Level

The two principal types of forest management unit in BC are the timber supply area (TSA) and tree farm licence (TFL). Socio-economic analysis is most appropriate at this planning level. A full socio-economic analysis would incorporate:

1. a stand level financial analysis to examine general stand treatment priorities across the range of species and sites within the unit and to assist in establishing potential treatment regimes;
2. a management unit level financial analysis to examine the monetary costs and revenues of incremental silviculture treatments and treatment regimes on achieving management unit objectives, particularly harvest flow and timber quality objectives;

[5] The term "economic analysis" is used in the quote. Under the terminology conventions of this report the kind of analysis referred to in the quote is considered a 'financial' analysis.

[6] This report is the source document for the tables in the *Silviculture Manual*.

3. an analysis of the wider social and economic impacts of several feasible program alternatives, looking at the full spectrum of costs and benefits at the management unit and provincial levels.

Stand level financial analysis was discussed in the preceding section. A review of the other two forms of analysis follows.

Management Unit Level Financial Analysis

The literature review found only one unpublished report (Barker, 1997a) containing a management unit NPV analysis of different spacing options and the effects on harvest forecasts for a coastal BC tree farm licence. Other studies (Messmer & White, 1998; Reid Collins, 1993c; Timberline, 1997) indicate the potential influence of incremental silviculture options on harvest flow, but do not contain a financial analysis per se, and more often than not involve a portion of a management unit rather than the whole. Messmer and White, for example, show outputs at various budget levels, but do not perform NPV analysis.

The Ministry of Forests does not have a standard methodology or model for either financial or socio-economic analysis of silviculture investments at the management unit level. This is a serious deficiency, as one of the major potentials of juvenile spacing, fertilization and commercial thinning is changing harvest flow patterns. Such effects are only measurable at the management unit level. In contrast to BC, the US Forest Service requires, "Within the framework of general Regional timber stand improvement (TSI) guidelines specific TSI guidelines *based on forest level analysis* must be established." (US Forest Service, 1990 - italics added)

Management Unit Level Socio-economic Analysis

The literature review found only one study at the management unit level that incorporates socio-economic outcomes of various incremental silviculture scenarios at the management unit level. This study, *The Potential Impacts of Enhanced Forestry on Forest Productivity and Yield in Three B.C. Timber Supply Areas* (Alexander et al, 1997), uses a multiple accounts analysis methodology examining silviculture activities in several TSA's. However, the study specifically made no attempt "to assess the economic feasibility of the silviculture treatments included in the model." (p.2)

British Columbia uses a multiple accounts analysis methodology to assess forest land management options (British Columbia, 1992). The Ministry of Forests has adapted this methodology for socio-economic analysis of timber supply forecasts. The methodology could also be adapted for management unit level modeling and socio-economic analysis of silvicultural treatment program options.

A form of cost-effectiveness analysis has been undertaken for all Vancouver Forest Region and some Nelson Forest Region TSA's. The objective of these analyses was to optimize the benefits of existing incremental silviculture program funding. They do not include a management unit level financial analysis, nor do they evaluate or compare options.

The absence of computer models and reliable data for management unit level analysis of incremental silviculture has been limiting in the past. While some limitations still exist, most have now disappeared. Forest inventory data sets at the management unit level are now regularly updated every five years. Computer processing power has increased enormously over the last decade,

with cost declining at the same time. Proprietary models are available, two examples of which are Woodstock,™ which can be used for undertaking constrained linear optimization analyses, and Options, which is a simulation model.[7] For an example of an application using Woodstock™, see *A Forest Estate Plan for the Invermere Enhanced Forest Management Pilot Area* by Messmer and White. For an example of an application using OPTIONS, see *The Potential Impacts of Enhanced Forestry on Forest Productivity and Yield in Three B.C. Timber Supply Areas* by Alexander et al.

The most significant deficiency remaining at the management unit level is growth and yield information for managed stands. This is discussed under "Data," page 27.

2.3 Regional Level

Regional level here refers to a large sub area of the province and is not necessarily synonymous with Ministry of Forests' regions. Some studies assess the entire BC coast which includes all of the Vancouver Forest Region and some of the Prince Rupert Forest Region. Other studies break the province into three or more regions for analysis.

Forest and Range Resource Analysis Reports

The Ministry of Forests' 1980 *Forest and Range Resource Analysis Technical Report* (1980b) contains projections of harvest levels based on three harvest level targets for each of eight regions. An analysis was not made of ways to influence future outcomes, such as the costs and benefits of various levels of silviculture investment. The 1980 analysis format was not repeated in either the 1984 or 1994 resource analyses.

Benefits of Incremental Silviculture Study

A socio-economic analysis of incremental silviculture was undertaken by the Ministry of Forests in 1990. This study, *Benefits of Incremental Silviculture,* divided the province into three regions and assessed total annual program expenditure alternatives of $18, $30 and $75 million for spacing, fertilization and pruning activities. It showed these expenditures would respectively yield 4%, 3% and 2% returns to the province. At the $75 million level "…lower priority incremental silviculture treatments are being applied. Many of these investments have poor or negative volume returns, and the impact is to reduce total harvest." (BC MoF, 1990b:8)

The study employed a "division of investment dollars and harvest [that] considered regional equity and social returns. If only economic returns are considered then higher proportions of the investment levels and the harvest levels should be allocated to the coast." (BC MoF, 1990b:6)

Key assumptions of the *Benefits* study were a 1%/year increase in future real log prices, a 15% operational adjustment factor on managed stand yields, and a two metre increase in site index for the incremental yield tables for poor and medium sites to represent an increase in top height achieved from spacing (BC MoF, 1990b:22). When log prices were held constant, only the $18 million program yielded a positive NPV at a 2% discount rate, but the operable wood supply was significantly expanded. The annual program levels -- $18, $30 and $75 million – were shown to

[7] Mention of these models is not intended as an endorsement or recommendation.

increase economically available wood supply by 1.3, 1.9 and 6.7 million cubic metres respectively. (BC MoF, 1990b:26-27)

Beyond the normal timber parameters, the *Benefits* study also looked at employment, forest health, biological diversity, rangeland, wildlife community and water resource benefits.

The *Benefits* study is a good example of a socio-economic analyses of silvicultural treatment options at the regional level. However, as the study itself states, "Local timber shortages that incremental silviculture would alleviate could not be reflected in the analysis and, therefore, a conservative estimate of potential benefits is presented." (BC MoF, 1990b:7) Complete analysis of the benefits of incremental silviculture, therefore, requires analysis down to the management unit level.

The model used in support of the *Benefits* study was a provincial level strategic model for incremental silviculture developed by ESSA in the late 1980's through funding by the Ministry of Forests. It does not appear to have been used by the ministry since.

Timber Supply and Silvicultural Investment Study

Messmer (1995) reported a demonstration of the Price Responsive Timber Supply Model (PRTSM) in *Timber supply and silvicultural investment in an economic context for coastal British Columbia*. The study applied to nine coastal timber supply areas (TSA's). Tree farm licences were not included. The coast data set consisted of 23 analysis units, each represented with its own set of cost, value, and yield curves, and its own set of silviculture responses and conditions. Regenerated or second-growth forest land is represented by a further 42 analysis units. Eight scenarios were run for the analysis based on variations in silviculture budget, a harvest schedule, a projection of annual real price change, a discount rate, and a discrete 20% first 5-year period price shock variable. Silviculture activities consisted of no treatment, planting, backlog regeneration and spacing, along with cost and labour productivity data. The main effects of the first 3 activities on the model are the re-assignment of harvested areas to different analysis units with different yield, cost and value curves and to vary regeneration delay. The effect of spacing, other than as a cost/labour productivity factor, is unclear but presumably affects log diameter distributions.

An important difference between this and other timber supply models is that PRTSM contains "…the notion of log value by diameter class, but not all possible variation on log value can be captured by this relationship alone." (1995:14)

Although the exercise was primarily intended as a demonstration, Messmer concludes "…that there is likely some optimum level of silviculture expenditure that satisfies timber supply sustainability constraints, and that this optimum level is highly dependent on future price expectations. Allocation of large sums (i.e. unconstrained) silviculture expenditures in the absence of sufficient future price expectations will have little effect on economic timber availability." Also "Timber supply has been shown to be highly responsive to both negative and positive price changes …. Excessively high costs or low prices (or a combination of the two) can, with relative ease, render forest growing stock 'no longer a going concern.'"(1995:24) This last observation appears very accurate in light of the extensive coastal forest operations shutdowns over the fall/winter of 1998/99 due to the high cost/low price factors.

With regard to the future potential of the model, Messmer observes that modifications could be made to the PRTSM code to include a higher order of silviculture detail. He also observes that

the model could be used for more detailed analysis of much smaller geographic areas of forest. (p. 15)

It appears that, with considerable development, PRTSM offers potential for silvicultural analysis at the management unit or higher level.

2.4 Provincial Level

Aside from the previously mentioned 1990 report, *Benefits of Incremental Silviculture*, there are no published socio-economic analyses of incremental silvicultural treatment options at the provincial level.

A structure for socio-economic analysis of silviculture treatment alternatives exists in section 8 of the *Ministry of Forests Act.* However, the analysis of options is reserved for presentation to cabinet and is not required under section 9 of the act to be released publicly. Sections 8 and 9 of the act are quoted below.

> **Five year resource program**
>
> **8** Not later than September 30 of each year the minister must submit to the Lieutenant Governor in Council a forest and range resource program containing
>
> (a) a presentation of the alternatives available for establishing free growing stands on forest land, for increasing the productivity of forest and range land and for otherwise improving forest and range resources in British Columbia, identifying the following:
>
> (i) estimated capital and current expenditures associated with each alternative;
>
> (ii) the estimated effect of each alternative on the productivity of the resources;
>
> (iii) estimated direct and indirect economic and social benefits and costs associated with each alternative;
>
> (iv) an assessment of the priorities that should be given to each alternative, and
>
> (b) a program recommended to be implemented by the ministry during the 5 year period beginning April 1 of the year following the date it is submitted, for establishing free growing stands on forest land, increasing the productivity of forest and range land and otherwise improving forest and range resources in British Columbia, including the following:
>
> (i) a schedule for implementing the program;
>
> (ii) the method to be used and priorities adopted for implementing the program;
>
> (iii) the roles to be played by the government and the private sector in implementing the program.
>
> **Analysis and program to be laid before Assembly**
>
> **9** A forest and range resource analysis and a forest and range resource program must be laid before the Legislative Assembly no later than 15 days after commencement of the first session in the calendar year following its submission to the Lieutenant Governor in Council under sections 7 and 8.

2.5 Summary & Conclusions

The following conclusions are drawn from the above review.

1. Stand level analysis is appropriately applied to classes of stands and not individual forest stands.
2. In British Columbia, a reasonable body of stand level NPV analysis work has been performed. A stand level financial analysis tool for spacing most major conifer species is available. Spreadsheet programs make constructing financial analysis tools for other species and treatments relatively simple. However, growth and yield data for such tools are limiting.
3. Little financial or socio-economic analysis has been published at higher levels. Management unit financial or socio-economic analyses of incremental silviculture program options are practically non-existent. A form of program optimization analysis has been undertaken for all Vancouver Forest Region and some Nelson Forest Region TSA's.
4. The Ministry of Forests does not have a standard methodology or model for either financial or socio-economic analysis of silviculture investments at the management unit level.
5. A framework for multiple accounts analysis of incremental silviculture at the management unit level can be readily developed.
6. A provincial/regional socio-economic analysis of three incremental silviculture activities was conducted in 1990, but was not widely published. While an excellent product at the time, it would now be considered narrowly focused. The study acknowledges that it underestimates the potential of incremental silviculture because the model used was incapable of demonstrating timber supply effects at the management unit level.
7. A framework for socio-economic analysis for incremental silviculture (among other things) is laid out in the *Ministry of Forests Act*, but the results of such analysis are not required to be publicly released.
8. Proprietary models using linear programming and simulation techniques are available for management unit simulation. Updated timber inventory data packages are available through the timber supply review process.
9. There does not appear to be a provincial level model that is capable of simulation down to the management unit level (of which there are 71 in the province). Because of the magnitude of such an analysis, it is probably better approached by conducting independent regional analyses and merging the results into a provincial analysis.

3. Key Considerations

The province has historically funded incremental silviculture activities for three basic purposes; for economic aspects such as regional development and strengthening the provincial economy; for short term social benefits, such as job creation and community stability; and for long term social benefits which are typically values-driven, such as for purposes of inter-generational equity, biological diversity, sustainability and global environmental services. Because a successful frame-

work must adequately cover all three of these fundamentals, each is addressed separately in this section.

3.1 Economic Development and Investment

Economic development and forest investment fall more within the domain of broad, classic economics. Over the past 20 years or so, both the provincial and federal governments have funded incremental silviculture programs for the express purposes of economic and regional development. The Forest Resource Development Agreements (FRDA's) are examples of such programs. Further evidence of government actions towards this purpose is contained in *Working Paper 3: Government's Goals, Proposed Guiding Principles*.

Economic development program initiatives are normally "big picture" items, usually not considered below the regional level. Thus, a framework for financial and socio-economic analysis must ensure information and analysis at this high resolution level.

3.2 Immediate Social Benefits

In British Columbia, public ownership provides the provincial government the opportunity to use the forests in its job creation strategies. Incremental silviculture offers the twin advantages of being highly labour intensive and in rural locations where there are not many other job creation alternatives. The fact that forest values are being improved is often merely a bonus.

Many past incremental silviculture programs have been implemented with employment as the primary purpose. Examples of these programs include:

- Employment Bridging Assistance Program (EBAP);
- Forestry for Social Assistance Recipients (ForSAR);
- Forestry JOBTRAC;
- Canada Job Strategy Program;
- Community Forestry initiatives program (ComFor);
- Forestry Enhancement Program (FEP); and
- Forest Worker Development Program (FWDP).

Currently, Forest Renewal BC program funding priorities are strongly biased towards funding activities having a high jobs component.

Virtually every kind of socio-economic analysis performed, therefore, must include measures of job creation, both immediate jobs which are associated with the work, and long term sustainable jobs that evolve from the work having been performed. Examples of long term jobs would be jobs associated with higher future harvest levels resulting from a fertilization program, or jobs associated with secondary and tertiary manufacture that is enabled due to a higher quality timber supply.

3.3 Long Term Social Benefits

Introduction

British Columbia is rather unique in the world's forested jurisdictions in that the vast majority of its lands (approximately 94%) are publicly owned. Because of this ownership, the funding of incremental silviculture activities has historically rested with the provincial government.[8]

This section explores some of the social values government either holds or must consider, and the consequent implications to a financial and socio-economic analysis framework.

The first few sections discuss some key underlying concepts. After this, some evidence of values held by the public at large is presented. Next, evidence of the government's willingness to act in a manner reflecting broader socio-economic considerations is given. Lastly, conclusions with respect to the development of a financial and socio-economic analysis framework are drawn.

Natural Capital and Sustainability

Prior to the beginning of commercial exploitation of BC's forest resources in the late 1800's, BC's coastal forests had been largely undisturbed except for the occasional catastrophic occurrence. Trees grew to huge sizes at very old ages. Thus the standing inventory of timber was built up. In the interior of the province, a similar but lesser inventory build up occurred. Here, large fires and major pest outbreaks took more of a toll, reverting areas back to young forests.

By and large, the inventory build-up is synonymous with old-growth forests. As this old-growth is harvested, harvest levels will gradually decline to a lower "sustainable" level; the highest sustainable level being equal to the annual growing capacity of the forest land less annual unrecovered mortality. In British Columbia, this anticipated reduction in harvest levels has been described as the *falldown*. The term is less frequently used as of late, however because forecast reductions in harvest levels are caused by a complex mix of effects including, in addition to the falldown, reductions to the timber harvesting land base (mainly due to the Protected Areas Strategy), more stringent forest practices requirements of the Forest Practices Code, and improved resource information.

Sustainable harvest levels that maintain a portion of the forest in old-growth are possible. An example of such a regime is that found under 'New Forestry' which is "an attempt to define forest management with timber production as a by-product of its primary function: sustaining biological diversity and maintaining long-term ecosystem health." (Hopwood, 1991:iii, quoting Lertzman) A harvest level below the cumulative growing capacity of the land base would allow a corresponding maintenance or re-accumulation of standing inventory in forests that remain in older condition (after allowing for unrecovered mortality).

In economic terms, the old growth forests constitute a form of *natural capital*, which is defined as "the stock of environmental and natural resources" (Tietenburg, 27). Old-growth forests are a renewable resource, albeit over a period of perhaps one or more centuries. Therefore, that portion of old-growth that is permanently drawn down may be considered (given they cannot quickly be renewed) to have many of the characteristics of a non-renewable resource.

[8] Funding mechanisms are not within the scope of this project.

From an economics perspective, the bottom-line questions become: How much of the remaining old-growth natural capital in forests - if any - do we use now through harvesting, and how much do we leave for the benefit of future generations? Similarly, what about the quality of the replacement forests? Old growth forests not only had higher volumes but also higher quality. How much do we re-invest in the forest to ensure a reasonable quality resource is passed on to future generations. These questions give rise to the matter of inter-generational equity. "As the economic models have made clear, current incentives for sharing the wealth from the use of depletable resources are biased toward the present, even in efficient markets." (Tietenburg, 1994:409)

The above questions also lead to the matter of sustainability. Future harvest rates are currently forecast to be considerably lower than today's levels. However, analysis shows that it is possible to increase future harvest levels back to a level similar to today's (see *Working Paper 4: Proposed Log Quality Framework, Timber Supply and Demand*). On the other hand, financial analysis suggests lower long term sustainable harvest levels would offer a greater return on investment (see "Under-utilization of Growth Potential," page 25). Higher sustainable harvest levels, therefore, come at a cost. On the surface, this appears as a straightforward consideration but it becomes less so when matters of community stability, intergenerational equity and the concerns of environmentalists about today's harvest levels being 'non-sustainable' are taken into account.

Inter-generational Equity - Many Choices

With respect to the remaining stock of old growth, a number of inter-generational equity choices arise regarding the consumption of this 'non-renewable' natural forest capital. The choices presented in the following list are from a utilitarian perspective, all involving timber harvesting. Choices such as preservation and biodiversity are brought into consideration shortly after.

From a timber utilization perspective, the current generation[9] can:

1. draw down the entire non-renewable natural forest capital through conversion of old-growth forests to other forms of capital, primarily for its own benefit, returning little to the forest other than basic reforestation;[10]
2. abstain from drawing down all of the old-growth capital, instead accepting lower harvest levels to allow some retention and replacement to enable future old-growth harvesting, albeit at much lower levels;
3. reinvest some or all of the harvested old growth capital back into the forests in the form of investments in stand tending, tree improvement, etc.; (Reforestation being assumed as part of a basic sustainable harvest regime.)
4. reinvest some or all of the capital gained from the harvest of old-growth forests into some form of alternate capital asset, such as the construction of hospitals, roads, schools, etc. for the benefit of future generations (as opposed to being consumed by the current generation);[11] or

[9] A generation is considered here to have an approximate 30 year span; the "current" generation referring generally to the age group having control over decisions regarding the forest. In British Columbia, this generation is represented by the elected provincial government, the large majority of whose members are 30 to 60 years of age.

[10] The evidence is that this is the minimum acceptable to society - see "The Public's Values," page 15. Therefore, nothing less than this is presented here as a choice.

[11] However, most of these are depreciable assets, lasting only 20 to 40 years and are of benefit to only the present and one or at most two future generations. Perhaps better long-term alternatives might be investments in medical

5. choose some combination of the above.

In reality, the choices are much more complex; turning more into the 'wicked' problem described by Brumelle et al.[12] Preserving other values can also be an important reason for investing in the forests of British Columbia. For example, Brummelle et al (1991:818) discuss three classes of non-use benefits: option value, existence value, and bequest value.

> *Option value* is reflected in willingness to pay for retaining an option to use a resource in the future which cannot be regenerated at that time and for which no close substitute is available. *Existence value* is the value derived from the knowledge that the resource exists in its specific form even when one does not desire to use it or be exposed to it. *Bequest value* is reflected in a desire to leave one's heirs an estate. These types of benefits are of significant value when one considers investment in and management of the public forests. Politically, the desire to ensure that future generations will have access to a variety of aspects of the forest resource, the need to preserve and enhance the resource in particular regions to provide the option of its use in the future, and the value that Canadians place on just having forests are all potent forces that need to be considered by those evaluating investments in silviculture.

Intergenerational equity choices therefore involve not only those to do with the consumption rate of the old-growth forest capital, but also its preservation for future scientific, amenity, environmental or other values. Postponement of old-growth harvests to maintain biodiversity results in postponement of old-growth harvesting in the present, but also enables future old-growth harvesting opportunities that may not have otherwise existed. On the other hand, incremental silviculture treatments can be used to accelerate stand development, thereby recruiting stands early into old seral states, potentially freeing other timber for harvest.

In conclusion, values can form reasons for government to chose to invest in incremental silviculture treatments. The possible choices are endless and cannot all be represented in a full socio-economic analysis. An analysis can only provide the basic elements which decision-makers can use intuitively to estimate the implications of their decisions.

The Public's Values

The public indeed holds a complex mix of values. This is demonstrated by the following selected findings from a 1989 Environics cross-Canada public opinion poll:

- 52% of British Columbians felt too many, 36% about the right number, and 2% too few trees were being logged in Canada every year;
- 64% of Canadians though it more important to preserve special forest areas than to ensure forest industry jobs;
- 61% of British Columbians disagreed with the statement that the forest industry has no real interest in long-term supply of trees;
- 57% of British Columbians felt the most important land use consideration was environmental impact, vs 17% who felt it was economic value, 9% job creation, and just 3% aesthetic impact;

or scientific research, the benefits of which accumulate over time, incrementally and continuously adding to human welfare.

[12] See quote - page 3.

- 64% of British Columbians felt not enough trees are being replanted to replace those being logged;
- ***94% of Canadians strongly or somewhat agreed that Canada's forests are a national treasure held in trust, while at the same time 79% strongly or somewhat agreed that they are a resource for our economic benefit.***

The Role of Government

The degree to which the natural capital is drawn down, the extent to which this capital is consumed or preserved by present generations, and the acceptability of substituting other forms of capital for the reduction in natural capital are value judgments. Given the resource is owned by the public, these value judgments are made by the elected representatives of the provincial government on behalf of its citizens.

Stanbury (1991:31), in his critique of the Forest Resources Commission report, contends that the decision for the amount to be invested in intensive silviculture is necessarily a political one.

> The Commission provides no argument why expenditures on forest renewal or intensive silviculture should not compete in the scramble for tax dollars along with pleas for more money for health care, education and highways. The first two involve human capital and the third transportation infrastructure. Some of the expenditures on these activities also involve long periods before the benefits begin to be evident – although not as long as the rotation period for forest crops in B.C. While the advocates of various programs may offer different ways to justify increased expenditures (including cost-benefit analysis), the ultimate decision is necessarily a political one.

Gregory (1987:293) reinforces this.

> "When should benefit/cost analysis substitute for political decision making?" The answer is NEVER. Any time benefit/cost analysis is allowed to substitute for the political process it is implied that maximization of societal preferences is "a good thing" – and this would make benefit/cost analysis heavily value-loaded. If we remember that benefit cost analysis is always a *guide*, not a *rule*, then it is far less normative. Yet is seems difficult to avoid the impression that benefit/cost analysis can be used as a "golden rule" – that it is perfectly objective, that its use eliminates the necessity for using judgment. Unfortunately, this is just not so! Benefit/cost analysis can only provide a guide to what society wants, and it is not necessarily true that what society wants will be good for it. Nor does it follow that an analysis, even one carefully made, includes all the factors that a decision-maker should weigh.

From a Ministry of Forests' perspective, this has two implications:

1. How can information be made available to the government to aid it in the decisions it must make? and
2. Once decisions are made, how can they be best implemented to maximize the benefits along the desired course established by government?

These again point to the need for a financial and socio-economic analysis framework.

Evidence of Government Recognition of Social Values

There is strong evidence of government recognition of social values in its forest resource management. The expressed goals of the provincial government for sustainability, community stability and a strong forest sector constitute the most obvious evidence. Similarly, the proposed companion guiding principles for an incremental silviculture strategy are largely value-based. These are derived mainly from other existing related statements of principle issued or endorsed by government for other environmentally related purposes.[13]

A good illustration of government acting in a values-based manner can be found in the history of the debate over reforestation funding for public land. For years, reforestation funding competed directly with other public funding demands and was under-funded. Also, the limits to the forest resource were not reached until the 1970's, giving a sense of low priority for reforestation. Consequently, the backlog of area considered not satisfactorily restocked (*backlog NSR*) grew ever larger, reaching 738 000 ha of good and medium site in 1984 (BC MoF, 1997p:iii).

Historically, some foresters argued that reforestation only 'paid off' on the higher growing sites. In his 1956 royal commission report, Chief Justice Gordon Sloan stated "…I am still of the opinion that the Forest Service is putting too much stress on the economics involved and that its estimates of areas to be planted are far too conservative and require drastic revision upward." (293) The next royal commissioner, Peter Pearse, an economist as well as a professional forester, didn't suggest an appropriate level of reforestation but wondered whether other silvicultural treatments might be a better use of funds. He stated, "… the priorities for artificial measures [of reforestation] are not evaluated so there is no clear measure of how much expenditure for this purpose is warranted, and no assurance that wherever planting is undertaken it is a more productive use of funds than alternative silviculture measures such as juvenile spacing, fertilization, and thinning." (1976: 277-278)

Even today, the largest forest company in the province reports, "In general, planting can produce a positive net present value (NPV) when a 4% discount rate is used, except on lower productivity Douglas-fir sites (SI 24 and less) situated on steeper terrain." However the company also reports, "If an 8% discount rate is used, planting is profitable only occasionally, mainly on high sites." (MacMillan Bloedel, 1997:24)

After decades of debate, in 1987, the provincial government put the issue of the economics of reforestation permanently to rest – it simply required by law that it be done on all harvested areas. If there was a socio-economic analysis of the decision, it was not shared publicly. Reforestation became, as Messmer (1995:13) puts it, "a cost of doing business" as opposed to an investment.

Brown (1995) traces the history of reforestation and related public opinion in BC and presents a clear correlation between public attitudes and government actions with respect to reforestation. The fundamental decision to require reforestation of all sites clearly can be attributed to acknowledgment by government of public values, reinforced by public pressure.

Summary and Conclusions

The preceding sections indicate that with respect to the relevance and importance of values in a framework for financial and socio-economic analysis:

[13] See *Working Paper 3 Government's Goals, Proposed Guiding Principles*.

1. Because British Columbia's forests are publicly owned, funding for incremental silviculture is a government/political decision, weighted against demands from other sectors for funds.
2. Over very long time periods, values clearly must outweigh investment returns in order to create a justification for silvicultural expenditures. In a public funding environment, these values and investment determinations and relative weightings are made by the government.
3. The matter of values is particularly acute in British Columbia due to the substantial publicly owned natural capital in form of the remaining old-growth forests and related issues of sustainability and inter-generational equity.
4. Government is best served by being presented with a range of information along with some discussion of the most sensitive factors. Socio-economic analysis must asses how alternative choices influence these.

4. The Discounting Issue

4.1 Introduction

Throughout the forestry and environmental economics literature, there is a near universal acceptance of the practice of discounting as a means of measuring the time value of monetary investments, except perhaps when very long time periods are involved. There is also strong consensus on the concept that social discount rates are different from private discount rates. Most texts then go on to agree that determining a social discount rate is difficult. Choosing a social discount rate is much more complex than choosing a private discount rate, having to factor in multiple objectives, the many externalities, and the longer time frames often associated with publicly funded projects. Field and Olewiler (1995:120) concisely summarize the sentiment regarding discounting, "We can conclude that although discounting is widely accepted, the rate controversy is far from being resolved."

This section reviews some of the major aspects and concerns regarding discounting associated with incremental silviculture.

4.2 The Social Discount Rate Defined

While there is general acceptance in the literature of the concept of a social rate of discount, there is not the same consensus on what the rate is or how it is derived. Lind summarizes the schools of thought as follows.

> The major contenders for the social rate of discount are
> - the marginal rate of return on private capital,
> - the consumption rate of interest taken as a measure of the social rate of time preference,

- a weighted average of the consumption rate of interest and the marginal rate of return on private capital, and
- a social rate of time preference revealed through the political process.

(Brumelle et al, 1991:820 quoting Lind. Bullets added for clarity)

Brumelle et al describe the *social rate of time preference* concept being based on "…the idea that society, through its governing institutions, has some rate of exchange at which it is willing to sacrifice present consumption for future benefits." They go on to say, "The opportunity cost of capital which is reflected in the market may not be equal to the social rate of time preference. Indeed it is usually suggested that the former exceeds the latter." (1991:819)

Heaps & Pratt, whose work is the basis for the social discount rate currently used by the Ministry of Forests, define a social discount rate as being "…a weighted average of the return needed to induce society to forego current consumption (i.e., the consumption rate of interest), the return needed to induce additional private investment (i.e., the marginal rate of return to private investment) and the social cost of foreign borrowing." (1989: 1-2)

Brumelle et al (1991:820) end their discussion of discount rates with a call for more research. "A direct empirical investigation of social rates of time preference using actuarial models of revealed choices or the judgments of panels is needed to examine the appropriateness of using consumption interest rates as indicators of social time preference." So far, in British Columbia this call has not been acted upon.

4.3 The Current Social Discount Rate in BC

In British Columbia, while no formal policy statement exists, a 4% discount rate is commonly accepted for analysis of publicly funded incremental silviculture investments. For example, the Ministry of Forests' *Silviculture Manual* states:

> The decision to space a stand is usually based on an evaluation of the value of the stand with spacing versus no spacing. For spacing projects to be feasible, the increased net present value (4% rate of return) due to spacing should be greater than or equal to the cost of the treatment. However, there are instances where lower financial returns are acceptable to fulfill non-timber objectives such as pest control, employment needs, alleviation of annual allowable cut shortfalls or maintenance of AAC, and biodiversity. (Section 9.2 page 5-30)

The manual provides no further guidance about what lower returns may be acceptable, or how to otherwise incorporate non-timber or higher level objectives into NPV analysis.

Regenerating British Columbia's Forests also uses a 4% rate in its sample NPV analysis. Again, it recognizes that other forest level factors, such as "…policy constraints, other resource uses, and forest age class profiles," can influence stand level decisions but gives no guidance in how to accommodate these (Lavender et al, 1990:29).

The 4% discount rate is based on an analysis and recommendation by Heaps and Pratt (1989). While they recommended a discount rate range of 3% to 5%, practitioners have done the obvious in choosing 4%.

4.4 Social Discount Rates Elsewhere

A specific review of discount rates in other public jurisdictions was not conducted. However, during the course of the general research, rates in use in some other jurisdictions were found and are shown below.

Agency	Real Discount Rate (%)	Source
U.S. Forest Service	4	USFS, undated
U.S. Office of Management and Budget	10	USFS, undated
Canada - Treasury Board	10	Field & Olewiler, 1995:120
Great Britain - Forest Enterprise (a government forest agency)	0	Price, 1997:396
New Zealand Treasury	state-owned forests removed from requirement to make a 10% return	Perley, 1998:13 (alternate rate not indicated but the context of the statement indicates it to be < 10%)

From this limited sample, social discount rates for forestry appear to be lower than rates specified for other kinds of investments. This may be at least partly in recognition of forestry's long-term investment nature. Brumelle et al (1991:819) appear to support this notion, stating "The choice of a lower discount rate for forest development may reflect society's choice to preserve the forest resource for the use of future generations."

4.5 Discounting Over Long Time Periods

The British Columbia Context

Incremental silviculture in British Columbia is normally a long term investment. Its benefits are captured from 10 to 100 years or longer in the future. Thus discounting must be done over exceedingly long time periods, time periods which are not normal in most other industries. Tietenburg (1994:175) acknowledges this, in what would be an understatement for BC forestry time frames.

> In contrast to many other living resources, however, the time period between initial investment (planting) and recovery of that investment (harvesting) is especially long. Intervals of 25 years or more are common in forestry, but not in many other industries.

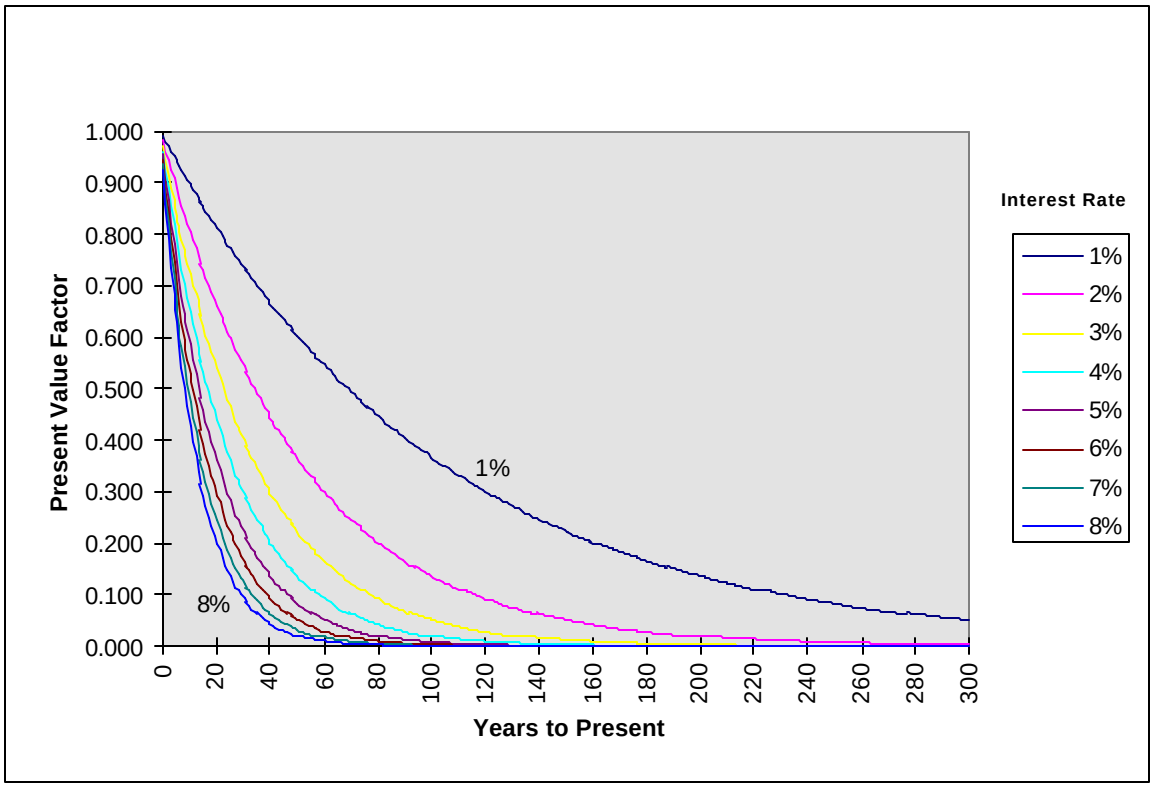
In *Forest Management,* Davis talks about "…the fallacy of compound interest, by which is meant the mathematical capacity of a sum at even a modest rate of interest to grow to astronomical and meaningless proportions over a long period of time, is simply an expression of the fact that absolutely safe and effortless investments over long periods of time do not exist." (1966:332) Later on, Davis states "There is an element of business unreality attached to any long-range compounding

of interest. The shorter the period, the more realistic the [land expectation] value becomes. Such calculations for periods of about 40 years or less are within the realm of business experience and have considerable practical significance." (364)

When discounting is applied over long time periods, as in forestry, negative treatment NPV's become a mathematical certainty. This is because discounting is exponential in nature, whereas tree and stand growth is not.

Figure 1 plots net present value factors for various discount rates over 300 years.[14] Factors become exceedingly small at higher discount rates over long periods of time. Figure 1 shows that any future income anticipated 140 years or more in the future at a discount rate of 4% or higher effectively has no present value. At an 8% discount rate, this time to effectively no present value declines to about 70 years.

To illustrate this point, at a discount rate of 4% income earned 140 years in the future is multiplied times a factor of 0.004. If this future income were one hundred dollars, its present value would be 40 cents. A present day expenditure of 40 cents must therefore yield a future value of greater than 100 dollars no later than 140 years from now in order to show a positive net present value at a 4% discount rate. Anything less than $100 at 140 years, the present value becomes less than 40 cents. So, if the future return was 90 dollars at 140 years its present value would be 36 cents, which is less than the amount invested. The *net* present value then becomes negative, that is, 36 - 40 = -4 cents.



[14] In the standard NPV formula, the discount rate is compounded as a divisor. For illustration purposes, this divisor is converted to a multiplication factor. The effect is the same.

Figure 1. Profile of Present Value Factors at Discount Rates of 1% to 8%

Logic, as well as probabilities, would indicate that not **all** long term incremental silviculture treatments will in reality yield a negative result, nor that **all** other investments will yield positive results. As Brumelle et al (1991:822) observe, "…to estimate a utility function one must compare risky and sure prospects and thus indicate tradeoffs between them. Most people have a very difficult time making such judgments consistently and logically." For example, over the 140 year forestry investment period discussed above, a stream of alternative investments might easily consist of 28 different investments averaging five years each in length. Choosing the same discount rate for each of these short term investments effectively puts them all on the same footing as the single forestry investment decision. On the surface, this appears to be a logical means of comparison between alternatives. However, at a 4% discount rate virtually all forestry investments made in year zero become impossible to show a positive financial return in 140 years while none of the short term decisions will ever have this "impossibility" problem. Nevertheless, using the same discount rate over all time periods suggests all 28 alternative decisions will **always** have a higher probability of exceeding the forestry investment. The number of business bankruptcies (e.g., Bering's, Olympia and York, Japanese banks, US savings and loans institutions), and indeed near bankruptcies of entire nations (e.g., Russia, New Zealand, Mexico, Indonesia) would suggest not.

The following example from Field & Olewiler (1995:120) illustrates the potential quandary of discounting over long time periods.

> Suppose today's generation is considering a course of action that has certain short-run benefits of $10,000 per year for 50 years, but which, starting 50 years from now, will cost $1 million a year *forever*. …. To people alive today the present value of that perpetual stream of future cost discounted at 10 percent is only $85,000. …. The present value of the benefits …($99,148) exceeds the present value of the future costs. From the standpoint of today, therefore, this might look like a good choice, despite the perpetual cost burden placed on all future generations.

The dilemma presented in this example tends to elicit a call for lower discount rates. However, rather than adjusting discount rates, another possible approach is to simply acknowledge that over very long time periods values tend to form more of a basis for decisions. Price (1997:394), in his review of the long-running debate about discounting in forest economics states, "…a decision to maintain [continuous forest] cover does not demonstrate the inapplicability of compound interest; the decision implies only that the importance of continuous cover is deemed to *outweigh* compound interest." It is possible that decision-makers have an intuitive feel for the effects of compound interest (rates of discount), tending to give it high credibility in the short and medium term but moving more to values-based judgments in the long term. Nonetheless, as the next section demonstrates, the psychological effects of negative outcomes can be a concern.

Effect in the Marketplace

British Columbians expect public forestry investments to be made in BC forests, not, for example, in forests in the US South, Chile or New Zealand. However, the financial aspects of private sector forest investment are real and cannot be ignored in a global context. The very long time periods before realization of investment returns associated with the typically long rotations of many of

British Columbia's forests discourage private sector investment in favour of investment elsewhere. As evidence of this, an estimated 500 000 ha's of new industrial plantations were established annually through the late 1980's and early 1990's in tropical and semi-tropical regions (Sedjo & Lyon, 1996:12), largely with private sector funds, but sometimes aided with local government subsidies or incentives. Rotation ages of these plantations are in the range of 5 to 30 years. In the states of Washington and Idaho, on dry sites east of the Cascade mountains, fibre farms of hybrid poplar are being established where drip irrigation can be applied.[15] "Growth rates with these plantations are impressive with yields about 7 tons per acre, or about 50 cubic metres per ha [per year]." (Sedjo, 1997:35)

4.6 The Risk of Bias

While some foresters espouse the rigid use of discount rates, others struggle to overcome the impression often left by negative NPV's that BC silviculture is "uneconomic." This negative impression is relevant because there is a natural tendency to favour hard 'objective' data over soft 'subjective' information. James Quinn, Professor of Management at the University of Dartmouth, states, "The [formal planning] approach unduly emphasizes 'measurable quantitative forces' at the expense of qualitative, organizational and power-behavioural factors that so often determine strategic success." (Moore: 1992 257)

Given that objective information tends to be favoured by decision-makers, negative NPV's make the case harder to justify a project on other grounds. As a case in point, take a situation where a funding request for a long term forest research project is up against a request for pruning funds. No other projects are being considered and only one of the two requests can be funded. Both requests are accompanied by verbal justifications, but only the pruning request comes with a financial analysis. The analysis shows strongly negative returns because the analyst does not believe that clear wood will command a significant price differential in 90 years. Both project requests make an equally eloquent subjective case. The pruning request includes a discussion on the potentially positive impact of real log price increases on the pruning outcome, but does not provide any numbers in support of this. Which project is likely to be funded? Would the pruning project have a higher chance of success if it were based solely on subjective arguments and not accompanied by a negative financial analysis? What if the decision-maker knew the auditor-general was going to be doing an audit in the following year and that this decision would come under the audit? Which, then, is the 'safer' decision?

To offset the negative financial analysis, the subjective case for the pruning project would have to be better than the subjective case for the research project, but in this example it isn't - it's only equal. Assuming the answers to the foregoing questions are self-evident, herein lies the reason why there has been debate over the choice of discount rate ever since Faustmann first proposed his economic theories in the mid 1800's. In a competition for capital, negative NPV's create a distinct disadvantage against other funding requests when these others are not accompanied by a financial analysis and the subjective cases for all are of equal merit. Conversely, positive NPV's are likely to give a funding request an advantage in the same situation.

To overcome the tendency of decision-makers to favour hard data, where financial criteria are a major decision factor, proponents of projects sometimes change the numbers to justify long term

[15] About 60,000 acres of mostly former Idaho potato fields have been planted. Source: consultant's notes taken during a November, 1997 forest management conference held in Spokane, Washington.

projects (Mintzberg, 1994:123). Examples in the case of evaluating silviculture investments would be the selection of lower discount rates (for no other given reason), optimistic treatment responses, and optimistic future real product or log price increases – all to achieve a more comforting positive NPV result. When this occurs, decision makers may not have a true representational analysis and can essentially be making uninformed decisions.[16]

One the one hand, standardization of a discount rate, as Tietenburg (1994:67-68) puts it, "…reduces biases by eliminating the agency's ability to choose a discount rate that justifies a predetermined conclusion. …. On the other hand, when the social opportunity cost of capital differs from this administratively determined level [10%], the benefit/cost analysis generally will not define the efficient allocation."

One way of eliminating potential bias, but yet provide decision-makers some latitude is to establish a standard social discount rate, but also require sensitivity analysis around that rate. Rather than attempt to have technical analysis make decisions, decision makers are better served by being presented with a range of information along with some discussion of the most sensitive factors. In a socio-economic analysis, an assessment of impacts on social values and expectations should be presented alongside financial analysis so that government has a view of all relevant factors.

4.7 Future Real Log Prices and Implications to Discounting

A *real log price change* is determined by subtracting total price inflation from the log price change over a specified period of time. Any difference indicates there has been a 'real' change in log prices. Real log prices are discussed in detail in *Working Paper 4: Proposed Log Quality Framework, Timber Supply and Demand*. There, the fundamental conclusion is that prices cannot be forecast over the time frames associated with BC's forests and that the best course of action is that which minimizes risk and maintains options.

Projecting real log price increases will act to offset the effect of discounting future income, especially if they are treated as compounding increases over time. Compounded real log price increases effectively reduce the discount rate; for example, a 1% real log price increase effectively lowers a 4% discount rate to 3%.

If real price increases are applied disproportionately, for example, by increasing the real log values of larger logs relative to smaller logs, the analysis results will favour treatments that enhance those particular characteristics.

Because real log price increases constitute an unknown and to avoid the possibility of bias the best course of action is to establish a common standard, and undertake sensitivity analysis around this. Other sensitivity analyses could be introduced as considered appropriate to an analysis.

[16] For further background, see "Limitations of Hard Information," in *Working Paper 2: Concepts of Strategy and Planning, Proposed Planning Framework*.

4.8 Other Considerations

Scheduling Treated Stands for Harvest

The use of financial investment analysis assumes a non-existent control over future harvest scheduling. Generally, all stands and treatments are evaluated with the assumption that they will be harvested at the 'optimum' time. However, the reality of future harvests are that a great many stands will be held beyond culmination in order to meet forest cover, older forest, and other non-timber requirements.[17]

Heaps and Pratt (1989:19) use a variation of the same argument to conclude silviculture investments to be risk free. They argue that the discretion to choose the date of harvest provides an opportunity for improved returns by harvesting when market values are high. This ability reduces risk.

To this, one could add that not only is risk decreased but that while a forest owner awaits better market conditions, the biological aspect of the forest asset enables continued addition to value, unlike many other asset classes. For example, an automobile that doesn't sell in the current model year rapidly depreciates in value. A living forest that doesn't sell in a low market, in contrast, continues to grow; adding volume and nearly always improving in quality.

A phenomenon of longer rotation ages is that it encourages commercial thinning as the lesser of two negative returns.[18] This is because even though a commercial thinning may reduce volumes at final harvest, revenue from the thinning is received earlier while the cost of the reduced final harvest is incurred at the end of the period.

Under-utilization of Growth Potential

Financial analyses conducted by MacMillan Bloedel (1997:23) brought the company to conclude "…financial rotation normally will occur before biological culmination of growth rate…." Similarly, from studies of stand tending benefits, Massie (1995:31) found, "…a discount rate of about 2% will give economic rotations comparable to culmination. At 4% the rotation will be less than culmination and at 6% considerably less than culmination. If a real [log] price increase is assumed … 2% will give economic rotations exceeding culmination, 4% will give rotations comparable to culmination and 6% will give rotations less than culmination."

A long term 'financial' sustained yield level, therefore, would be below a long term 'biological' sustained yield. Given falling harvest levels, there is an evident social desire to maximize sustained yield for economic development, community stability and employment reasons.

4.9 Summary and Conclusions

The preceding sections indicate the following with respect to discounting.

1. Discounting is widely accepted as a means to account for the time value of monetary investments.

[17] See *Working Paper 7: Review of TSA Issues and Planning Processes* and TimberWest, undated (b):2. Of interest, the associated timber costs of such harvesting deferrals form shadow prices for these other values.

[18] See MacMillan Bloedel, 1997:25; Stone, 1996:102; and Price, 1997:391.

2. Forestry investments in British Columbia are often for extraordinarily long time frames compared with other industries.
3. Social rates of discount for publicly funded projects are different from private discount rates, widely acknowledged as being lower.
4. There is a need for further empirical research to define a social rate of time preference appropriate to BC incremental silviculture investments.
5. The generally accepted discount rate for use in British Columbia is 4%. However, the study on which this rate is based suggests it to be within the range of 3 to 5%.
6. The long time frame associated with forestry investments appears to be recognized in lower social discount rates being prescribed by governments in other jurisdictions for forestry than for other investments. Further research would be needed to confirm this preliminary finding.
7. There is some dispute over the practicality/methodology of discounting over long time periods.
8. Particularly at rates of 4% or higher, without an offsetting assumption of compounded real log price increases, a positive net present value becomes mathematically impossible for very long term silvicultural investments. This is because discounting is exponential in nature while biological responses to treatments are not.
9. The use of a discount rate as an exponential implies there is an exponential certainty about the financial outcome of alternative investments; that at some point any other series of shorter term investments are certain to give a better yield.
10. There is a natural tendency in decision-making to favour hard financial analysis over soft qualitative information.
11. There is some indication that values tend to form the basis of decisions for projects having impacts over the very long term.
12. The case for silvicultural investment is more easily made when positive net present values result from financial analysis of proposed investments. This need tends to encourage bias in the selection of figures to be used in calculations. This potential for bias can extend to assumptions about future real log price changes. Bias can be reduced through the specification of standards for discount rates and real log price changes, including the need for sensitivity analysis regarding both of these.
13. With requirements to hold stands for longer rotations, many treated stands will not be harvested at the ideal point of maximum financial return (at least insofar as a current calculation may indicate).
14. Particularly when longer rotations exist, financial analysis results encourage commercial thinning.
15. Without the use of offsetting compounded real log price increases, discount rates above 2% generally encourage under-utilizing the growing potential of B.C.'s forests by establishing financial rotation ages in advance of culmination ages. A long term 'financial' sustained yield level, therefore, would be below a long term 'biological' sustained yield. Deciding between these two levels has implications for sustainability, community stability, employment, etc.

5. Models & Data

5.1 Introduction

Along with assumptions employed, critical factors in a financial analysis are the accuracy of the model used to forecast stand yields and the data upon which the model depends.

After conducting extensive financial analysis using TASS outputs, McWilliams and Carter (1998:executive summary) conclude "Site quality is shown to be the key variable determining silvicultural investment returns…". In the Ministry of Forests' stand model, TASS, as in all growth models, site quality affects yields over time. The higher the site quality, the higher the yield over the same time period. By deduction, the accuracy of the model and the data on which the model depends are also key variables in a financial analysis.

Following is a brief look at the data and models upon which financial analysis of incremental silviculture treatments depends.

5.2 Data

A major problem to successful financial and socio-economic analysis at all levels has been and will continue to be the lack of growth and yield information related to silvicultural treatments on managed stands.[19] The application of managed stand yields to existing stands in timber supply areas during the Timber Supply Review indicates active management of second growth stands has only been taking place for as little as 10 years in more remote locations and as long as 40 years on some lower coastal areas.[20] Consequently, hard information is simply not available, with foresters having to rely on computer models to simulate potential effects.

BC's growth and yield information is almost nothing in comparison to the hundreds of years' experience in managing some European forests. In fact, Sweden has a longer history of experimental plots on BC's lodgepole pine grown in Sweden than BC itself has for its own native stocks.[21]

5.3 TASS / TIPSY Model

Note: This entire section requires review with TASS/TIPSY specialists in MoF Research Branch. The following presents a critique which requires additional comment/counter-points by Research Branch.

The Ministry of Forests relies almost exclusively on stand yields from its own stand model, the Tree and Stand Simulator (TASS). Because this model is main-frame based, information from

[19] See MacMillan Bloedel, 1997; Bonnor et al, 1995:1; Kovats (1993:450) to name but a few examples.
[20] See BC MoF, 1992-1996.
[21] Sweden has 70 year old experimental plots on BC's lodgepole pine grown in Sweden (Kovats, 1993:451).

TASS is disseminated via the ministry's TIPSY program (Table Interpolation Program for Stand Yields), which operates on desktop computers having the MS Windows operating system.

Comparison to an Ideal Stand Model

Following is a brief assessment of the TASS / TIPSY combination in comparison with the characteristics of an ideal stand model. These characteristics are taken from FORUM (1996:41-42).

Ideal Model Characteristic	TASS/TIPSY
• have a user interface that is simple for field practitioners to use;	The TIPSY user interface is excellent and can largely be learned and used intuitively without the need for formal instruction. TIPSY is backed by an on-line help facility.
• be available on a microcomputer platform in a "Windows" environment;	TASS is mainframe based and can only be operated by ministry specialists. TIPSY is "Windows" based and has wide public distribution.
• be capable of modeling all major BC coniferous and deciduous tree species;	TIPSY covers 6 of the major BC conifers (2 of which have coastal and interior variants). If white spruce is accepted as a TASS species substitute for Engelmann spruce, then the 6 TASS species directly and indirectly represent 94% of trees planted in FY 95/96. Notably missing from TIPSY are abies species, which are the leading species for 13% of forest area in BC (MacKinnon & Still, 1996:12). Abies also often exists as a significant component of mixed stands (Forum, 1996:17). TIPSY does not contain yields for deciduous species.
• be able to model the age and species diversity of stands, particularly during the establishment and early growth phases where there is much variability and where silviculture treatments most often occur and have the greatest effect;	TASS does not recognize ingrowth, assuming any trees established naturally after planting or after initial natural establishment will be beneath the canopy of the establishment trees and therefore will die.[22] This is at least in part a function of TASS's origin as an even-aged, single species model.
• be able to model voids in a stand;	TASS has a 'clumpiness' factor which enables limited simulation of voids. TIPSY allows the user to specify an operational adjustment factor, which can be used as a substitute for voids.
• be able to model the effects of all silviculture treatments commonly applied under a silviculture or stand management prescription, including commercial thinning;	Spacing is the only available silvicultural treatment. TIPSY, not the user, specifies spacing age. There is considerable debate among BC professional foresters regarding the efficacy of spacing treatments based on TASS/TIPSY simulation results.[23]
• be able to model potential symbiotic effects of mixed stands that commonly grow together (e.g., hemlock/balsam,	Because TASS is a single species model, TIPSY represents mixed stands by pro-rating TASS stand output for each species according to the proportion existing at the

[22] Ken Polsson, personal communication.

[23] See *Working Paper 4: Proposed Log Quality Framework, Timber Supply and Demand* for further discussion of the spacing debate.

Ideal Model Characteristic	TASS/TIPSY
hemlock/cedar, interior Douglas-fir/lodgepole pine, etc.);	time of stand origin. Because TASS does not simulate the growth of mixed species stands biologically, Research Branch recommends "that the multiple species feature not be used in the preparation of silvicultural prescriptions." (BC MoF, 1997o) Species mixes do not change over time, so spacing treatments are uniformly applied in the model regardless of how a treatment prescription may favour some species over others. Mortality functions are applied in accordance with single species stand dynamics, not mixed stands, therefore TIPSY stand proportions remain static over time. "Trees stop growing and die when their crown is over-topped by adjacent crowns." (Greenough et al, 1995:2) Such dynamics are clearly not the case in mixed species stands having a mix of shade tolerant and intolerant species. Future plans include enhancing TASS to simulate mixtures of species (BC MoF, 1997o).
• be able to model the growing multiplicity of silvicultural systems, including partial cutting;	TIPSY provides final stand yields only, thus representing a clearcut silvicultural system. Partial yields through commercial thinning or partial harvesting are not available.
• enable the prediction of wood properties and qualities for use in economic evaluation and forest planning; and	TIPSY provides a log table for some coastal scaling grades. Clear grades are not available. TIPSY provides stand and stock tables by diameter class from which some size-related quality attributes can be inferred.
• be capable of multiple simulations with relative ease, to assist in the formulation of district incremental silviculture plans.	Multiple TIPSY runs are simple and easy.

From this review it is clear that the TASS/TIPSY combination, while excellent in many aspects, requires considerable additional development before it fulfills the conceptualization of the ideal model.

Empirical Validation

"Empirical validation requires that the model's predictions be compared with real world data that are independent of the data that were used to construct the model." (Brumelle et al, 1991:832) While TASS has been calibrated to permanent sample plots,[24] there is no published evidence that it has been statistically validated in the manner noted by Brumelle.

[24] "Permanent sample plot data (14,000 data points) were used to calibrate TASS for a variety of tree species growing on different quality sites (as measured by site index)." (Greenough et al, 1995:2)

Comparison to Other Models

Another method to test a model is to compare simulation results with those of other models. "To many growth modellers, the comparison with other models represents the ultimate test. Is the new model within the range of the others, or 'out in left field'?" (Bonnor et al, 1995: 4) No comprehensive comparative analysis between TASS and other models has been published. However, a few limited comparative analyses between TASS and other models have been undertaken for specific species.

Douglas-fir

In comparing TASS and 3 other models for Douglas-fir, Curtis (1994: 10, 22) found, "Although there are differences in early growth patterns, most estimates of net MAI are fairly close at ages 50 to 60 years…. Notable exceptions are … the TASS estimates for unthinned stands on site II [good site, coastal Douglas-fir], which show densities, volumes, and diameters much greater than the other simulators do." Curtis goes on to say, "DFSIM, SPS, and ORGANON all predict substantial volume production gains from precommercial thinning…. TASS is more equivocal … possibly because of the very high densities predicted for the NT [no treatment] regime."

Coastal Western Hemlock

Bonnor et al (1995:4) compared the output of STIM "…with five other models used in the Pacific Northwest." Bonnor does not report the full analysis, but the one example given (p. 11 - species not stated, but presumably coastal western hemlock) indicates strong correlation between 3 of the 5 models until the 50 year age range, after which there is very strong divergence. By 90 years of age, forecasts between the same 3 models diverge by almost 40%. At the outer extremes, at age 90, the highest forecast was nearly twice that of the lowest. Bonnor attributes these differences "… partly to the data used in their construction: models giving high predictions [of which TASS was one] were constructed from fully stocked research plots, while models giving low predictions were constructed from operational, growth monitoring, or inventory plots."

Lodgepole Pine

Kovats (1993) compared TASS projections for lodgepole pine with those of Britain and Sweden. "The objective of this report is to investigate the usefulness of European managed-stand projections for the estimation of silvicultural treatment responses in British Columbia." Both Britain and Sweden's models are for stands of lodgepole pine from British Columbia, Alberta and Oregon provenances. Since the stand management history for their stands is longer than that in British Columbia, the idea was to see if the information could be put to use in British Columbia.

Kovats found "British and Swedish projections show 4-13% more useable wood and 36-52% larger diameters at top height 28 m for thinned stands than for unthinned stands predicted for British Columbia."

Discussion

The model comparisons demonstrate there are (or at least 'were' at the time the studies were done) significant differences between models. These differences result from factors such as a model's fundamental architecture (for example, whole stand model vs. individual tree model), the purpose/use for which a model was constructed (for example, to update natural stand inventories

vs. to project yields of silvicultural treatments on managed stands), equations and concepts employed (for example, mortality functions may vary, data may be chosen to approximate the upper end of biological potential rather than average potential), and the data used in model calibration (different provenances of the same species will produce different yields), etc.

As noted previously, there is considerable debate in professional circles in British Columbia regarding pre-commercial thinning (juvenile spacing). This debate focuses on forests grown by the TASS model, but there is virtually no discussion of the model that grows the forests. Two of the studies covered in the above sections indicate variances with TASS with respect to spacing outcomes. The third study shows variances in unspaced projections. Yet all stand level financial analysis work reviewed under this project use the model virtually without qualification, presenting no evidence of the suitability of the model for the use to which it was being put. This a substantial failing in methodology in that a significant source of potential error is not addressed. This likely is because there is little published information about TASS's construction, calibration or validation. However, good methodology would dictate there be mention of the potential of model variance and some sensitivity analysis to demonstrate the possible implications.

Given the ministry's almost total dependence on TASS in the preparation of harvest forecasts[25] and silvicultural financial analysis, undertaking and publishing extensive validation and comparative analysis studies of the model appears due.[26] TASS is not unique in this regard, however, for Brumelle et al state "Very few models have been statistically validated under a variety of silvicultural regimes and/or compared with other models as in the Ek and Monserud studies." (1991:833)

One way to handle uncertainty about stand yields is through use of sensitivity analysis to assess the impacts of a possible range of yields. Varying the yields of regenerated stand volumes by ± 10% or ± 20% is a standard sensitivity test used in the timber supply review process. Testing the range of potential for model error is not quite as simple, however, requiring independent variation of either the treated or untreated stand results, that is, increasing or decreasing the difference between treated and untreated stand volumes. Such a sensitivity test is good for some, but not all forms of error, so it may be of limited value. For example, a constant percentage adjustment to stand volume over all ages may not compensate for an error which is not constant over the life of the modeled stand; for example, an error pertaining only to the early, mid or late stage of stand development.

5.4 Summary and Conclusions

Note: The following requires review with TASS/TIPSY specialists in MoF Research Branch. The above requires comment/counter-points by Research Branch.

The preceding sections indicate the following with respect to models and data.

1. A major problem to successful financial and socio-economic analysis at all levels has been and will continue to be the lack of growth and yield information related to silvicultural treatments on managed stands.

[25] Forecast long term timber harvesting levels for timber supply areas have a direct correlation to TASS yields. For a large majority of TSA's a 1% increase or decrease in regenerated stand volumes (derived from TIPSY) results in a corresponding 1% increase or decrease in the long term harvest level.

[26] For a discussion of validation and comparison techniques and results, see Brumelle et al, 1991:833.

2. The TASS/TIPSY combination, while excellent in many aspects, requires considerable additional development before it fulfills the conceptualization of the ideal model.
3. The few published comparative analyses between TASS and other growth and yield models indicate substantial variances in certain areas.
4. The thinning debate focuses on forests grown by the TASS model, but there is little discussion of the model that grows the forests. All stand level financial analysis work reviewed under this project use the model virtually without qualification, a substantial failing in methodology in that a significant source of potential error is not addressed.
5. The Ministry of Forests relies almost exclusively on stand yields from its TASS model, which has limited ability to simulate silvicultural treatments and does not model mixed species stands. Given the ministry's almost total dependence on this one model, and given its importance to harvest forecasting and silvicultural investment decision making, publication of a comprehensive statistical validation and comparative analysis appears due.
6. Uncertainty about stand yield can be dealt with to a limited degree through use of sensitivity analysis to assess the impacts of a possible range of yields. Testing the range of potential for model error is not quite as simple, however, requiring independent variation of either the treated or untreated stand results, that is, increasing or decreasing the difference between treated and untreated stand volumes. Such a sensitivity test is good for some, but not all forms of error, so may be of limited value.

6. A Proposed Financial and Socio-economic Analysis Framework for Incremental Silviculture

6.1 Introduction

The preceding sections:

- indicate the need for a working framework for financial and socio-economic analysis for incremental silviculture;
- review the current status of financial and socio-economic analysis;
- demonstrate that economic development and investment, and immediate and long term social benefits are key considerations; and
- review the issues regarding discounting, models and data.

This section builds on this information to propose a financial and socio-economic analysis framework.

The proposed framework and resultant analyses could be used by the Ministry of Forests to aid it in achieving two functions. First, it could aid the ministry in its role as a provider of information to the provincial government. It could specifically help to fulfill the ministry's legal obligation under section 8 of the *Ministry of Forests Act* with respect to incremental silviculture programs. Section 8 requires the ministry to present the government with alternatives for increasing the productivity of forest and range land, complete with a socio-economic analysis of each alternative.

Secondly, it could aid the ministry in fulfilling its stewardship function. Section 4 of the *Ministry of Forests Act* charges the ministry to "manage, protect and conserve the forest and range resources of the government, having regard to the **immediate and long term economic and social benefits** they may confer on British Columbia." (bold added for emphasis) The ministry cannot properly discharge this responsibility without first having undertaken informed analysis.

The proposed financial and socio-economic analysis framework is designed to work in concert with the incremental silviculture planning framework proposed in *Working Paper 2: Concepts of Strategy and Planning, Proposed Planning Framework*. It is important that the process of undertaking analysis not be confused with being a strategy. An analysis is not a strategy. Analysis assists in the development, choice or evolution of strategy, as the case may be. It is also valuable towards effective and efficient implementation of strategy.

Lastly, a word about discount rates, long time frames, and social values. The proposed framework cannot solve these issues - it only aims to create a means to put such matters forward for informed decision-making. To use a soup analogy, it is foresters, planners, economists, interested publics and private interests who put ingredients in a soup pot. Debate among these groups and between political parties stirs the soup in the pot, but it is the elected government that ultimately tastes the soup and declares it ready for consumption. The next batch of soup, though, will likely have different ingredients and different tasters. To conclude the analogy, a financial and economic analysis framework is essentially nothing more than a soup pot with a basic recipe. If the framework is done well, all the essential ingredients will be in the pot, ready for stirring and tasting.

6.2 Overview

Figure 2 shows the proposed financial and socio-economic analysis activities by planning level and the relationships between them. Each is described in more depth in the sections that follow.

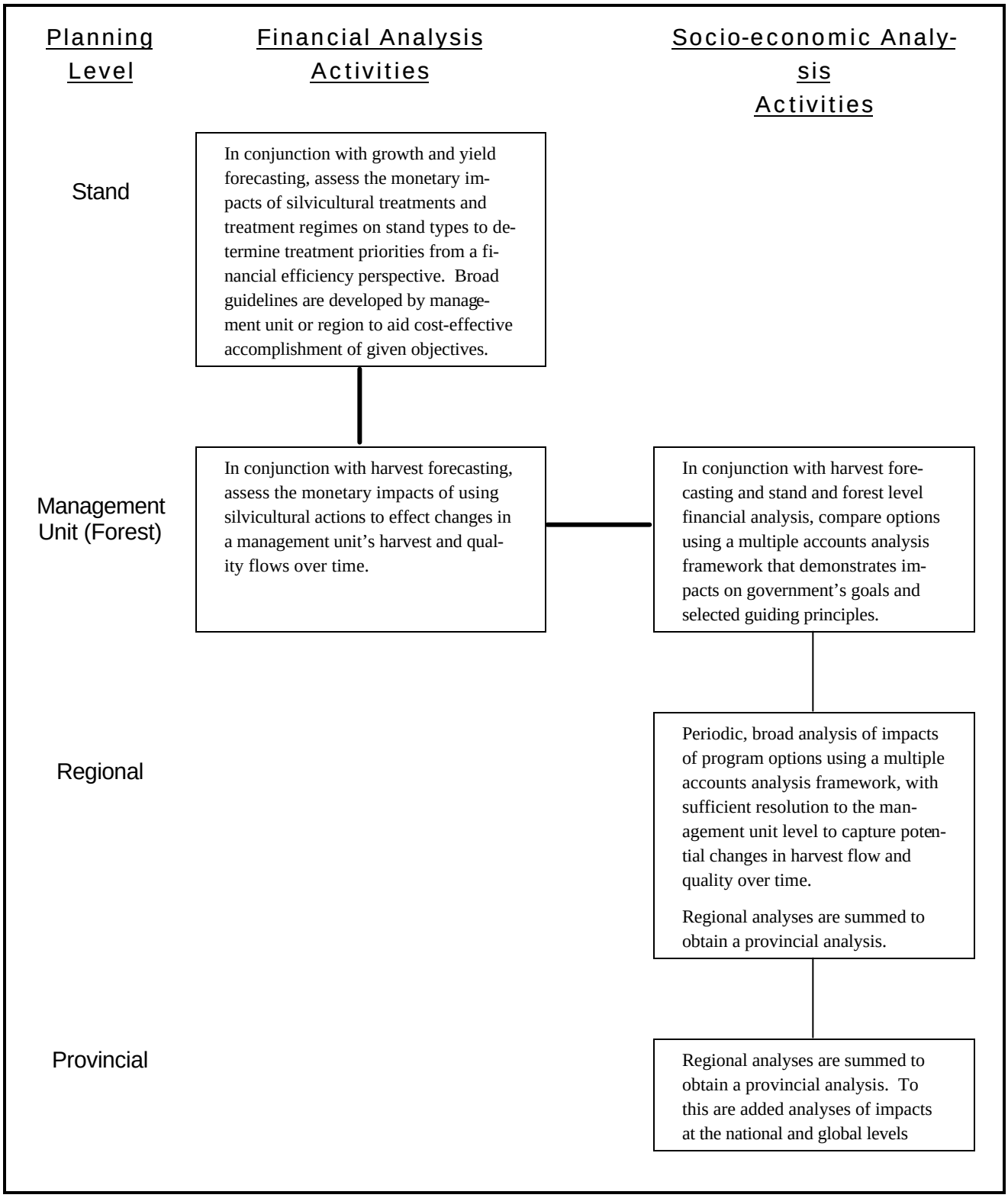


Figure 2. Overview of the Financial and Socio-economic Analysis Framework

6.3 An Approach to the Discount Rate Issue

While there is general agreement over the concepts of discounting and of social and private discount rates, controversy over the choice of rate remains. Matters such as the effect of discounting over long time periods, the acknowledgment of or weighting given to values, ideological positions, etc. all enter into the discussion over choosing an appropriate rate. Even a methodology of sensitivity testing of a range of rates leaves the questions of what range to use. Mixed in with all this is the fact that objective information tends to be favoured by decision-makers over subjective information.

Essentially, every concern is valid. There **is** an opportunity cost of capital,[27] discounting over long time frames **does** bias treatment choices to the present, and social values **are** highly important and difficult to measure in monetary terms, particularly over the long term. Thus, a discount rate that reflects only one of these aspects, is incorrect in ignoring the others. So, in the context of long term public forest management, choosing a discount rate based solely on the cost of capital biases against the long term, choosing a lower rate solely on the justification of equalizing short and long term options is arbitrary,[28] and choosing a rate solely on the basis of values removes any incentive for improving economic efficiency.

A discount rate based on a blend of rates acknowledges the importance of all of them. A blended rate can form the standard or benchmark rate for comparative purposes. Sensitivity analysis would include rates both high and low enough to capture the other 'pure' rates.

A blended rate that is the simple average of two rates is proposed. These rates are the marginal opportunity cost of capital rates and the social rate of time preference (as exhibited by revealed preferences). The first of these is relatively straightforward in measurement. The second requires research to establish. There are many examples of revealed choices. The average internal rate of return of reforestation costs in BC would be one such example. This is in the range of 4% on the coast (MacMillan Bloedel, 1997:24) and is likely close to 0% in the interior for planted stands. Another example would be the internal rate of return associated with the adoption of a biological sustained yield level (as opposed to a financial sustained yield level). Harvest flow policies are yet another source of revealed preferences. Harvest flow constraints result in trees that are merchantable now not being harvested until later so that interim timber supply deficits do not occur.

Whenever government chooses to accept a lower rate of return, that rate should be referred to as an *accepted* internal rate of return (IRR). It is *accepted* in the context of the non-monetary benefits associated with the activity. These benefits are sufficient for the government to feel comfortable with the indicated financial IRR. To keep terminology clear, the accepted IRR should not be referred to as either the discount rate or the social rate of time preference. In Price's (1997:396) words, "…while long rotations might result in low rates of return, they do not justify low rates of discount."

[27] This opportunity cost exists regardless of whether it is a private or public sector frame of reference. In the public sector the opportunity cost could be hospital beds foregone, a higher student/teacher ratio, etc.

[28] Price (1997:396) states, "Emphatically, lowering the discount rate because of non-market effects provides no reliable means of adjustment. While lower rates favour long rotations, not every category of non-market effect is thereby favoured."

In support of the above, further research on the matter of a social discount rate for forestry is needed. Possible studies include;

1. A survey of social discount rates for forestry in other jurisdictions.
2. A revisitation of the analytical work by Heaps and Pratt to capture any further theoretical developments since.[29] Also, their work is now 10 years old and is based on data that are now up to almost 35 years old.
3. "A direct empirical investigation of social rates of time preference using actuarial models of revealed choices or the judgments of panels is needed to examine the appropriateness of using consumption interest rates as indicators of social time preference." (Brumelle et al, 1991:820)

6.4 Stand Level Financial Analysis

Stand level financial analysis looks at the costs and potential revenues of different stand treatments, either as stand alone treatments or as regimes of treatments. It is conducted broadly on classes of stands, rather than on actual stands themselves.

Within the proposed framework, stand level financial analysis has two roles:

- as a building block to higher level analysis and strategy; and
- as a cost-effectiveness analysis tool to determine the most efficient way to achieve a given objective.

The outcome of stand level financial analysis should **never** be considered as a strategy in itself. Although a silvicultural treatment may be highly cost-effective at the stand level, it could be exactly the opposite at the forest level.

The following suggested methodological standards for stand level financial analysis are intended as an example of such standards and can be a starting point for their further development.

Item	Standard	Sensitivity Tests
Volume measures	Total, merch & sawtimber	---
Discount rate	4%*	1%, 2%, 3%, 5%
Real log price changes - all logs	0%	-0.5%, 0.5%, 1.0%/yr - declining linearly to 0 in year 50
Real log price changes - lg. dia.	0%	as above, large dia only
Real log price changes - clears	0%	as above, clear grades only
Real cost changes (e.g. road, harvesting costs)[30]	0%	---

[29] For example, Heaps and Pratt acknowledge option value, but do not incorporate it in their recommended discount rate range because "…there is at the moment no operational method of evaluating the options created by silvicultural investments." (1989:20)

Item	Standard	Sensitivity Tests
Untreated and spaced stand volume projections	TIPSY	± 10% treated stands only; ± 10% untreated stands only
Other silvicultural treatment responses	Best available model outputs or professional opinion	± 10%
Anticipated/conjectured changes to site productivity, either due to new estimates or in response to silvicultural treatment	Cannot be part of base case. If changes are highly probable, must generate a second set of sensitivity analysis with a modified base case.	Specifications as appropriate

*Further study may result in possible change to the standard discount rate. See "An Approach to the Discount Rate Issue," page 35.

Major assumptions must be stated on every page of NPV analysis result tables.

6.5 Management Unit Financial Analysis

A management unit financial analysis looks at the costs and revenues associated with different program options for meeting management unit timber harvest flow and quality objectives.

Management unit level financial analysis has two roles:

- as a part of a management unit socio-economic analysis; and
- as a cost-effectiveness analysis tool to determine the most efficient way to achieve a given objective.

All scenarios should be conducted with the same sensitivity analysis standards specified above for stand level financial analysis. Sensitivity analysis of real cost changes should also be considered.

6.6 Management Unit Socio-economic Analysis

A management unit socio-economic analysis is a multiple accounts analysis of possible incremental silviculture program options. Some elements for a multiple accounts framework are suggested on page 39. These are derived from government's expressed goals in forest resource management and from the proposed guiding principles. Further work is required to standardize the multiple accounts framework.

Management unit socio-economic analysis has several roles:

[30] The suggested standard should be reviewed prior to adoption. The Forest Practices Code has brought about substantial real increases in logging costs. Nominal log costs increased 50% between 1992 and 1996, substantially above inflation over the period (KPMG 1997:4). Sedjo (1997:21-22) reports real logging costs to have been in a rising long-run cost trend for both coast and the interior BC forest for the period 1965 to 1996. The cost increases are attributed to rising labour costs in the 1970's and increasingly severe environmental regulations beginning in the late 1980's. No doubt a third reason could be added, that of the fact that over this period harvests are continuously moving into more remote and difficult areas.

- it improves the knowledge of government about the social and economic impacts of choices;
- it aids the Forest Service in achieving its mandate for "having regard to the immediate and long term economic and social benefits they may confer on British Columbia"; and
- it provides information support to higher level analyses.

Financial analysis of options as described under section 6.5 would form part of the socio-economic analysis. Within each option analyzed, treatment priorities may be described based on stand level financial analysis.

6.7 Regional / Provincial Socio-economic Analysis

Here, regional level refers specifically to Ministry of Forests' regions.

Because it is a major undertaking (and therefore also expensive), a provincial level socio-economic analysis of incremental silviculture options need only be undertaken on a periodic basis.

The major purpose of the regional/provincial analysis is to improve knowledge regarding strategic options. Because of this, it is not necessary to have the same precision in modelling as at the management unit and stand levels.

It is recommended the ministry develop a regional model and undertake separate regional socio-economic analysis as building blocks to the ultimate provincial analysis. This has the multiple benefits of:

- providing a tool for regions to use in on-going analysis;
- makes the task at the provincial level less daunting by breaking the project into six parts;
- makes the results directly meaningful and useful to a distinct organizational group within the ministry (i.e., the six forest regions);
- requires less computing power than attempting the entire province under one model; and
- facilitates contracting the analysis, should the ministry choose to do so.

A regional analysis should have the following characteristics:

- Each management unit (both TSA's and TFL's) separately identified and plotted, with summation to the region (a similar process to maintaining landscape units within a TSA analysis).
- Consistent core options assessed in each regional analysis, so that results can be summed to the provincial level. A provincial analysis design must be configured beforehand.
- At a minimum, timber quantity and quality forecasts should be made in the first analysis, with a habitat supply forecast in future analyses. Mechanisms to generate a log quality profile will be needed.
- NPV sensitivity analysis of each incremental silviculture option, using the methodological standards specified in "An Approach to the Discount Rate Issue," page 35. A mechanism to generate log prices for the interior will be required.
- Reporting in a multiple accounts format. See "Preliminary Multiple Accounts Framework," below.

To put a provincial analysis in context, the following additional analysis are applicable to a provincial level socio-economic analysis:

- a periodic global timber supply and demand analyses (this is normally included in the ministry's forest, range and recreation resource analysis process, so may not require additional effort);
- analysis of the impacts of options at the national and global levels.

6.8 Preliminary Multiple Accounts Framework

Earlier in this paper, a multiple accounts framework has been found to be suitable for economic analysis of incremental silviculture options. In this section, some preliminary work towards the development of a framework. It is intended as a starting point for further development.

There are five sources having concepts and structure of use in developing a possible accounts framework:

1. the Interim Evaluation Guidelines for *Social and Economic Impact Assessment of Forest Land management Options in British Columbia* (British Columbia, 1992);
2. government's goals and the proposed guiding principles as identified in *Working Paper 3: Government's goals, Proposed Guiding Principles*;
3. sections 4 and 8 of the *Ministry of Forests Act*;
4. the *Socio-Economic Analysis Reports* of the Timber Supply Review; and
5. the *Criteria and Indicators of sustainable forest management in Canada* (Canadian Council of Forest Ministers, 1997).

Some elements can be borrowed from each of these in the creation of a multiple accounts framework for analysis of incremental silviculture options.

Primary Accounts

The *Ministry of Forests Act* (s. 4) directly charges the ministry to "manage, protect and conserve the forest and range resources of the government, having regard to the immediate and long term economic and social benefits they may confer on British Columbia." These requirements, therefore, form the basis of the primary accounts which are proposed to be:

Economic and Investment:	Short term (next 5 years)
	Long term (6+ years)
Social:	Short term
	Long term

Analysis Zones

Both the *Interim Evaluation Guidelines* and the *Socio-economic Analysis Report*s have two analysis zones, the former having regional and provincial zones and the latter having TSA and provincial zones. The *Proposed Guiding Principles* and the *Criteria And Indicators Of Sustain-*

able Forest Management indicate that higher level analysis must also consider the national and global zones. In this framework it is proposed that management unit level analysis have a TSA and a provincial scope, regional analysis have a regional and provincial scope, and provincial analysis have regional, provincial, national and global and scope.[31] This is summarized in the following table.

Planning Level	Primary Account Analysis Zones				
	Management Unit	Regional	Provincial	National	Global
Management Unit (TSA)	**X**		X		
Regional	X	**X**	X		
Provincial		X	**X**	X	X

Sub-accounts

This paper demonstrates that economic and social considerations have strong roles in government forestry investment decisions. Because these are captured in government's goals and guiding principles, the goals and principles are presented as a starting point for the further development of a sub-account structure. Many of these sub-account items are the same or similar to the criteria and indicators of sustainable forest management developed by the Canadian Council of Forest Ministers (1997). However, there are 6 criteria, 22 elements and 83 indicators within the criteria and indicators framework – too many to deal with here. During further development of a sub-account structure, compatibility should be ensured.

As noted in *Working Paper 3: Government's Goals, Proposed Guiding Principles*, government has the following three goals:[32]

- Sustainable Resource Use
- Community Stability; and
- A Strong Forest Sector.

A socio-economic analysis should therefore indicate how every option contributes to or detracts from these goals. However, because these are effectively captured by the proposed guiding principles they do not warrant separate consideration.

The relevant proposed principles from *Working Paper 3: Government's Goals, Proposed Guiding Principles* are repeated below, along with suggested measurement criteria.[33]

[31] While it was noted earlier that a regional analysis must be able to analyze timber supply effects at the management unit level, the associated socio-economic effects may be determined at the regional level.

[32] These are the broad goals as demonstrated through government actions. Other goals, for example underlying objectives regarding income and wealth distribution, may exist but have not been publicly expressed.

[33] Some principles are process-oriented and would not be measured in a socio-economic analysis.

Proposed Principle	Socio-economic Analysis Sub-Account
Forest management is a long term activity and, as the distant future cannot be foretold, the best and only course of action in managing the timber resource is that which minimizes risk and maintains options.	*Effects on risk and options*
The short, mid and long term are of equal importance in the development of incremental silviculture plans and priorities. Each time period merits consideration within the context of the specific needs and available management options in each forest management unit.	*Relative emphasis in each time period vs available options.*
British Columbia's forests are important locally, provincially, nationally and globally, and should be managed in this context.	*Local, provincial, national (e.g., National Forest Strategy) and global impacts.*
British Columbia's integrated resource management forests are a renewable resource and can be maintained as such only by using practices which ensure long-term ecosystem health.	*Ecosystem health indicators.*
British Columbia has a unique richness of biological diversity which warrants care and preservation, including maintaining all stages of successional forest across the landscape.	*Biological diversity indicators, seral stage distribution, habitat supply.*
Each generation of British Columbians becomes the steward of the province's forest resources and has a moral obligation to preserve this heritage for future generations by restoration of historical degradation and by passing on forest resources undiminished or enhanced in growing potential, yield and value.	*Inter-generational equity indicators.*
A healthy environment and a healthy economy are essential to the social, cultural, material, physical and spiritual well-being of British Columbians.	*Environmental and economic indicators.*
Community stability and well-paying jobs (capable of supporting families) are stated social objectives of government, to be supported through investment in the forest and in jobs by means of undertaking incremental silviculture activities.	*Jobs, community stability effects.*
A balanced portfolio of regeneration, stand tending, and forest health activities is necessary to maintain a diversified, stable base of contractors with high levels of expertise.	*Balance between activities.*
Incremental silviculture expenditures must be fiscally responsible and the most economically efficient possible, within the context of social or other non-quantifiable objectives as may be established by government.	*Financial analysis.*

Socio-economic analysis could provide a useful assessment of or even challenge some of these principles. At the very least, the costs and benefits of adopting a principle will be better understood.

7. Recommendations for Future Development

An objective of this review was to "indicate the gaps in knowledge and methodology that need further research and development action to fill." The following summarizes the requirements for further research and development that were found.

1. A regional/provincial model needs to be developed to enable strategic incremental silv analysis. This model should be run at the regional level and be able to demonstrate implications at a low resolution level for every management unit in the region. A provincial result is determined by summing the regional results.
2. There is a need for empirical research to define a social rate of time preference appropriate to BC incremental silviculture investments. (See "An Approach to the Discount Rate Issue," page 35.)
3. Because of the dependency of financial analysis on the TASS stand model, the ministry should consider undertaking a comprehensive independent statistical validation and comparative review of the model. (See "TASS / TIPSY Model," page 27)
4. A multiple accounts framework for socio-economic analysis of incremental silviculture program options needs finalization. (See "Preliminary Multiple Accounts Framework," page 39.)