Lakes TSA
Timber Supply Analysis

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Preface

This analysis is part of the provincial Timber Supply Review being carried out by the British Columbia Forest Service. The review is examining the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) throughout British Columbia. In many areas of the province, timber supply analyses performed in the early 1980s have not been updated to reflect new inventory information or changes in management practices.

To determine allowable timber harvesting levels accurately and rationally, the Chief Forester must have an up-to-date assessment of timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

Unlike past analyses, which normally assessed the implications of several forest management scenarios, this report focuses on a single scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area, and include guidelines for the protection of forest resources, and official land-use decisions made by Cabinet. The current nature and capabilities of the local forest industry are also considered.

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province to be completed by mid-1995. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

This report is one of four documents that will be released for each TSA in the province as part of the Timber Supply Review. Two of these documents provide detailed technical information on the results of timber supply and socio-economic analyses. Another document summarizes this information to provide a focus for public discussions of possible timber harvest levels. The fourth outlines the Chief Forester's decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Lakes Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the both the short (next 20 years) and long (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The area of the Lakes TSA available for timber harvesting under current management practices is about 634 000 hectares of a total land base of about 1 123 000 hectares. The total volume of standing timber in the area is about 143 million cubic metres, of which 118 million cubic metres or 83% is currently above minimum harvestable age. The present forest structure has 69% of the stands possessing an age in excess of 100 years. The timber harvesting land base is composed of lodgepole pine (77%), spruce (21%) and balsam (2%).

The current AAC for the Lakes TSA is 1 500 000 cubic metres per year. Under current forest management assumptions, the analysis results indicate that the current harvest level can be maintained for 7 decades. In the eighth decade a 10% decline is projected followed by a 3% decline to a harvest level of 1 310 000 cubic metres per year. A rise to the long-term harvest level of 1 441 000 cubic metres will occur in decade 18. Timber harvesting is expected to have a relatively long transition from harvesting existing timber to harvesting predominantly second growth due to forest cover guidelines. The cover guidelines require a percentage of forest cover to be maintained in ages over 100 years and cause a slower rate of access to the standing inventory in some zones than in the integrated resources management zone.

The analysis has shown that the initial harvest rate could be raised without incurring large timber shortages or violating current management assumptions. An alternative harvest forecast is identified which begins at 1 650 000 cubic metres per year with a decline in the sixth decade to the current harvest level of 1 500 000 cubic metres per year followed in the seventh decade by a further decline of 10% to 1 350 000 cubic metres. A 3% decline would be required in decade 8 to a harvest level of 1 310 000 cubic metres per year. Raising the initial harvest level does not jeopardize the rise to the long-term harvest level in decade 18.

The harvest level cannot be maintained at or above the long-term harvest level, even if it is immediately reduced to the steady long-term level.

The above results reflect current knowledge and information on forest inventory and growth. However, it is important to recognize that uncertainty exists about several of the factors that define timber supply. A series of sensitivity analyses indicate that these uncertainties can affect timber supply to varying degrees.

The largest impact observed in the analysis is due to uncertainty in site index for regenerated pine stands. Recent studies in the Lakes TSA and the Morice TSA have shown that the site index for existing pine stands underestimates the growth potential of regenerated pine. It appears that by controlling the number of trees per hectare, a higher growth rate can be achieved. The impact of this is cumulative as faster growth enables trees to produce higher volumes at younger ages and increases the rate of access to the zones where harvesting activity is constrained by the amount of area that may be below the green-up age. The estimated green-up age is lowered by up to 4 years in the caribou corridor and visual quality objective (VQO) zones. The resulting initial harvest level after adjustments have been made is 25% higher than the current harvest level and a further 14% increase in harvest level occurs in decade 18.

Timber supply is quite robust to all sensitivity analysis over the next 20 years. Moderate increases in the current harvest level may also be achieved if either existing volumes are being under-estimated or if visual quality objectives can be met with less restrictive forest cover guidelines.

Moderate extensions of the current harvest level beyond the base case may be achieved if stands become merchantable 10 years earlier, if the timber harvesting land base increases or if green-up ages are in fact lower, as a faster rate of access in the caribou corridor and VQO zones can occur.

The analysis does show that moderate impacts in long-term timber supply may require the harvest level to decline 2-3 decades earlier than in the base case or require a deeper dip below the long-term harvest level to avoid serious timber supply shortfalls. Uncertainties which show this trend are the uncertainty in existing stand volume estimates, the uncertainty about old-growth requirements, the uncertainty in the size of the timber harvesting land base and the uncertainty in the green-up age required to meet adjacency constraints.

In conclusion, this analysis indicates that using current inventory and growth and yield information, the current harvest level can be maintained safely for the next 20 years without jeopardizing future opportunities in forest management. Several uncertainties important to timber supply produce moderate impacts which will deserve further discussion in the future. However the opportunities produced by high growth rates in managed pine stands provide a great deal of flexibility in the harvest level and may completely offset any negative impacts on timber supply due to other uncertainties. It will be important to determine if the growth response that has been observed to date will continue.

Table of Contents

Preface ... iii

Executive Summary ... iv

Introduction ... 1

1 Description of the Lakes TSA ... 3

2 Information Preparation ... 5

- 2.1 Land base inventory ... 5
- 2.2 Timber growth and yield ... 11
- 2.3 Management practices ... 12
- 2.4 Management zones ... 14

3 Analysis Methods ... 15

4 Results ... 16

- 4.1 Base case harvest forecast ... 16
- 4.2 Area, average volume, and average area harvested ... 20

5 Timber Supply Sensitivity Analyses ... 25

- 5.1 Alternative initial harvest levels and harvest flows over time ... 25
- 5.2 Uncertainty to existing timber volumes ... 27
- 5.3 Uncertainty in minimum harvestable ages ... 28
- 5.4 Uncertainty in land base available for harvesting ... 30
- 5.5 Uncertainty in forest cover objectives for visual quality ... 32
- 5.6 Uncertainty in regenerated stand yield estimates ... 34
- 5.7 Uncertainty in green-up ages ... 35
- 5.8 Uncertainty in the requirement for old growth ... 36
- 5.9 Uncertainty in site index for managed pine plantations ... 38
- 5.10 Uncertainty in the method used to represent adjacency objectives ... 39
- 5.11 Uncertainty in the forest cover objectives in the wildlife and riparian zones ... 41
- 5.12 Deferral extension for the Sutherland valley ... 42

6 Summary and Conclusions ... 43

7 References ... 45

8 Glossary ... 46

Table of Contents

APPENDIX A Description of Data Inputs and Assumptions **49**

Introduction **50**

A.1 Zone and Analysis Unit Definition **51**

A.2 Definition of the Timber Harvesting Land Base **55**

A.3 Forest Management Assumptions **58**

A.4 Existing and Managed Stand Yield Curves **62**

APPENDIX B Paired Plot Impacts **68**

Paired Plot Impacts **69**

Tables

1. Timber harvesting land base, Lakes TSA 7
A-1. Analysis unit characteristics 52
A-2. Distribution of area and merchantable volume in the current timber harvesting land base by zone and analysis unit 53
A-3 Ownership codes for the Lakes TSA 55
A-4. Per cent of area considered unavailable for timber harvesting because of environmental sensitivity 55
A-5. Per cent of non-merchantable forest cover considered unavailable for timber harvesting 56
A-6. Unsalvaged losses 57
A-7. Not satisfactorily restocked areas 58
A-8. Regeneration assumptions by analysis unit 58
A-9. Existing managed stands by analysis unit 59
A-10. Minimum harvestable age for each analysis unit 59
A-11. Forest cover requirements and green-up age 61
A-12. Forest cover guidelines by VQO class (percentages) 62
A-13. Timber volume for existing and regenerated stands by analysis unit 64
B-1. Green-up age changes due to site index adjustment on lodgepole pine 70

Table of Contents

Figures

1. Map showing the location of the Lakes TSA within the Prince Rupert Forest Region 4
2. Classification of the total and productive forest land bases — Lakes TSA, 1995 8
3. Area by main species and site productivity — Lakes TSA timber harvesting land base, 1995 ...9
4. Area by main species and maturity — Lakes TSA timber harvesting land base, 1995 10
5. Current age class distribution — Lakes TSA timber harvesting land base, 1995 11
6. Major resource emphasis groupings — Lakes TSA timber harvesting land base, 1995 14
7. Base case harvest forecast for the Lakes TSA, 1995..17
8. Comparison of two harvest flow strategies — Lakes TSA, 1995 18
9. Changes in timber growing stock over time — Lakes TSA base case, 1995 19
10. Area harvested by decade — Lakes TSA base case, 1995 20
11. Average volume per hectare — Lakes TSA base case, 1995 21
12. Mean area weighted harvest age — Lakes TSA base case, 1995 21
13. Age class distribution over time — Lakes TSA base case, 1995 23
14. Alternative harvest flow forecasts — Lakes TSA, 1995 26
15. Harvest forecasts with existing stand timber yield estimates changed by 10% — Lakes TSA, 1995..27
16. Harvest forecasts with minimum harvestable ages changed by 10 years — Lakes TSA, 1995 29
17. Harvest forecast with a change in the size of timber harvesting land base — Lakes TSA, 1995 31
18. Harvest forecasts if forest cover objectives for visual quality management changed by 8% — Lakes TSA, 1995 33
19. Harvest forecasts with regenerated stand yield estimates changed by 25% — Lakes TSA, 1995 34
20. Harvest forecasts if green-up ages were 5 years different than the base case — Lakes TSA, 1995..35
21. Harvest forecasts if the forest cover objectives for old growth were different than the base case — Lakes TSA, 1995 36
22. Harvest forecast with site index adjustments to regenerated pine stands — Lakes TSA, 1995 38
23. Harvest forecast with a 6-pass harvesting system — Lakes TSA, 1995 40
24. Harvest forecast with changes in forest cover requirements in the wildlife and riparian zones — Lakes TSA, 1995 41

Introduction

Timber supply is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 200 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the Forest Act now requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 6 *of the* Forest Act.

Allowable annual cut (AAC)
The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with Section 7 *of the* Forest Act.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Lakes TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. The report ends with a summary and conclusions.

The appendix contains further details about the data and assumptions used in this analysis.

Forest inventory
Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.

1 Description of the Lakes TSA

The Lakes TSA, covering 1.12 million hectares, is the easternmost TSA in the Prince Rupert Forest Region (Figure 1). The Lakes TSA extends from Babine Lake in the north to the Entiako River in the south and lies along the northeastern boundary of Tweedsmuir Provincial Park.

The Lakes TSA drains into two major watersheds, the Skeena and the Fraser and is divided by three major water bodies — Babine Lake in the north, Francois Lake and Ootsa Lake. Approximately 114 000 hectares, or 10% of the total land base is classified as lake. These lakes provide natural barriers to the transportation of timber to processing plants located along the Highway 16 — CNR transportation corridor. The Lakes TSA contains the larger community of Burns Lake, which serves as the supply and distribution centre for various rural areas, and smaller settlements situated along the Highway 16 — CNR transportation corridor and between Francois and Ootsa Lakes.

The economy of the area is dominated by logging and sawmilling activities. Mixed farming and cattle ranching are secondary and many of the small farmers turn to logging or sawmilling in the winter to supplement their incomes. The economy is also stimulated by summertime tourism activities. Two large sawmills, Decker Lake Forest Products and Babine Forest Products, provide much of the local economic activity through direct employment in the mills and associated logging activities. Babine Forest Products purchases a substantial portion of their timber from small operators harvesting under the Small Business Forest Enterprise Program or from private lands. A large percentage of the timber harvested in the southern portion of the Lakes TSA is transported to manufacturing plants outside the TSA at Lejac.

The Lakes TSA contains important habitat for the Entiako caribou herd. The southern portions of the Lakes TSA, which border on Tweedsmuir Provincial Park, provide a migration corridor and winter range. Areas of highly productive moose and deer habitat are connected by numerous wetland complexes. The Lakes TSA also supports a small grizzly bear population in the Klaytahnkut Lake and Sutherland River areas and scattered satellite populations of mountain goat inhabit higher elevations.

Due to the number of lakes and the highway corridor in the Lakes TSA, visual quality of the landscape is important. Approximately 35% of the total land base has some degree of visual sensitivity to harvesting activity.

A Land and Resource Management Planning (LRMP) process is ongoing in the Lakes TSA. Representatives of the provincial and local governments, aboriginal peoples and the public are developing a land use and management plan that will account for the diverse values in the area.

1 Description of the Lakes TSA

Figure 1. Map showing the location of the Lakes TSA within the Prince Rupert Forest Region.

2 Information Preparation

Many pieces of information are required to conduct a timber supply analysis. Each piece falls into one of three categories: land base inventory, timber growth and yield, and management practices.

2.1 Land base inventory

Land base inventory information used in this analysis comes in the form of a computer file prepared by the B.C. Forest Service Inventory Branch in 1993. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

Initially, this file is a representation of the land base for the entire TSA. It includes data for areas on which timber harvesting operations are not expected to take place, and therefore do not contribute to the timber supply of the area. Examples include land that has been set aside for a park, or areas occupied by power lines, highways or town sites. Before this land base file is used to make timber supply projections, data for these non-contributing areas must be removed to ensure that the file represents the timber harvesting land base*.

The reduced data file is derived through a computer process that identifies information for non-contributing areas and removes it from the file. When these reductions are made, care is taken to ensure that only a single reduction is made where categories overlap (for example, where a park area also has unstable soils).

It is important to remember that removal of data for areas not contributing to the timber supply does not imply withdrawal of these areas from the TSA. The B.C. Forest Service still manages the entire area of the TSA (except for certain designated lands) as a forest unit that contributes a mix of timber and non-timber values. Within that integrated resource context, the timber supply is managed.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean that an area is open to unrestricted harvesting activities. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites with adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

Under current management within the Lakes TSA, certain areas are not expected to contribute to the timber harvesting land base. These are:

- areas not managed directly be the B.C. Forest Service — these include non-Crown land, areas managed by other agencies (for example parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licences).
- non-forest areas — areas not capable of growing productive forest (e.g. rock, swamp and alpine areas).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.

Timber harvesting land base
The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.

- non-merchantable forest types* — areas occupied by timber stands of low volume, non-merchantable species, stands with non-merchantable secondary species, stands with insufficient height or with low timber-growing potential. Table 1 shows six categories of non-merchantable forest types. They are labelled low productivity based on site index, non-merchantable balsam stands, per cent of non-merchantable in pine stands, insufficient height in balsam and spruce stands, insufficient height in pine stands and non-merchantable stocking class 4 pine stands. Each of these categories is considered non-merchantable under current economic conditions.
- existing roads, trails and landings — forest land lost to future timber production due to past access development and harvesting.
- environmentally sensitive areas (ESA)* — portions of the area classified as sensitive are considered unavailable for timber harvesting.
- future roads, trails and landings — to account for future losses of productive land to development. These areas are initially included in the harvesting land base, and are removed as part of the first harvest.
- not satisfactorily restocked (NSR)* areas — these areas are initially removed, but are considered available for timber production and are added back into the timber harvesting land base once prescribed treatment plans have been specified.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions."

Table 1 summarizes the areas in each category and shows the area of the timber harvesting land base. The reductions to productive Crown forest are made in the order of appearance in Table 1.

Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

Environmentally sensitive areas
Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Not satisfactorily restocked (NSR)
An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service, Silviculture Branch. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.

Table 1. Timber harvesting land base, Lakes TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	1 123 667	100.0	
Not managed by B.C. Forest Service	86 280	7.7	
Non-forest/non-productive	171 019	15.2	
Total productive forest managed by Forest Service (Crown forest)	866 368	77.1	100.0
Reductions to productive Crown forest:			
Non-commercial cover	3 727	0.3	0.4
Environmentally sensitive areas	42 267	3.8	4.9
Low productivity based on site index	39 713	3.5	4.6
Deciduous forest types	40 973	3.6	4.7
Non-merchantable balsam stands	9 015	0.8	1.0
Per cent of non-merchantable in pine stands	2 921	0.3	0.3
Insufficient height in balsam and spruce stands	4 352	0.4	0.5
Insufficient height in pine stands	50 770	4.5	5.9
Non-merchantable stocking class 4 pine	93	0	0
Existing roads	12 764	1.1	1.5
Not satisfactorily restocked	24 098	2.1	2.8
Total current reductions	- 230 693	20.5	26.6
Current timber harvesting land base	635 675	56.6	73.4
Area returned to land base for not satisfactorily restocked reduction	+ 22 350	2.0	2.6
Future reductions for road development	- 23 538	2.1	2.7
Long-term timber harvesting land base	634 487	56.5	73.2

Figure 2 represents both the total Lakes TSA area and the breakdown of the productive forest. Within the total land base, approximately 92% is directly under B.C. Forest Service management with 77% being considered productive Crown forest. Of the productive forest land, over 73% is considered to contribute to the timber harvesting land base. The area that is considered unlikely to contribute to harvesting activity under current management is portioned mainly between environmentally sensitive areas (ESAs) and non-merchantable cover types.

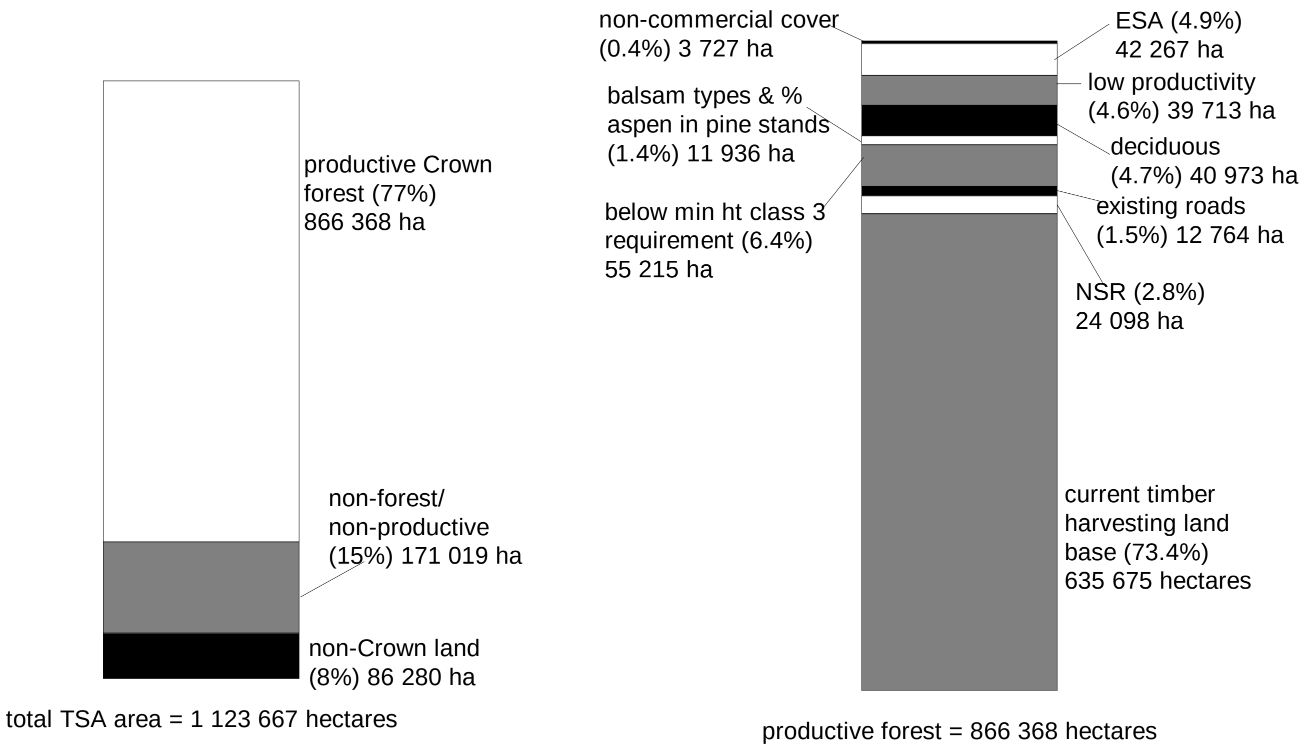

Figure 2. Classification of the total and productive forest land bases — Lakes TSA, 1995.

The predominant species within the timber harvesting land base is lodgepole pine while the secondary species is spruce. Balsam and Douglas-fir are present but are only occasionally the dominant species in stands. Figure 3 provides the breakdown of species by site productivity. The Lakes TSA is composed predominantly of sites of medium productivity.

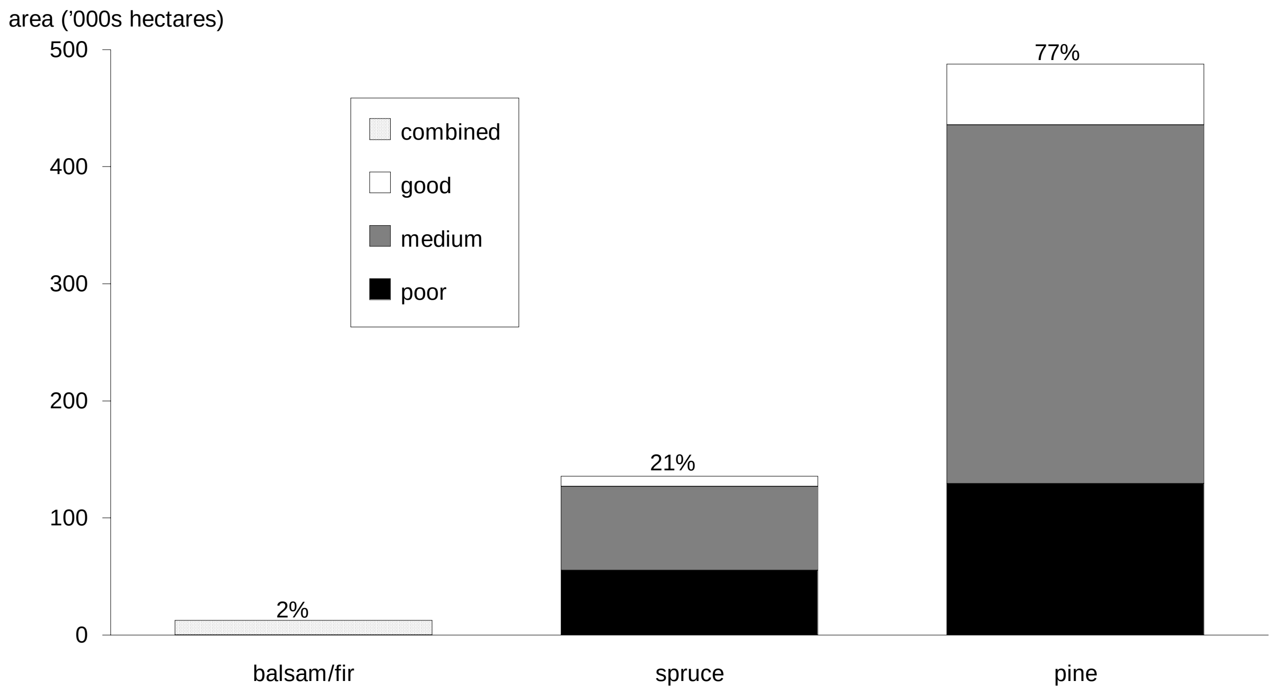

Figure 3. Area by main species and site productivity — Lakes TSA timber harvesting land base, 1995.

The timber harvesting land base is comprised mainly of mature forest as can be seen in Figure 4. The species and age composition of the forest in the Lakes TSA create conditions suitable for mountain pine beetle outbreaks. An aggressive mountain pine beetle control program in the Lakes Forest District has kept timber losses to moderate levels.

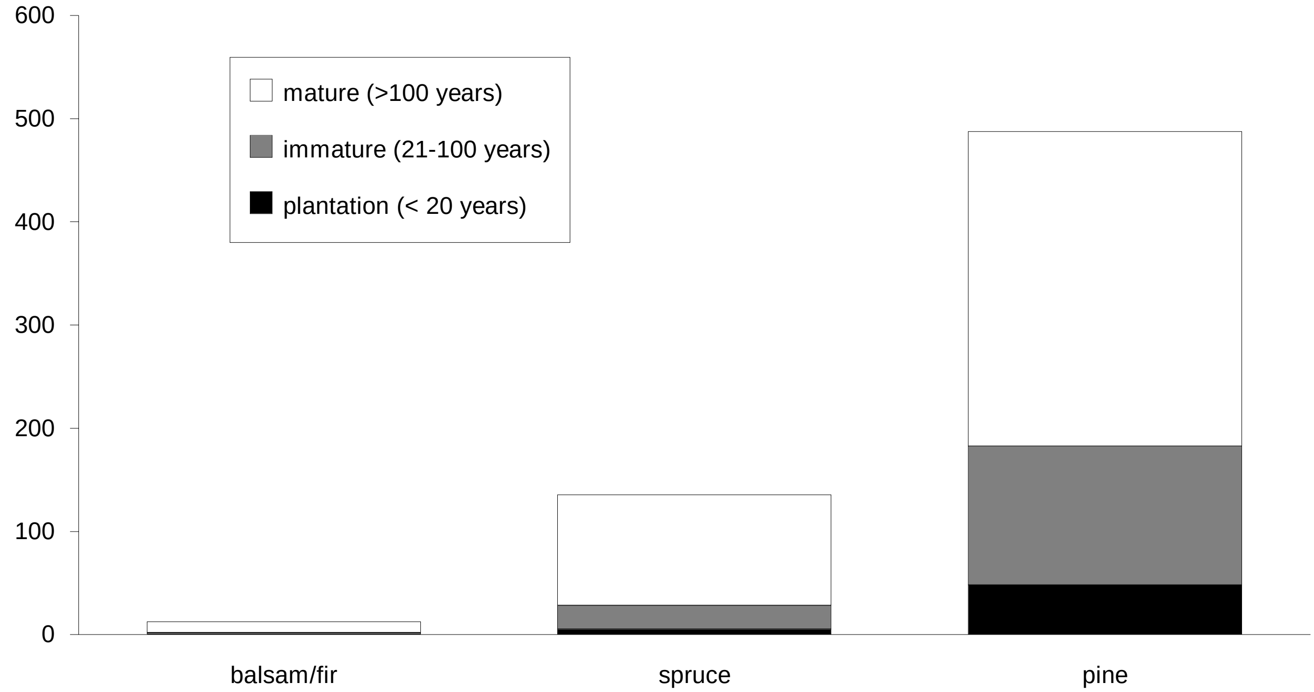

Figure 4. Area by main species and maturity — Lakes TSA timber harvesting land base, 1995.

2 Information Preparation

The current age class distribution (Figure 5) shows that over 64% of the timber harvesting land base is covered by stands over 100 years old. Two notable gaps in the age classes occur between the 30-50 year age classes and the 90-100 year age classes. The gaps are a result of periods in time when few disturbances occurred due to insects, wind, fire, or human endeavor to replace older stands with younger ones. To maintain a steady flow of timber, the existing natural stands must be allocated to accommodate harvesting until currently younger areas become old enough to harvest.

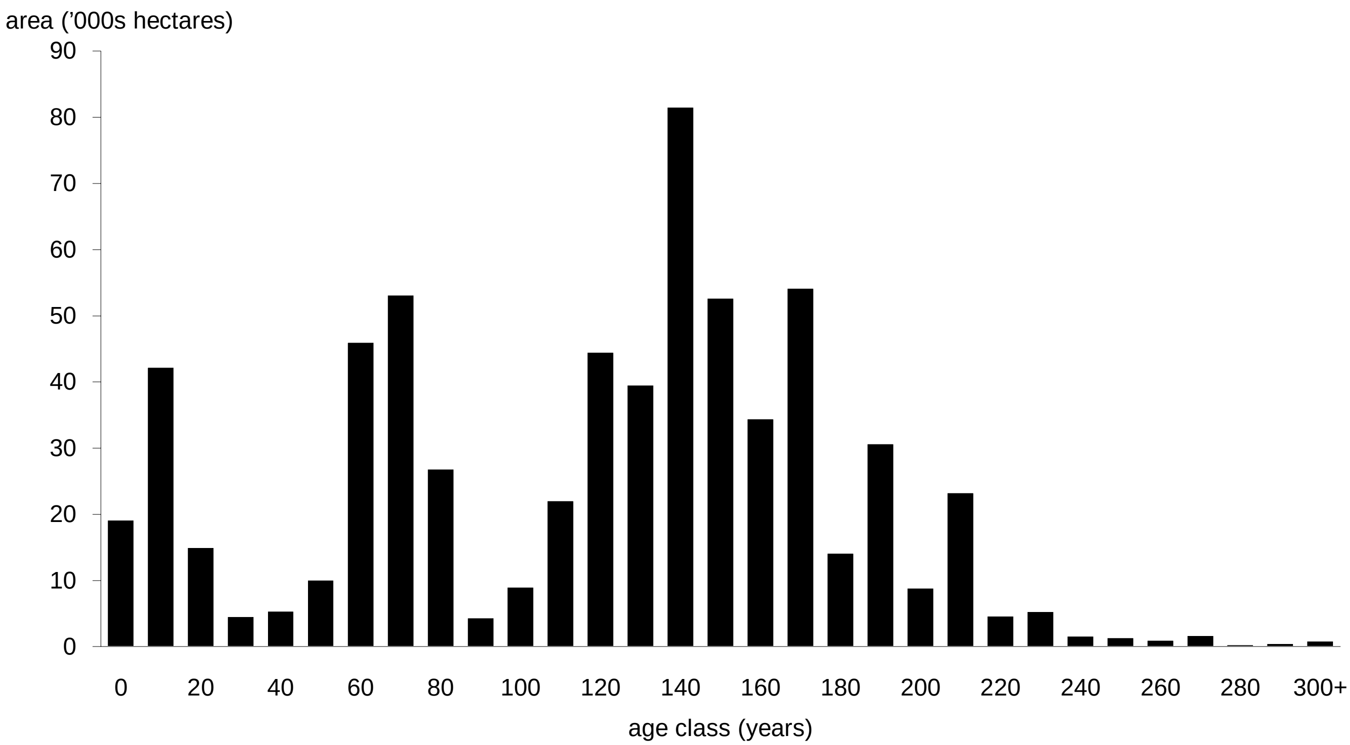

Figure 5. *Current age class distribution — Lakes TSA timber harvesting land base, 1995.*

2.2 Timber growth and yield

Timber growth and yield refers to the predictions of the growth and development of individual forest stands over time. The most common measure of the amount of standing timber is volume per unit area (in British Columbia, cubic metres per hectare). This measure assumes a utilization level or set of dimensions that establishes a minimum size limit for trees and logs that may be harvested and removed from a site. See Appendix A, "Description of Data Inputs and Assumptions" for more details on utilization.

Timber volumes applied to existing stands in this analysis are based on the Variable Density Yield Prediction (VDYP) model developed by the B.C. Forest Service, Inventory Branch. This model provides estimates of stand volume according to age. Timber volumes estimated for regenerated second-growth stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service, Research Branch. Sensitivity analysis addresses the possibility that stand volumes may be different from those predicted.

2.3 Management practices

Timber supply is directly connected to forest management activity. The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* guide forest management practices in the Lakes Forest District. The focus of the Timber Supply Review is to describe the timber supply based on current management practices, as implemented in development plans for the area. Staff in the Lakes Forest District and in the Prince Rupert Forest Region defined these practices as described in the following management assumptions*.

- Basic silviculture levels — reforestation activities required to establish free-growing* stands of acceptable tree species. The primary harvesting system in the Lakes TSA is clearcut harvesting* with all restocking by planting.
- Forest health and unsalvaged losses* — expected losses due to insects, diseases, fire and wind damage are estimated to be 39 000 cubic metres per year. This amount has been subtracted from all harvest forecasts* in this report.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable size. For this analysis the ages have been set to the age when the maximum average annual growth occurs. Actual harvest age may be greater due to a combination of factors, including age of other stands, forest cover objectives* and overall timber harvest targets. It is important to remember that managing for the interests of other resources may necessitate harvesting stands at ages well above the minimum with an associated loss in long-term timber yield.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Clearcut harvesting
A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standard by appropriate means including planting and natural seeding.

Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Forest cover objectives
Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.

- Cutblock adjacency* and green-up* — the *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* specify that previously harvested stands must reach a desired condition, or green-up (3 metres in height), before adjacent stands may be harvested. The Lakes Forest District require that a maximum of 33% of an area being developed for harvesting be less than 3 metres tall. The purpose of the green-up height requirement is to prevent harvesting from becoming overly concentrated in an area at any time.
- Representation of forest types — harvesting guidelines outline objectives to retain a minimum proportion of the harvesting land base in old-growth conditions to help maintain some types of biological diversity and provide the forest types necessary for seasonal wildlife habitat.
- Riparian areas* — harvesting in riparian areas of 100 hectares or more in size takes into account the retention of old-growth timber. Retaining mature timber maintains thermal cover and general biological diversity.
- Visual quality — 151 671 hectares (24%) of the timber harvesting land base are being managed for visual quality. Maintaining visual quality requires that visible evidence of harvesting be kept within limits. Forest cover guidelines are stated in terms of the maximum proportion of an area that may be less than 6.5 metres tall (the visual green-up). The proportion depends on the specific visual quality objective (VQO)* and the visual sensitivity*. In this analysis, areas managed for visual quality fall into two categories: 1) retention* where evidence of timber harvesting must be minimal; and 2) partial retention* where harvesting may be noticeable but not dominant on the natural landscape.

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Visual Quality Objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Visual sensitivity
A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.

Retention VQO
Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity.

Partial retention VQO
Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective).

2.4 Management zones

The timber harvesting land base within the Lakes TSA has been divided into seven resource emphasis groupings or zones based upon common management objectives (Figure 5). Each zone has a unique forest cover requirement and green-up age and is composed of all areas which will be managed in a like manner. The Sutherland Valley is an undeveloped area that has been designated for the short term as a no-harvest area within a local resource use plan. A 10 year deferral on harvesting activity has been placed on the area for this analysis. The riparian zone consists of all riparian complexes greater than 100 hectares in size. The Entiako Caribou Corridor is the migration corridor used by the Tweedsmuir Entiako caribou herd to travel between summer range and calving areas in Tweedsmuir park and the winter range located south of Tetachuk Lake. Due to the large number of lakes and the two highway corridors in the Lakes TSA, 24% of the timber harvesting land base has been placed in one of two visual quality zones, either the partial retention zone or the retention zone. The moose and deer winter range is composed of the prime habitat areas providing winter forage, thermal cover and security cover. The largest zone, labelled the integrated resources management zone, is composed of the areas which have not been delegated to any other zone.

A full explanation of the zones and the forest cover requirements* is found in Appendix A, Description of Data Inputs and Assumptions."

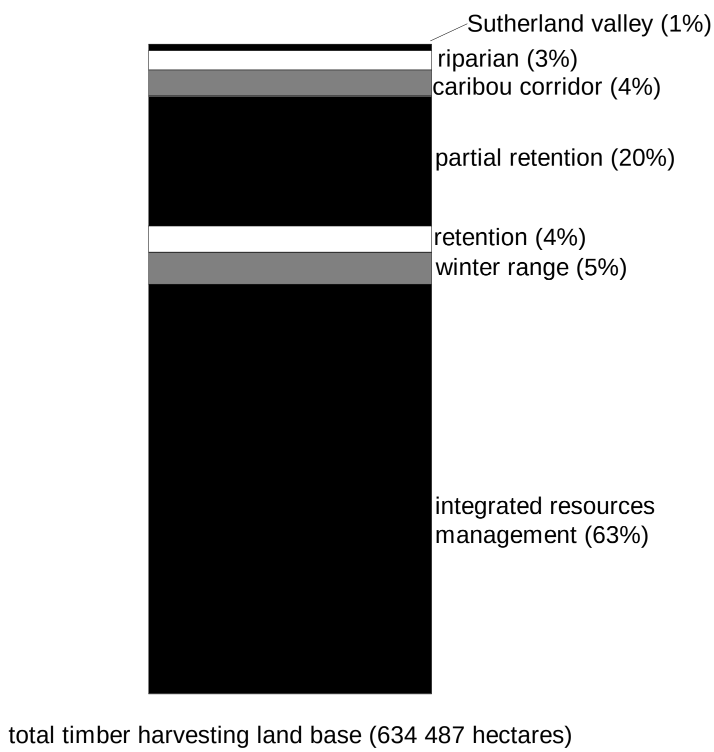

Figure 6. Major resource emphasis groupings — Lakes TSA timber harvesting land base, 1995.

> ***Forest cover requirements***
> *Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest adjacency and green-up guidelines are also specified using forest cover objectives (see* ***Cutblock adjacency guidelines and Green-up).***

3 Analysis Methods

The purpose of this analysis was to examine both the short- and long-term timber harvesting opportunities in the Lakes TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how trees grow and are harvested over a period of up to 400 years. Generally, only the results for the first 250 years are shown graphically in this report because the harvest remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. However, the Forest Service model differs from most other models in that it allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of cutblock adjacency and green-up prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model examines the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular timber harvesting regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will allow local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However**, the results of the analysis are not meant to be taken as recommendations of any particular AAC.**

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

4 Results

This section presents results of the timber supply analysis for the Lakes TSA. The analysis uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation." These results will be referred to as the base case because they form the basis for comparison when assessing the effects of uncertainty on timber supply. Because forest management is inherently a very long-term venture, uncertainty surrounds much of the information important in determining timber supply. These factors will be discussed in Section 5, "Timber Supply Sensitivity Analyses."

4.1 Base case harvest forecast

The base case harvest forecast based on current forest management assumptions for the Lakes TSA is shown in Figure 7. The base case should not be viewed alone but in concert with the sensitivity forecasts for a complete understanding of the impacts that various factors have on timber supply.

The initial harvest level is set at the current level of 1 500 000 cubic metres per year. In the eighth decade the harvest falls by 10% to 1 350 000 cubic metres per year. The following decade a further 3% decline is made to 1 310 000 cubic metres per year. This harvest level is maintained until decade 18 when the harvest increases 9% to a sustainable level of 1 441 000 cubic metres per year.

The estimated unsalvaged losses of 39 000 cubic metres per year have been removed from all harvest forecasts shown in this report.

Several criteria were used in defining the base case harvest forecast. The initial level was set at the current harvest level. The long-term harvest level* was the level which enabled a steady growing stock* (Figure 9) capable of supporting the requested harvest level in perpetuity. A continually declining growing stock would signify that timber is being harvested above the productive capability of the land. The long-term level in the base case is 18% below the maximum productive capacity of the land due to the impact of forest cover guidelines. The maximum productive capacity of the forest can only be captured if all stands are harvested at the culmination of mean annual increment (MAI)*. For the base case, the minimum harvestable ages were set to the age when this occurs, however forest cover guidelines impact the age at which a stand is harvested. For example, in the retention zone, only 2% of the area may be below 6.5 metres. Applying this constraint reserves stands well past the culmination age* in the retention zone which is 4% of the timber harvesting land base.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base and includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Growing stock
The volume estimate for all standing timber, of all ages, at a particular time.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Culmination age
The age at which a timber stand reaches its highest mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.

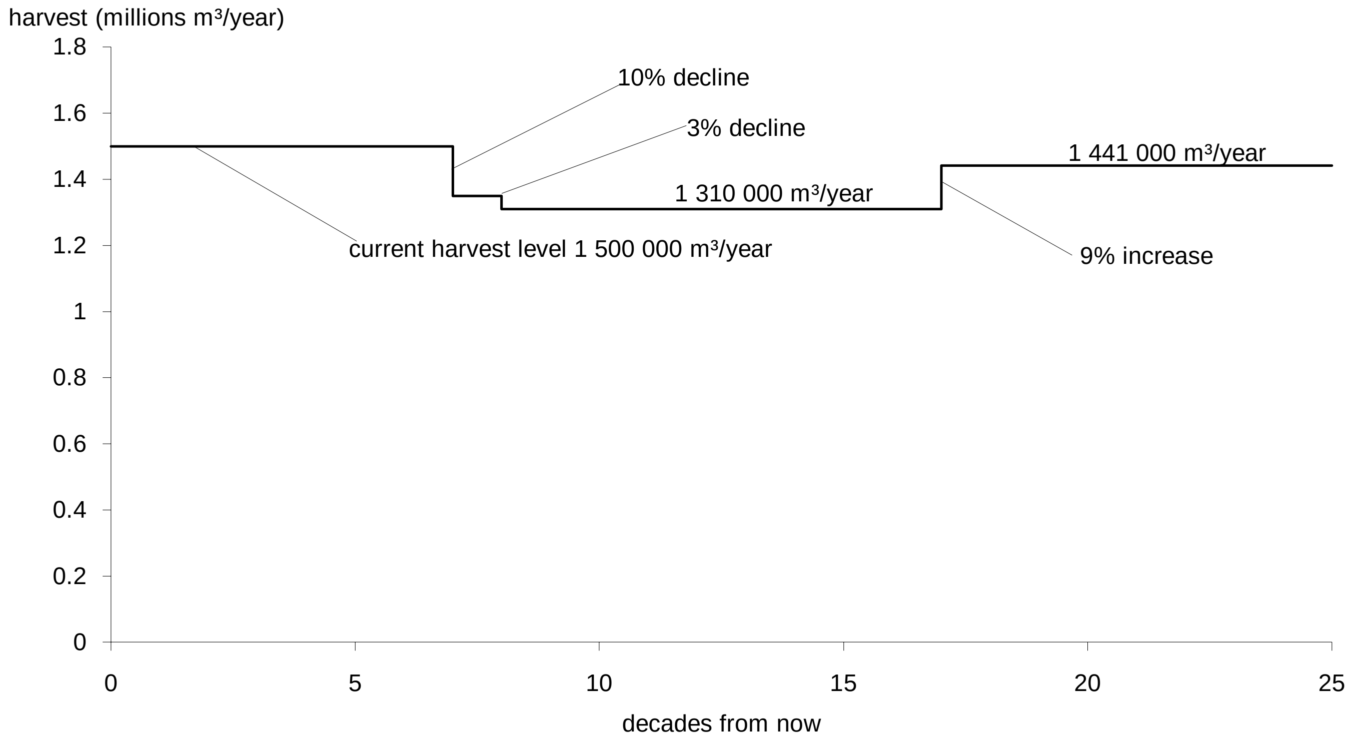

Figure 7. Base case harvest forecast for the Lakes TSA, 1995.

The transition from the initial harvest level to the long-term harvest level is dependent to a large degree on the transition from harvesting in existing stands to harvesting managed stands, the rate of acceptable decadal decline and the depth of that decline. A simple drop from the current harvest level to the long-term harvest level will still not eliminate the need to drop below the long-term harvest level as shown in Figure 8. The harvest flow policy chosen for the base case maintains the current harvest level, minimizes the number of steps down from the current level and hastens the rise to the long-term level.

If the current harvest level continued without the decline observed in the base case, a large shortfall of timber would occur between decades 11 and 14, when the area that can be harvested is at a minimum as many stands are below minimum harvestable age or are required to fulfill forest cover requirements. Viewing the age class distribution after 100 years illustrates this point (see Figure 13). The area in forest cover over 100 years old is primarily reserved for old-growth retention or is in zones which are preserving visual quality. To avoid the shortfall the harvest level must be reduced prior to this time. By declining by 10% in decade 8, the merchantable volume, or the volume above minimum harvestable age is accessed at a slower rate and therefore is available over a longer time period. The second decline of 3% in decade 9 allows an increase to the long-term harvest level in the eighteenth decade. If only the 10% decline is taken, the rise to the long-term level cannot occur before decade 21 without jeopardizing the ability to maintain that harvest level. Therefore the second decline allows a rise to the long-term level sooner than if it was not made. If the rise to the long-term level is brought forward to decade 15 without a reciprocal increase in the second step down, the ability to maintain the long-term harvest flow may be jeopardized. Increasing the size of the second decline can shorten the time until rising to the long-term level, however this would also increase the size of the step up. In the base case, the step up to the long-term level is 9%.

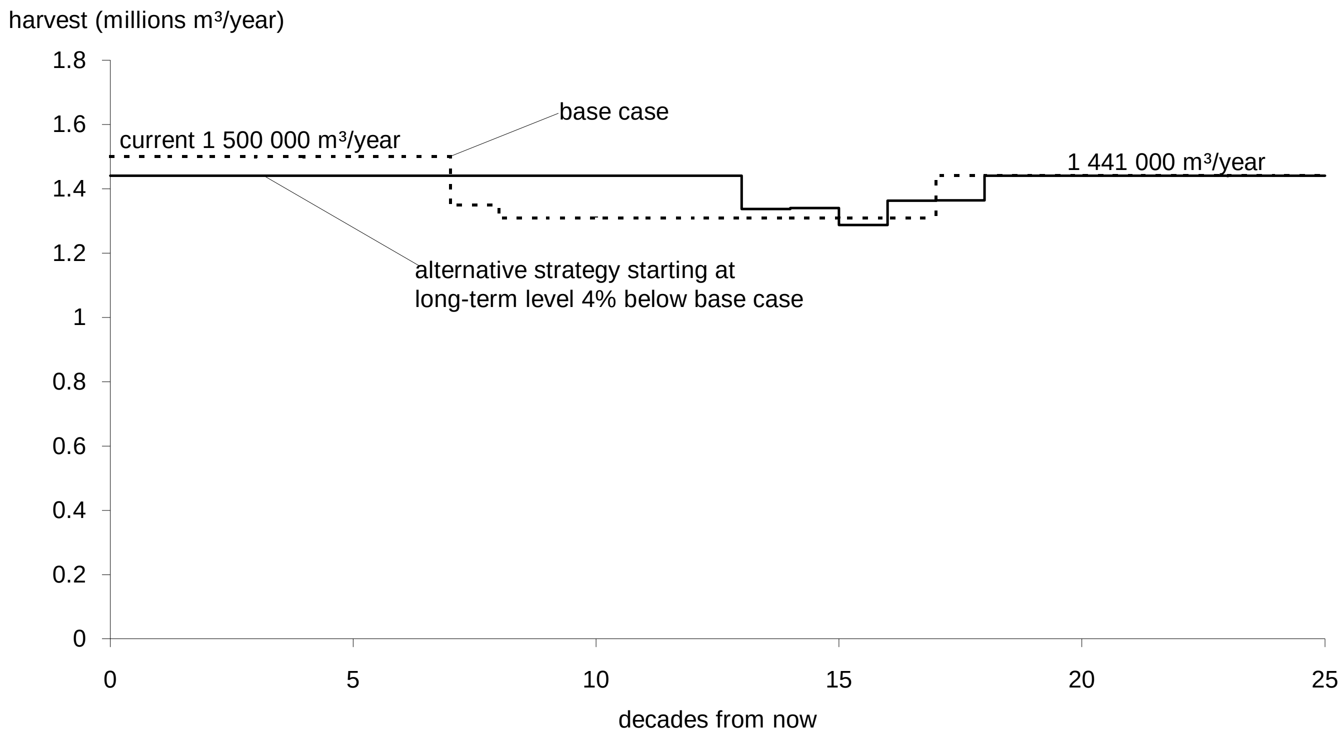

Figure 8. Comparison of two harvest flow strategies — Lakes TSA, 1995.

Figure 8 further illustrates the shortfalls that are expected to occur. This figure identifies the base case and an alternative harvest flow, represented by the solid line. The alternative harvest flow starts at the long-term harvest level which is 4% below the current harvest level. A shortfall is still expected, however, it occurs 3 decades later than if the harvest level was simply set at the current level. An increase to the long-term level occurs one decade later than the base case. The shortfall is an artifact of the transition from harvesting naturally regenerated stands to harvesting managed forest. The long-term harvest level is supported by second-growth forest which produces similar volumes at lower minimum harvestable ages than the existing forest. This means that second-growth forest is expected to produce similar volumes much earlier than the existing stands. The timber supply issue becomes "at what rate should the existing timber be accessed to minimize possible shortfalls in the future?" Both harvest flow strategies indicate that a drop below the long-term harvest level is required.

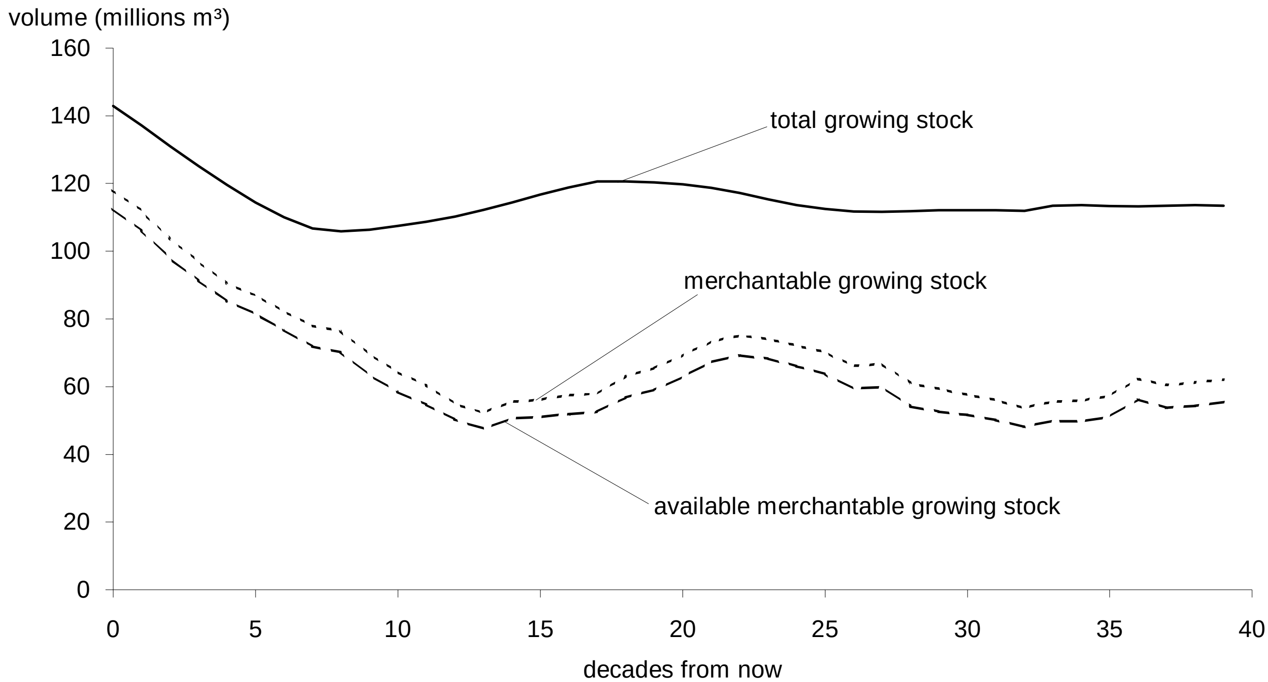

Figure 9. Changes in timber growing stock over time — Lakes TSA base case, 1995.

Figure 9 shows both the total and harvestable growing stock projected over time. There is currently a total of about 143 million cubic metres of timber in the timber harvesting land base, as indicated by the solid line. Of the total, about 118 million cubic metres of timber is currently old enough to be considered harvestable, as shown by the dotted line. The actual available timber, after old-growth requirements are met, is 113 million cubic metres and is represented by the dashed line. Growing stock declines over the next 5 decades as mature standing volume well past minimum harvestable age is removed and replaced with a younger forest. The available timber is projected to remain above 50 million cubic metres due to the slow replacement of existing stands with second-growth forest in visual quality objectives (VQO) zones. The existing growing stock is not removed before decade 20 within the partial retention zone and is not completely removed within the planning horizon of 400 years for the retention zone. The total growing stock is projected to level out at about 113 million cubic metres after decade 23. The planning horizon has been extended to 400 years in this graph to display the flattening of the total growing stock which is indicative of a sustainable harvest level.

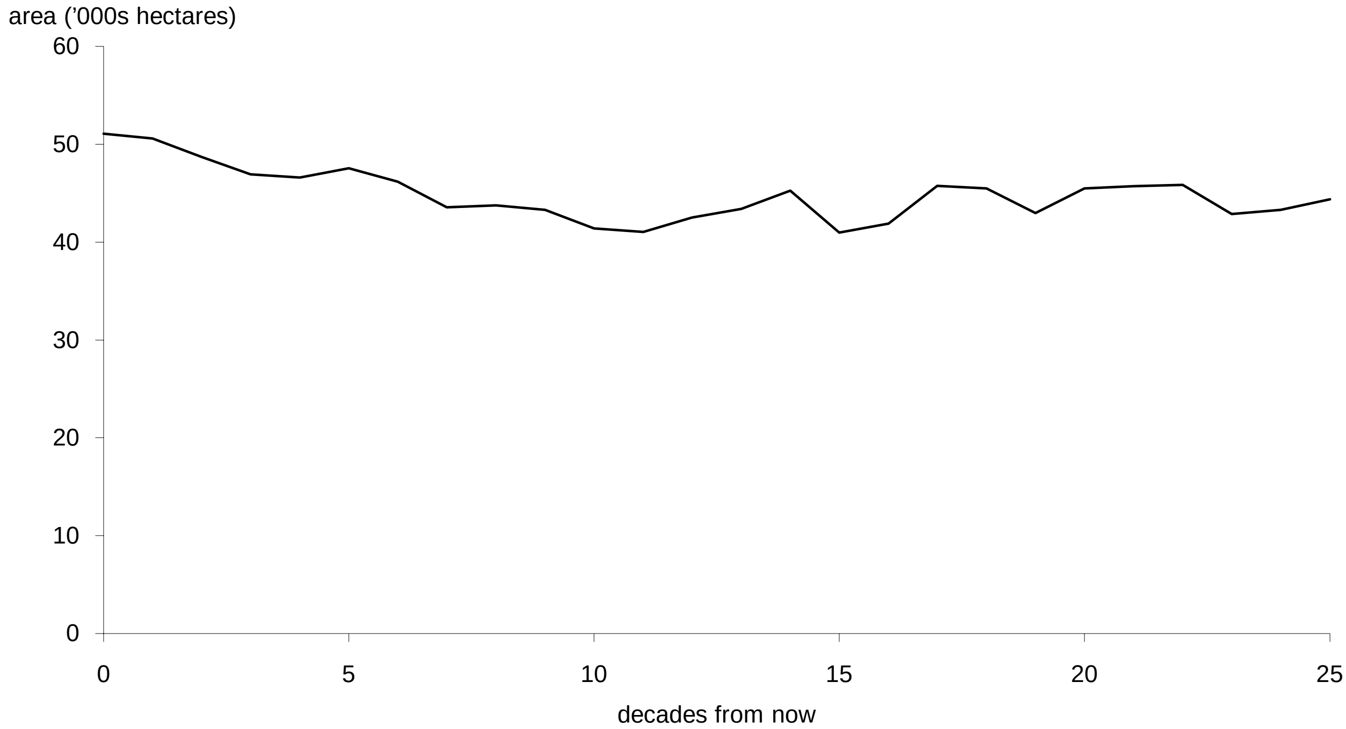

Figure 10. Area harvested by decade — Lakes TSA base case, 1995.

4.2 Area, average volume, and average area harvested

Figure 10 projects the variation in area harvested over the next 250 years if the base case harvest forecast were followed. Area harvested is projected to range from 40 000 to 50 000 hectares per decade. Figures 11 and 12 illustrate a peculiarity. The average volume harvested, as shown in Figure 11 remains between 300 and 340 cubic metres per hectare even though the area weighted harvest age shown in Figure 12 declines steadily from about 210 years to 140 years by decade 16. This result is due to two factors. First, the volume curves for all existing stands are relatively flat after the culmination age. This translates into a range of ages above the minimum harvestable age providing similar harvest volumes. Therefore despite a steady decline in harvested age, the volume per hectare of land harvested remains relatively constant. Second, despite lower minimum harvestable ages for most regenerated stands, the volumes expected to be removed will be the same. This fact is born out by the relatively flat area harvested graph in Figure 10.

The peak in the area weighted harvest age (Figure 12) which occurs in decade 18 is a function of how stands are scheduled for harvest. In this decade harvesting occurs in mainly poor site balsam and spruce which have a minimum harvestable age of 170 years. The area weighted harvest age remains at about 140 years after decade 10, however most of the harvest occurs in stands of 90-100 years of age. The higher mean harvest age shown in Figure 12 is an artifact of averaging these younger stands with older stands. These older stands either served as old growth, have high minimum harvestable age or are harvested well beyond minimum harvestable age due to the impact of visual quality objectives.

4 Results

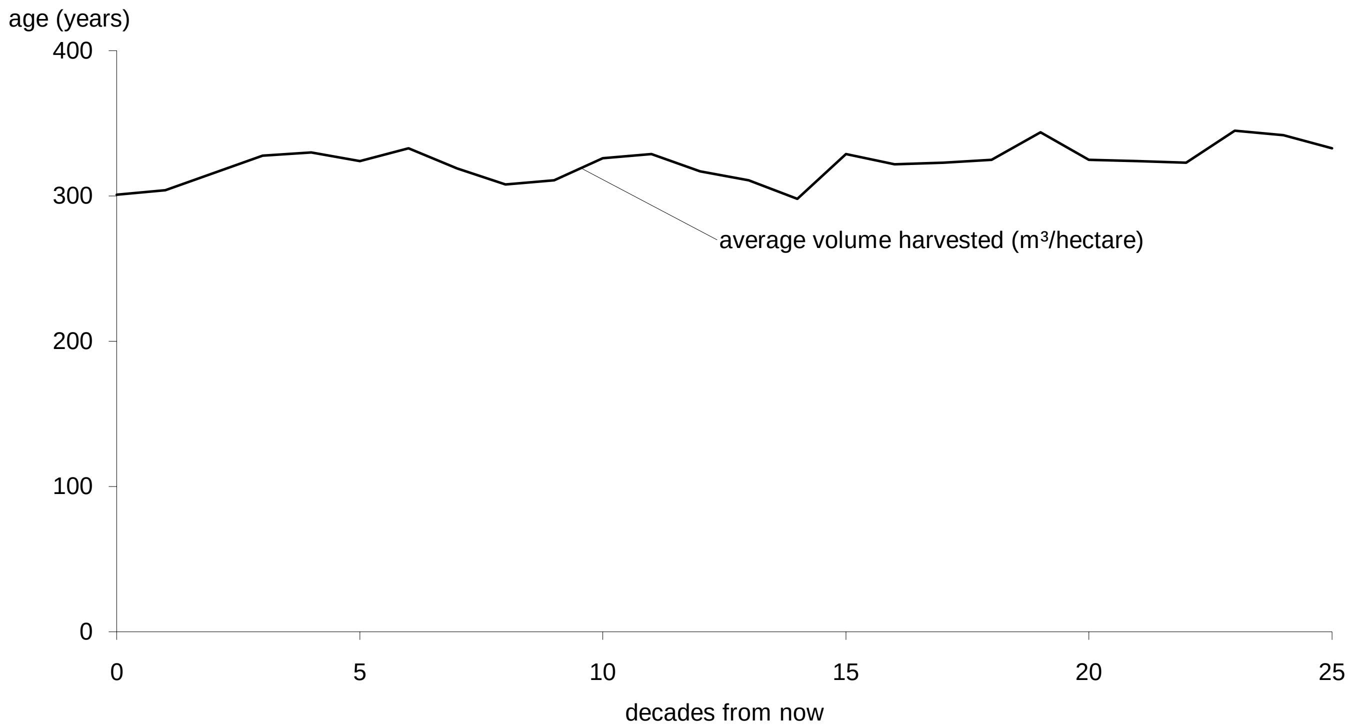

Figure 11. *Average volume per hectare — Lakes TSA base case, 1995.*

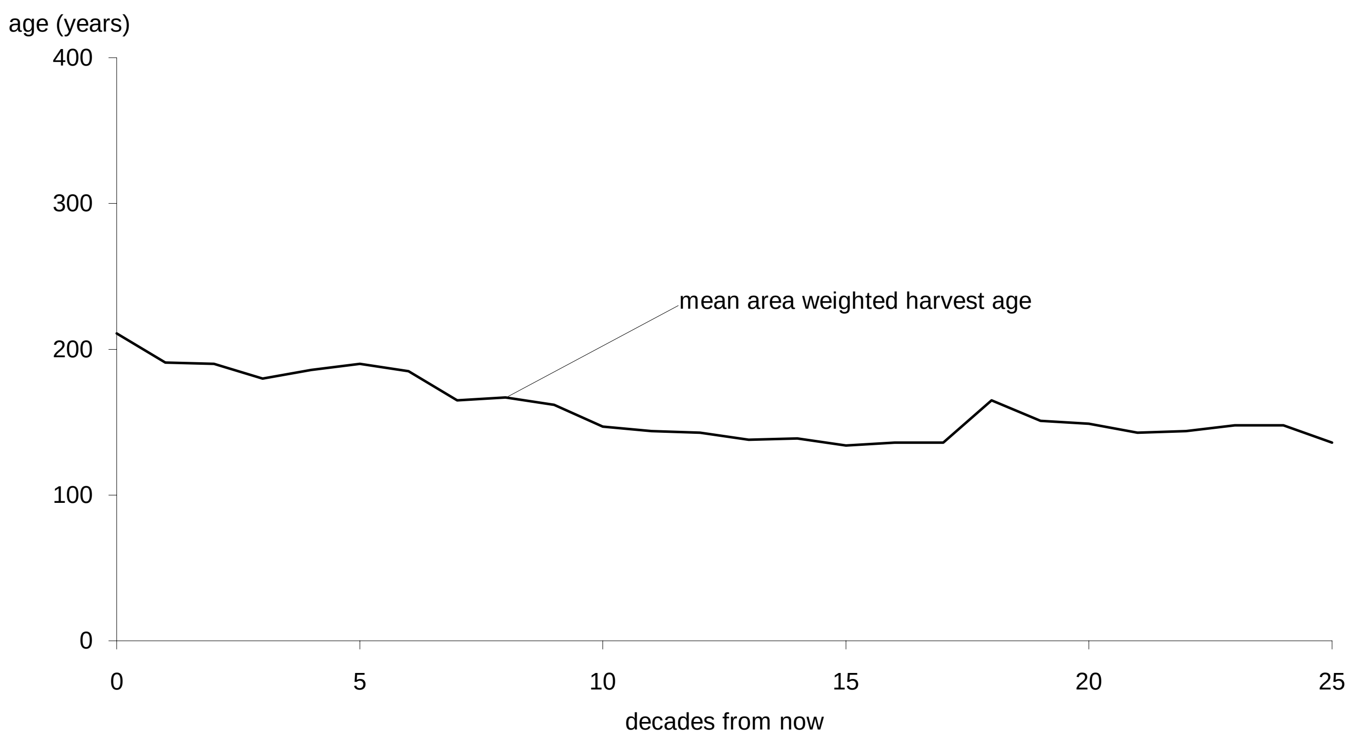

Figure 12. *Mean area weighted harvest age — Lakes TSA base case, 1995.*

4 Results

Figure 13 shows the changes projected to occur in the age distribution of the timber harvesting land base in the Lakes TSA. Currently, the timber harvesting land base is predominantly older than 100 years.

In 250 years, most of the timber harvesting land base is split into basically equal areas in age classes below 100 years of age. However there is still approximately 32% of the timber harvesting land with an age greater than 100 years. Many stands in the retention zone are not harvested within the 250 year time frame. This can be seen by the area accumulating in the older age classes. The graphs do not include environmentally sensitive areas, non-merchantable stand or deciduous stands.

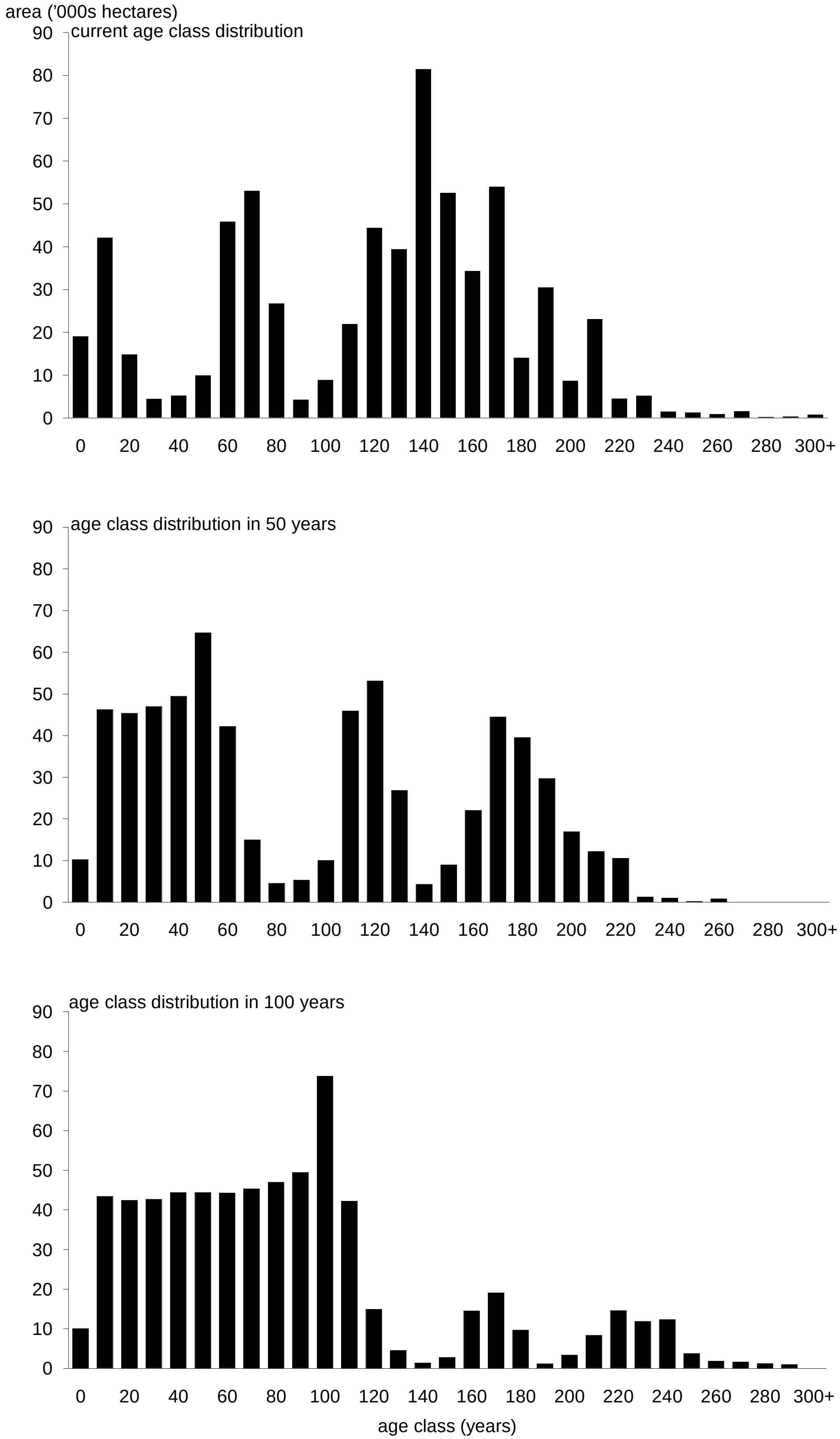

Figure 13. Age class distribution over time — Lakes TSA base case, 1995.

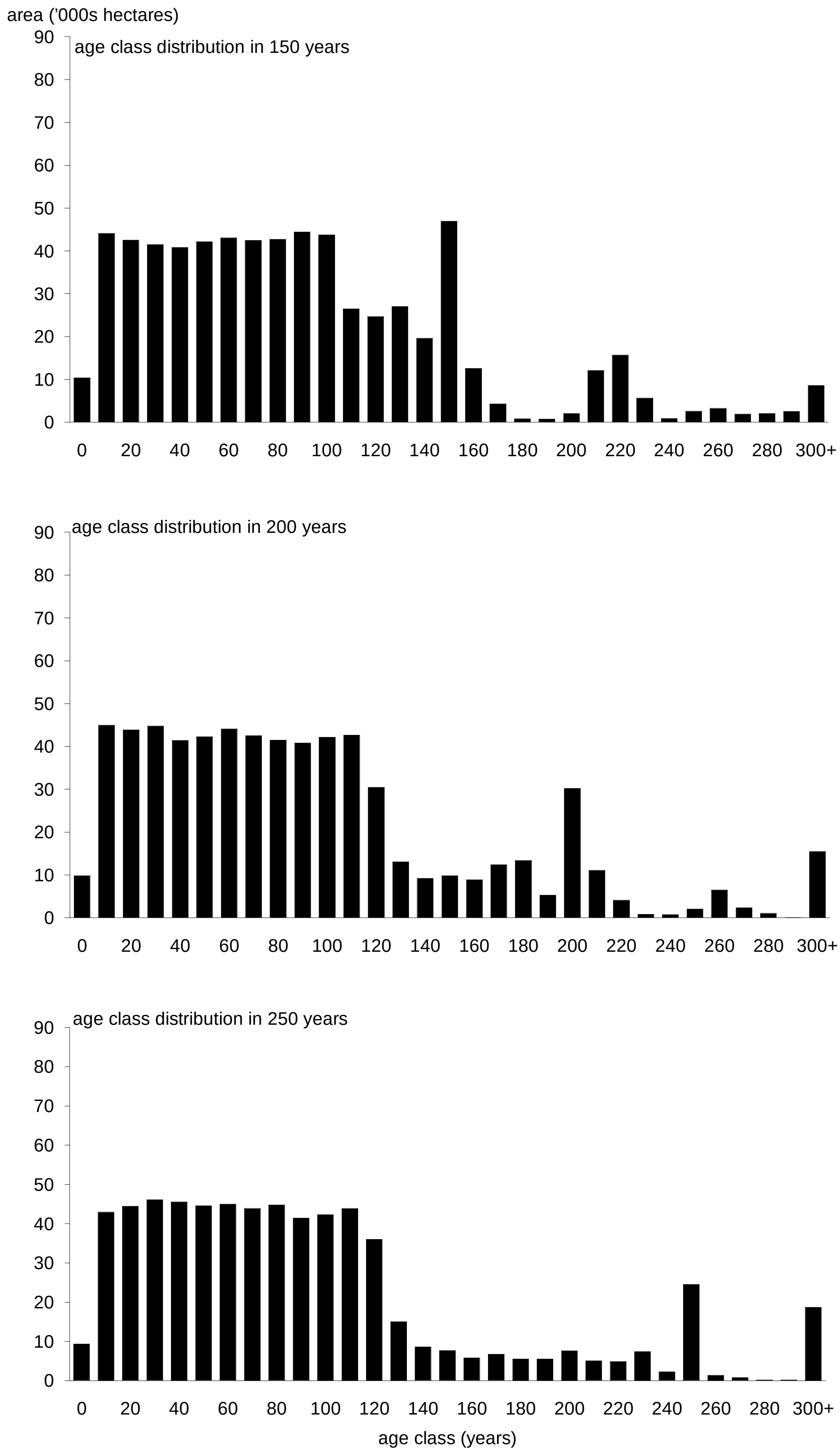

Figure 13. *Age class distribution over time — Lakes TSA base case, 1995 (concluded).*

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated and ever-changing endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

Some recognition of the potential effects of uncertainty is important because every decision, either implicitly or explicitly, incorporates an attitude towards uncertainty. For instance, someone who feels that existing information accurately reflects reality is, technically speaking, neutral to uncertainty, essentially believing that any inaccuracies probably balance out. Ignoring uncertainty is implicitly neutral. If maximizing timber supply were the goal, someone with an optimistic attitude towards uncertainty would believe that current information probably underestimates timber supply, and that problems can be resolved through human ingenuity and changes to practices. A conservative position would be that current information probably overestimates timber supply, and that decisions should minimize the potential for future timber supply shortages, or negative effects on other values.

This report does not advocate any of these positions. One of its goals is to supply information to assist people with different attitudes towards forest management and uncertainty to provide input.

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions (shown in Figures 7-13) are referred to as the base case.

5.1 Alternative initial harvest levels and harvest flows over time

The base case harvest forecast shown in Figure 7 was defined using criteria such as maximum rate of decline per decade, avoidance of large harvest shortfalls, and maintenance of a fairly constant growing stock level over the long term. While the last of these criteria is linked to maintaining the productivity of forest land, and is therefore a legislated requirement, the other criteria are not requirements, rather they are attempts to avoid both excessive changes from decade-to-decade, and significant timber shortages in the future which might limit future options. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short-term and long-term harvests.

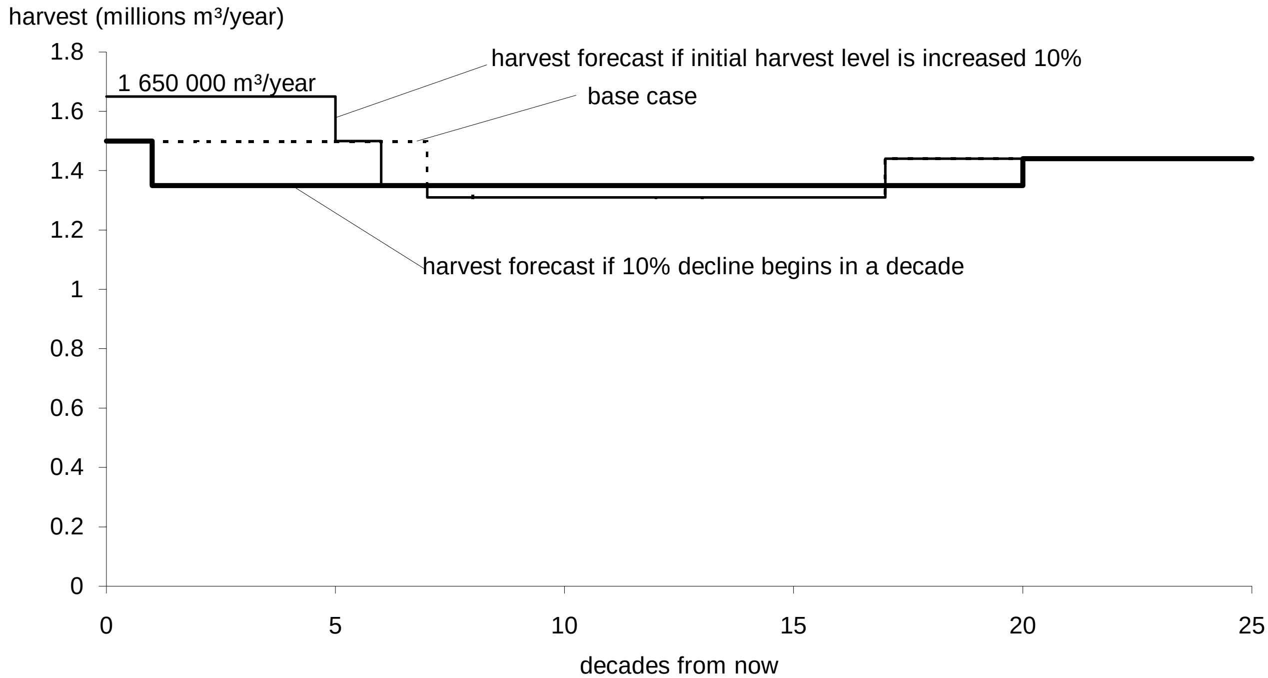

Figure 14. Alternative harvest flow forecasts — Lakes TSA, 1995.

Figure 14 compares two harvest flow alternatives to the base case. If the initial level is set 10% above the current harvest level at 1 650 000 cubic metres per year, the rate can be maintained for 5 decades with a drop of 10% to the current level in decade 6, a further 10% in decade 7 followed by a 3% drop in decade 8. This alternative flow follows the trends of the base case but with a larger initial starting level. This flow indicates that **under current management assumptions**, there is some flexibility in the level of the initial harvest rate that may be achieved without jeopardizing the long-term harvest level or implying serious shortfalls in the mid-term timber supply. By raising the initial harvest rate, substantially more volume is removed over the planning horizon. Under this alternative, more area is placed under management each decade than in the base case. When the timber shortfall occurs in approximately 100 years, a larger portion of the harvest is second growth.

Another feasible harvest flow represented in Figure 14 by the thick, solid line, shows a 10% decline below the current level after 1 decade and rise to the long-term level in decade 21. Generally, a decline in the harvest flow provides a reciprocal ability to rise to the long-term harvest level earlier. However, even by declining after the first decade, a rise to the long-term level cannot be made until decade 21 without jeopardizing the long-term harvest level. By lowering the harvest level, the transition period from existing stands to regenerated stands is extended and stands are harvested much later than the age where maximum growth occurs. This strategy does not completely capture the productive potential of the forest. A further decline would be required in the third decade to allow the harvest to rise to the long-term level earlier than decade 21.

5.2 Uncertainty to existing timber volumes

Estimates of timber volumes in existing stands are subject to uncertainty because they are based on extrapolating statistics from some stands to all stands in an area, and on inventory classifications which contain uncertainty. The volumes are more accurate when averaged over large areas than for estimating volumes for individual stands.

Figure 15 indicates the changes in harvest flow with uncertainty about existing volume estimates. The heavy, solid line portrays a projected harvest flow if existing volumes are being over estimated by 10%. Under this assumption, the current harvest level can only be maintained for 3 decades before declining by 10% in decade 4 and 4% in decade 5 to 1.29 million cubic metres per year. The harvest then increases in decade 18 to the same long-term level as the base case. If existing volumes are over-estimated, more area will be harvested to meet the harvest target due to less volume being harvested per hectare. This will remove the existing forest at a faster rate than the base case and will require a lowering of the harvest level to ensure a timely transition to harvesting in the second-growth forest. With less existing growing stock, more volume must be reserved to accommodate harvesting until regenerated stand volumes are available.

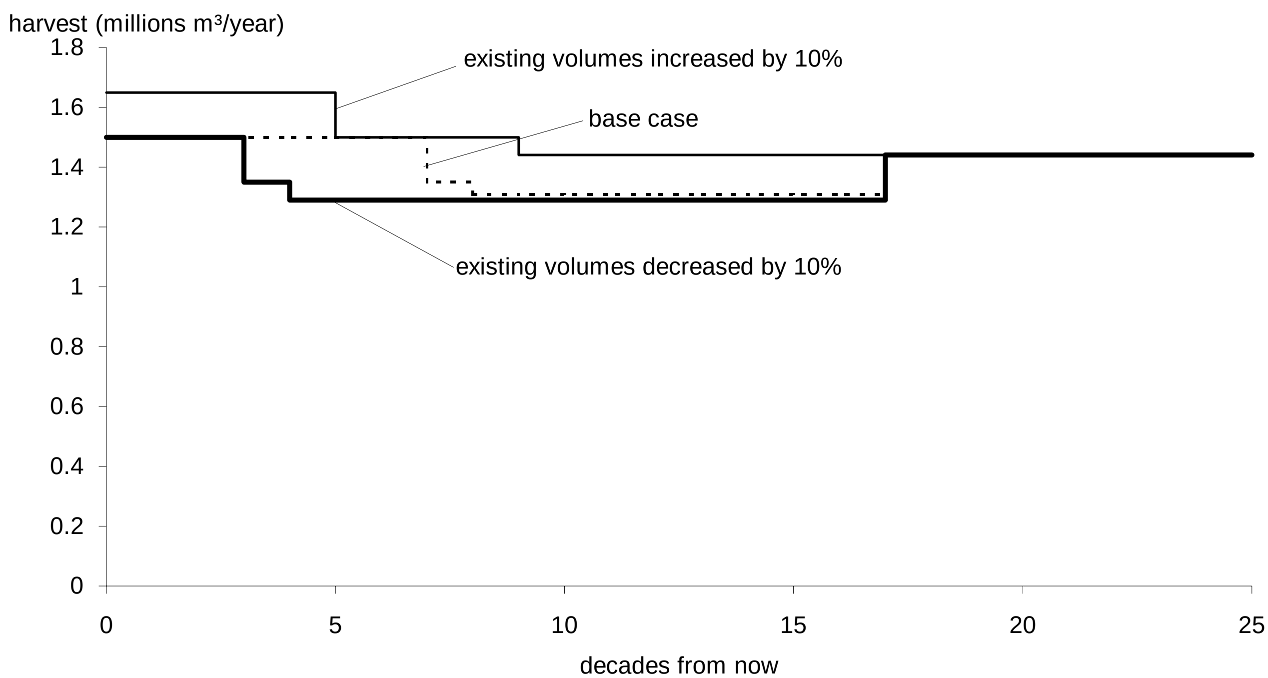

Figure 15. Harvest forecasts with existing stand timber yield estimates changed by 10% — Lakes TSA, 1995.

If the existing volumes are currently underestimated by 10%, the light, solid line portrays the achievable harvest forecast. The dip in timber supply projected in the base case to begin in decade 8 is eliminated and a drop to the base case long-term level may be achieved in decade 10. Although the flexibility in the short-term timber supply has been mentioned in the sensitivity to alternative flows, the elevated initial harvest level does not change the timing of the decline to the long-term level in decade 10. In other words, if the initial level were set at the current harvest level, the decline to the long term would still have to occur in decade 10 to ensure that the long-term level could be maintained in perpetuity.

One method for assessing the likely accuracy of yield estimates is to compare field data to analysis output. Average timber volumes from cruise data from the last 4 years, and average harvested volumes forecasted in the first decade of the analysis were very similar. This comparison does not suggest any major inaccuracies in yield estimates.

This sensitivity analysis shows that timber supply over the next 3 decades is unaffected by over-estimating existing mature volumes as much as 10%. However under-estimation of existing volumes could enable the initial harvest level to increase and eliminate the necessity to drop below the long-term harvest level.

5.3 Uncertainty in minimum harvestable ages

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Since most existing stands are above minimum harvestable ages, changing minimum harvestable age has a greater impact on when second growth will be available for harvest and therefore determines how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain, partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, the minimum harvestable age is estimated to be the age at which the stand reaches the maximum average annual growth rate (or culmination of mean annual increment). This age was chosen to produce the maximum achievable long-term production of volume on the timber harvesting land base although forest cover guidelines may increase the actual age at harvest beyond the stated minimum for a stand in order to maintain a non-timber resource.

Lowering minimum harvestable ages by 10 years is shown by the light, solid line in Figure 16. By lowering the minimum harvestable ages, all stands become eligible for harvest earlier than in the base case. This increases the timber available between decades 11 and 14 and thus, enables an extension of the current harvest level for one more decade than the base case and allows a shorter and shallower decline. The long-term level is also achievable 2 decades earlier and is 20 000 cubic metres per year greater than the base case. Generally lowering the minimum harvestable ages will lower the long-term harvest level as stands may be harvested before reaching the maximum growth rate. However in this case, the harvest flow seen in Figure 16 balanced the three flow considerations used to derive the base case. The current harvest was extended one decade but in combination with an earlier rise to the long-term level. Most stands were not harvested at the minimum harvestable age but the increase in available volume was used to offset the timber supply shortfall described in the base case. A second flow alternative would be to sacrifice the long-term productivity and maintain the current harvest level beyond one additional decade. Extending the harvest level would create a harvesting cycle requiring most stands to be harvested before attaining their maximum average

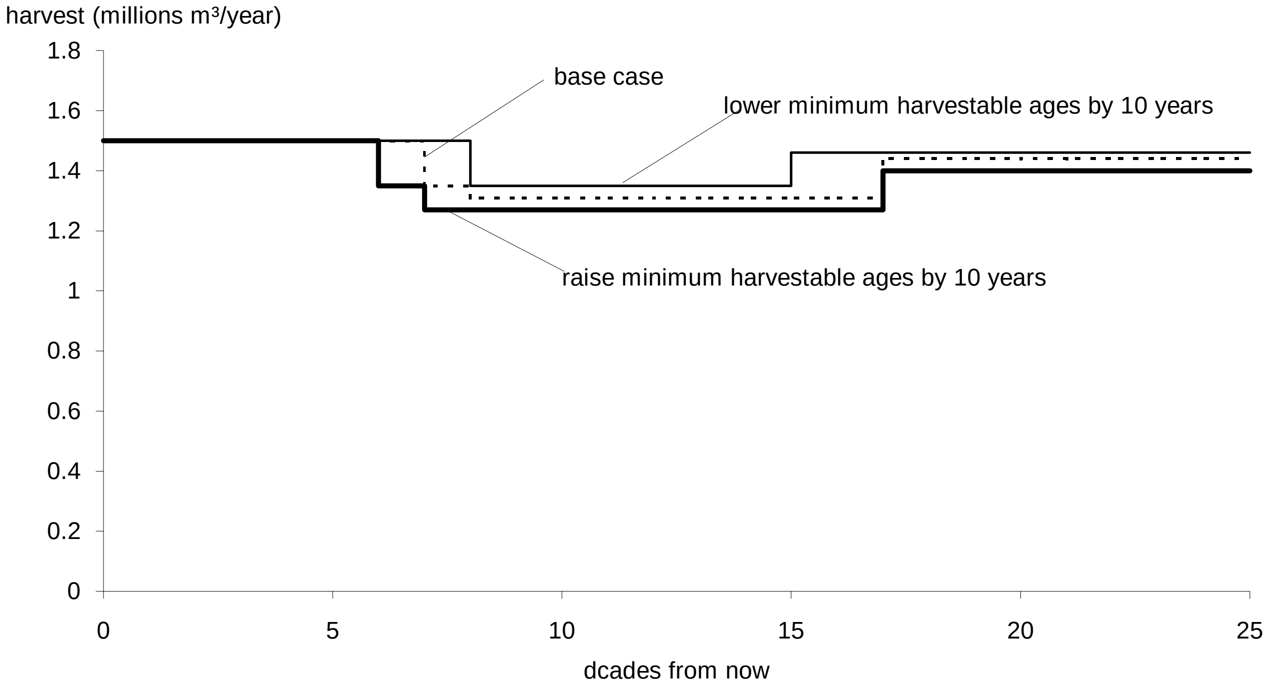

Figure 16. Harvest forecasts with minimum harvestable ages changed by 10 years — Lakes TSA, 1995.

growth rate. If this policy were chosen, the harvest level in the future would need to drop well below the long-term harvest level for several decades in order to allow stands to grow to the age of maximum growth before being harvested.

By raising minimum harvestable ages by 10 years, which is beyond the age when maximum growth occurs, many stands are reserved past the age when they were scheduled for harvest in the base case harvest forecast. This lengthens the transition time between harvesting mainly existing stands to harvesting regenerated stands which occurs between decades 11 and 14 since the regenerated stands which are scheduled to be harvested are delayed by one decade. A larger reserve of existing timber is required to avoid serious timber shortfalls. One harvest strategy for accomplishing this is shown by the thick, solid line in Figure 16. The current harvest level would decline by 10% one decade earlier then the base case with a 6% decline in decade 8 to 1.27 million cubic metres per year. The rise to a long-term level of 1.4 million cubic metres occurs in decade 18. This level is 3% below the long-term level observed in the base case due to reserving stands past their maximum growth potential.

These results show that the timber supply over the next 100 years is moderately sensitive to uncertainty in harvest ages for second growth. Changes in minimum harvestable ages do not impact the timber supply forecast for the next 20 years.

5.4 Uncertainty in land base available for harvesting

Defining the timber harvesting land base involves several assumptions about the types of forest land that are available for harvesting. The forest cover inventory and the merchantability standards for forest stands currently being harvested were used to approximate which stands are merchantable and physically operable. Given these approximations, and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the harvesting land base under current management. A specific example relates to the minimum height class requirement for merchantable stands. Given the dynamic nature of the forest, a future re-inventory of the stands that were removed from the timber harvesting land base for the purpose of this analysis may indicate that the stands have achieved the minimum standard and would then be included in the timber harvesting land base for timber supply analysis. Changing markets and technology may further impact on the merchantable and physically accessible area. With the implementation of forest cover constraints in the Forest Service simulation model, areas which previously were not considered to contribute to the timber harvesting land base can now be included. In the last analysis, environmentally sensitive areas critical to wildlife were removed from the timber harvesting land base for modelling purposes as there was not a technique to ensure that forest cover constraints were adhered to. Issues of this sort have had an impact on the size of timber harvesting land base in this analysis as the timber harvesting land base is 5% larger than in the last analysis completed for the Lakes TSA. To capture the impacts of uncertainty about the timber harvesting land base under current management assumptions, the land base was increased or decreased by 5%.

The Lakes Forest District staff have outlined several issues that are currently outside the context of current management yet imply land base uncertainty. These issues can be grouped into resource values which do not currently have timber management guidelines or resource values which have not been adequately identified. For example, the Entiako caribou winter range currently has not been harvested and no guidelines exist for harvesting activity. Under current management, the area, approximately 7% of the timber harvesting land base, is placed in the integrated resources management zone. However, the degree to which the winter range will be available for harvesting is uncertain. A similar concern is in the maintenance of island remnants or patches of older forest for biological diversity within harvested areas. In addition there are various land use planning processes such as the protected areas strategy and the ongoing Lakes TSA land and resource management plan which may also impact on the size of the timber harvesting land base considered for modelling. In order to ensure adequate flexibility for forest managers in the future, a harvest forecast was determined by decreasing the size of the timber harvesting land base by 20%. The size of the reduction is only meant to qualify the robust nature of the current harvest level and is not meant to capture specific land use issues. A similar increase in land base has not been performed as there is little evidence to indicate that a 20% increase would occur.

Figure 17 displays the impacts of both larger and smaller timber harvesting land bases. If the land base is 5% larger than in the base case, the light, solid line depicts the harvest forecast. The current harvest level could be extended for 3 decades over the base case while only a 9% decline in decade 11 to 1.365 million cubic metres is required to make the transition from harvesting existing stands to harvesting regenerated stands. The long-term level of 1.515 million cubic metres which is 5% greater than the base case is achieved in decade 18.

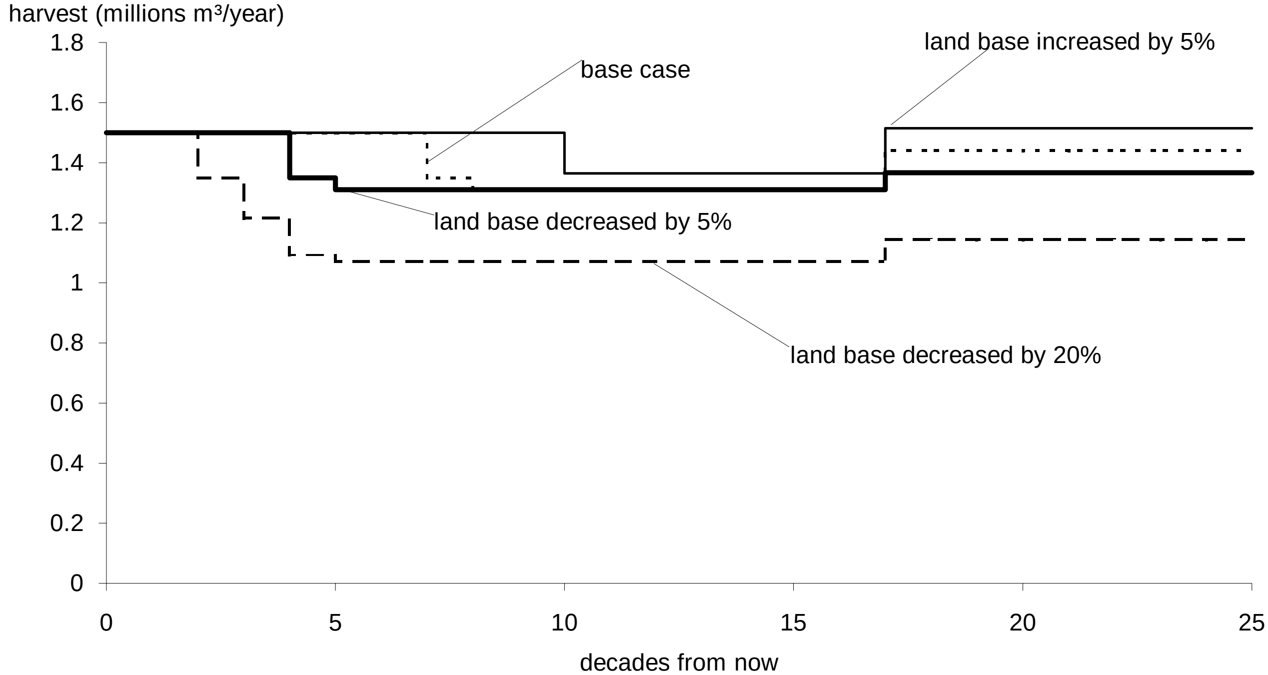

Figure 17. Harvest forecast with a change in the size of timber harvesting land base — Lakes TSA, 1995.

The harvest forecast with a 5% decrease in the size of the timber harvesting land base is shown by the thick, solid line seen in Figure 17. If the timber harvesting land base is actually 5% smaller, the current harvest level can only be maintained for 4 decades if the decadal decline of the base case is to be followed. Maintaining the harvest level longer would require dropping below the 1.31 million cubic metres per year shown. The harvest level would still increase to the long-term level in decade 18 but would be 5% lower than the base case.

If the land base were actually 20% smaller than currently projected due to changes in forest management, the harvest forecast is likely to change as shown by the thick, dashed line in Figure 17. The current harvest level could be maintained for 2 decades before declining at 10% per decade for 3 decades followed by a 2% decline to reach a harvest level of about 1 million cubic metres per year in decade 6. The rise to the long-term level of about 1.1 million cubic metres would occur in decade 18 as in the base case. The long-term level is 20% below the level achieved in the base case.

In summary, timber supply projections under different timber harvesting land bases indicate that the current harvest level can be safely maintained for at least 20 years without serious timber supply shortfalls occurring. Impacts from the removal of unique geographic areas may produce different harvest forecasts than the sensitivity analysis and should be addressed individually for a complete understanding of the short- and long-term impacts.

5.5 Uncertainty in forest cover objectives for visual quality

Visual quality objectives (VQOs) are stated in terms of the degree to which forestry activities should be visible to the average viewer. The B.C. Forest Service, Recreation Branch has provided a range of visible disturbance limits for each VQO category (stated as a maximum per cent area younger than the green-up age). Different disturbance limits will meet a particular objective for visual quality (for instance, partial retention), depending on the terrain and forest in the area. For this analysis, determining forest cover objectives for each VQO category involved a series of calculations to incorporate information on visual sensitivity (see Appendix A, "Description of Data Inputs and Assumptions.")

Uncertainty about forest cover objectives may arise from inventory and classification of land into VQO and sensitivity categories, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality. This section investigates how uncertainty in the VQO classification impacts on timber supply. Adjusting the forest cover guideline by 8% has the effect of raising or lowering the VQO zones by one VQO category and still maintaining a similar visual sensitivity rating in the new VQO category. For example, the partial retention zone has a forest cover requirement which allows a maximum of 12% of the area to be below 6.5 metres. The range possible within the partial retention zone is between 5 and 15%. If the partial retention zone were managed as a modification VQO*, the allowable range would be between 16 and 25%. By adding 8% to the forest cover requirement, the new constraint would allow 20% of the zone to be below the minimum greened-up age. As noted in the Section 2, "Information Preparation" of this report, about 24% of the timber harvesting land base has been placed under some visual quality objective.

Modification VQO
Alterations may dominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.

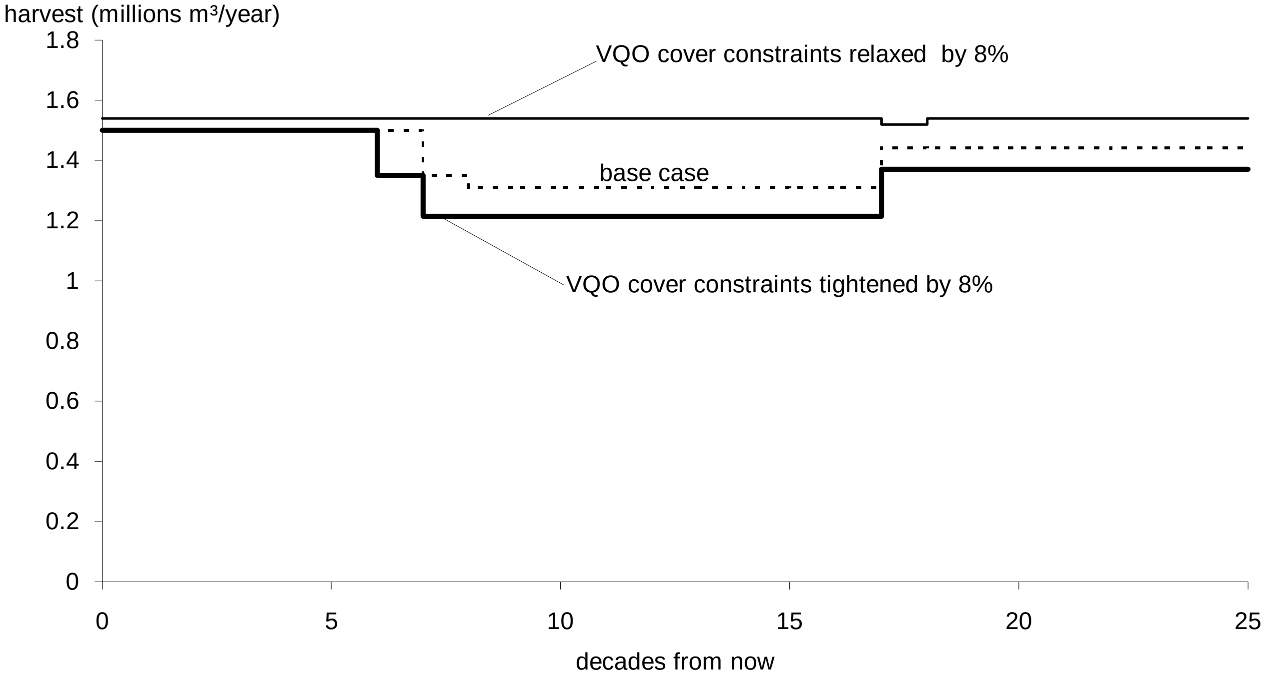

Figure 18. Harvest forecasts if forest cover objectives for visual quality management changed by 8% — Lakes TSA, 1995.

The light, solid line in Figure 18 shows the impacts of raising the amount of visual disturbance allowed for visual quality objectives. The harvest forecast portrays an even flow projection 3% higher than the current harvest level. By increasing the allowable disturbance area visible within visual quality areas, the necessity to drop below the long-term harvest level has been removed and the new long-term level would be 1.54 million cubic metres per year or 7% higher than the base case long-term harvest level.

The thick, solid line represents the harvest flow projection if visual quality objectives were tightened by 8%. This changes the VQO category of the retention zone to preservation which is a no harvest designation and the partial retention zone to retention. The decline anticipated in the base case would occur one decade earlier and would then decline at 10% per decade to 1.215 million cubic metres per year in decade 8. The long-term level of about 1.37 million cubic metres is 5% below the base case.

The sensitivity around VQO objectives shows a greater response to raising the allowable disturbance within VQOs than an identical lowering of the allowable disturbance area. The reason for the difference is that the forest cover requirements in the base case are quite restrictive for visual quality. A further restriction results in relatively small impacts. However, by increasing the area that may be disturbed in both VQO zones, a greater harvest level can be maintained.

5.6 Uncertainty in regenerated stand yield estimates

The productivity of a site largely determines how quickly trees will grow, and therefore affects both expectations of timber volumes in regenerated stands, and the age at which those stands will reach merchantable size. The most accurate assessments of site productivity come from stands between 30 and 150 years old. Estimating site productivity in both young and old stands is difficult. Growth in young stands often depends on recent weather, stocking (number of trees per unit area), and competition from other vegetation as much as on site quality. Old stands have not been subject to management of stocking, and trees used to measure site productivity may have grown under intense competition or been damaged, and therefore do not reflect actual site potential. The current age composition of the forest (Figure 13) shows that 39% of the forest contains stands which may have inappropriately assigned site productivity values. This section examines how timber supply is affected by uncertainty in site productivity estimates by increasing and decreasing regenerated volumes by 25%. The regenerated yields were modified by 25% as there is a 25% difference in growth between managed stands and existing stands. Decreasing the regenerated volumes by 25% produces the harvest forecast that would be projected if managed stands were to show no improvement in growth over existing stands. Site productivity can also affect green-up age and minimum harvestable age however these were not evaluated in this sensitivity. New information about the site productivity of regenerated pine stands is shown in Section 5.9, "Uncertainty in site index for managed pine plantations."

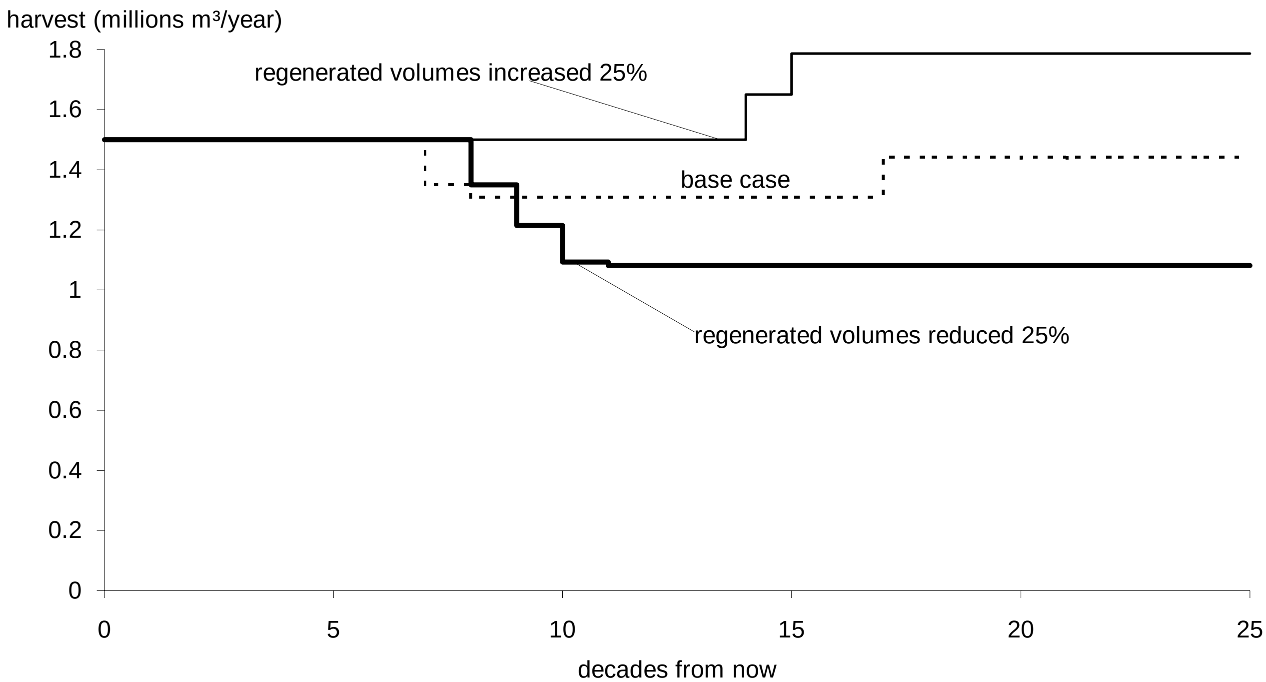

Figure 19. Harvest forecasts with regenerated stand yield estimates changed by 25% — Lakes TSA, 1995.

The light, solid line in Figure 19 shows the results if regenerated yields are 25% greater than those assumed in the base case. In this sensitivity, the decline projected in the base case does not occur but is replaced with a non-declining yield forecast which maintains the current harvest level for 140 years before rising 20% over 2 decades to a long-term level 24% higher than in the base case. If managed stands were to exceed present yield estimates, the noticeably higher volume contributions of managed stands to the harvest level allows existing stands to be harvested at a slightly higher rate than in the base case and eases the transition from harvesting existing stands to harvesting regenerated stands.

The thick, solid line in Figure 19 shows the harvest forecast if regenerated volumes are 25% less than in the base case. If regenerated volumes are in fact lower than expected, the long-term level would occur well below the current harvest level. In order to prepare for the decline, the current harvest level is maintained while assuring a smooth transition to the new long-term harvest level of 1.081 million cubic metres per year. It was found that the current harvest level could actually be maintained one decade longer than the base case. The harvest projection in this case continues to follow the same harvest flow objectives as the base case, however the long-term level is 25% below the current harvest level. With a much lower long-term harvest level, the existing stands that were reserved to ensure a reasonable harvest flow transition in the base case can be scheduled for harvest earlier.

In general, the uncertainty about regenerated stand yields does not impact the timber supply projection for the next 20 years. However the long-term harvest level could be dramatically affected depending on the performance of second growth.

5.7 Uncertainty in green-up ages

As discussed in Section 2.3, "Management practices," the required green-up ages used in the base case harvest forecast are the estimated number of growing years before the trees on a previously harvested area reach the required height. Uncertainty in the required green-up age stems from both the uncertainty in stand height growth rates as well as the subjectivity of the height requirement before a stand is considered "greened-up." The following sensitivity analysis examines the effect that uncertainty in the required green-up age has on the harvest forecast.

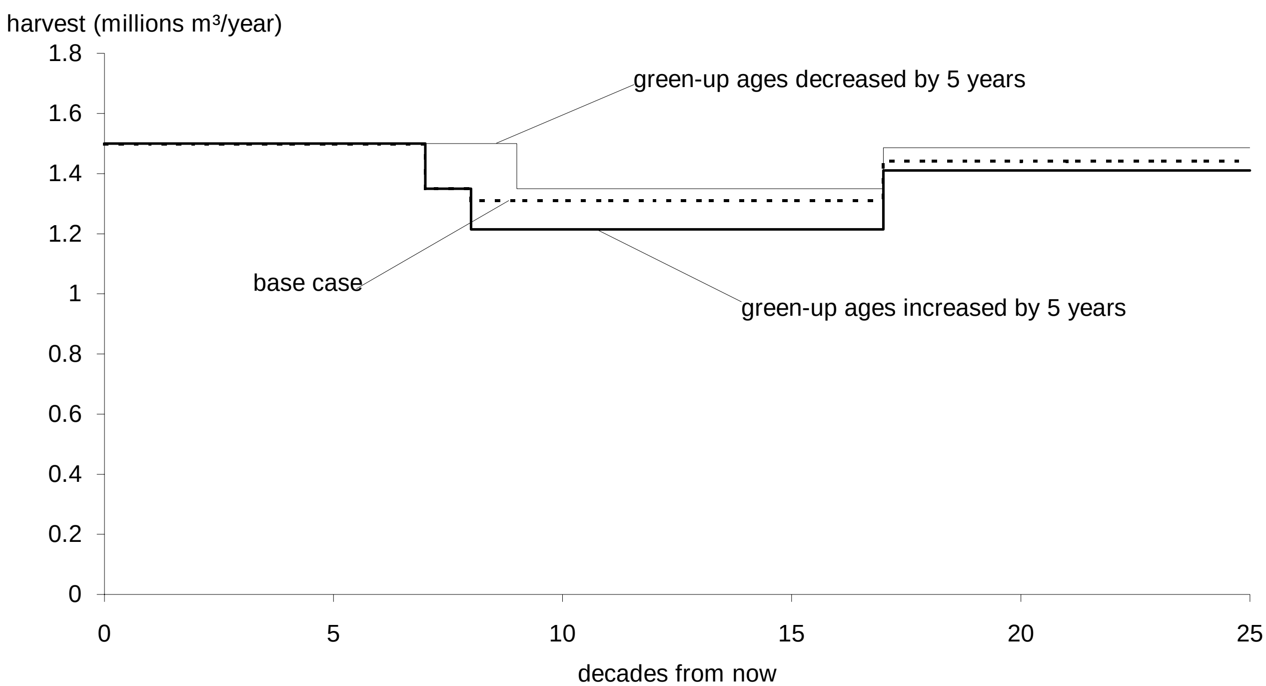

Figure 20. Harvest forecasts if green-up ages were 5 years different than the base case — Lakes TSA, 1995.

The light, solid line in Figure 20 shows the harvest forecast if all green-up ages are reduced by 5 years. The decrease in the time required to reach a greened-up condition increases the availability of timber in the zones where the forest cover requirement is constraining, namely the caribou corridor, the partial retention and the retention zones. The current harvest level can be maintained for 9 decades with a 10% decline in decade 10 until rising to the new long-term level of about 1.5 million cubic metres per year in decade 18.

The impact of increasing all required green-up ages by 5 years can be seen by the thick, solid line in Figure 20. A longer green-up age lengthens the time before further harvesting can occur in an area. The zones mentioned above which are constrained by forest cover requirements are further impacted by lengthening the green-up age. The harvest declines at 10% per decade to a level of 1.215 million cubic metres per year before rising to 1.371 million cubic metres per year which is 2% lower than the base case.

Overall, there is no sensitivity in the short-term timber supply forecast to changes in green-up age because the zones where forest cover requirements are constraining comprise only 28% of the timber harvesting land base and the composition of the remaining zones is such that green-up age currently plays no direct role in timber supply. The long-term level can be moderately impacted during the transition from harvesting existing stands to harvesting regenerated stands as the existing timber in the constrained zones is either released for harvest or reserved from harvest.

5.8 Uncertainty in the requirement for old growth

The *Interim Regional Timber Harvesting Guidelines* contain an objective of maintaining 12% of the landscape in an old-growth condition. Realization of this objective has been difficult in operational plans at the landscape level due to inadequate criteria for delineating "old growth." Depending on the means for delineating old growth, different modelling approaches could be chosen. As a first approximation, a forest cover constraint of 10% of the area being greater than 140 years was applied to all zones that did not have an old-growth constraint in the base case or other forest cover constraint which produces the desired old growth by default. The only zones which are actually impacted by this constraint are the Sutherland Valley and integrated resource management which comprise about 64% of the timber harvesting land base. The 10% figure was chosen because a portion of the 12% old-growth objective may be met by forest in environmentally sensitive areas and non-merchantable forest types.

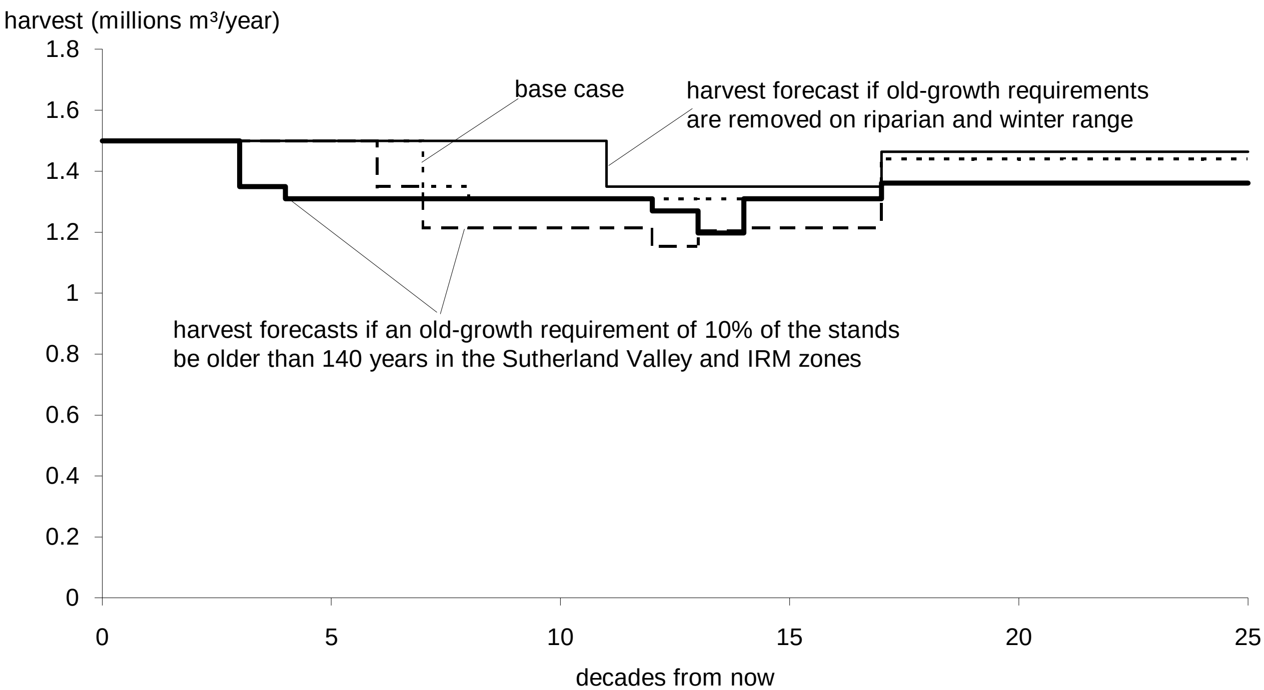

Figure 21. Harvest forecasts if the forest cover objectives for old growth were different than the base case — Lakes TSA, 1995.

5 Timber Supply Sensitivity Analyses

Figure 21 presents the harvest forecasts projected for different assumptions concerning old-growth requirements. If the old-growth requirements were removed on the riparian zone and the moose and deer winter range, the current harvest level can be maintained for 11 decades before declining by 10% as shown by the light, solid line. A rise to a long-term harvest level 2% higher than the base case is projected in decade 18. Even without an old-growth constraint, a minimum of about 10% of the timber harvesting land base is older than 140 years at the end of the 250 year planning horizon. The older forest is retained in part due to high minimum harvestable ages on some analysis units and the strict forest cover requirements necessary under the visual quality objectives present in the base case.

If meeting old-growth objectives requires that 10% of the forest be retained in stands with ages in excess of 140 years, the current harvest level can be maintained for only 6 decades before declining at 10% per decade to 1.215 million cubic metres per year as shown by the dashed line in Figure 21. A rise to a long-term harvest level of 1.361 million cubic metres per year occurs in decade 18. The long-term level is about 6% below the base case level.

An alternative harvest forecast shown by the thick, solid line maintains the current harvest level for 3 decades before following the decline rates found in the base case. The rise to the long-term level of 1.361 million cubic metres per year still occurs in decade 18. In both harvest flows a larger reserve than the base case must be set aside to maintain the harvest level through the transition from harvesting existing stands to harvesting second growth as available volume is reserved to meet the old-growth objective.

There is no short-term impact observed with the old-growth requirement as approximated for this analysis due to the extent of area with stands currently over 140 years of age. The mid-term impacts depend on the harvest flow objectives that will be followed in the future. The long-term impacts are reasonably small at 2% if old-growth requirements can be met without the guidelines used in the base case and 6% if old-growth requirements are required as outlined in the sensitivity analysis.

5.9 Uncertainty in site index for managed pine plantations

A recent study in the Lakes TSA and a similar study in the Morice TSA have both shown a marked improvement in the managed stand site indices* for lodgepole pine over existing site indices. The research was conducted by the Research Branch of the B.C. Forest Service. The strategy for the study was to evaluate the performance of managed pine plantations by comparing them to adjacent existing stands within identical biogeoclimatic zones with similar site characteristics. The study appears to indicate that the dense, thick stocking* that occurs in fire regenerated pine stands suppresses the true growth potential of pine. A site index equation adjusting the site index for regenerated pine was applied to all pine leading areas to determine an average regenerated pine site index (see Appendix A, "Description of Data Inputs and Assumptions" for further details).

Adjustments to the site index of regenerated pine stands in the timber harvesting land base have a cumulative impact on timber supply. The connected impacts are: a significant lowering of the minimum harvestable age of medium and poor site pine, an increase in the total volume that can be removed on pine sites over time and a lowering of the green-up ages by 2 to 4 years in all zones. Each of these factors has been shown in earlier sensitivities to have a positive impact on timber supply. Figure 22 shows the result of the cumulative impact of a change in the site index for regenerated pine stands.

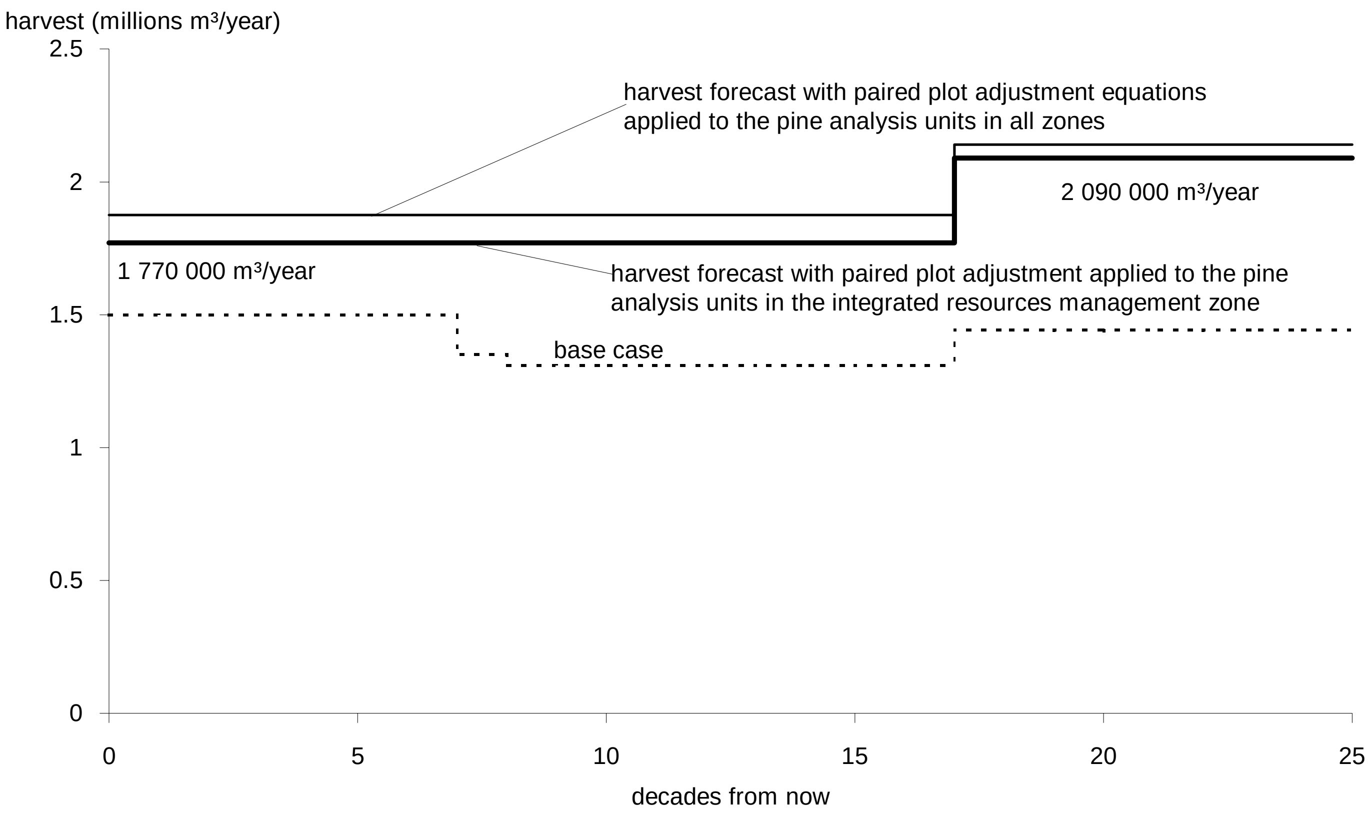

Figure 22. Harvest forecast with site index adjustments to regenerated pine stands — Lakes TSA, 1995.

> ***Site index***
> *A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species.*

> ***Stocking***
> *The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.*

The initial harvest rate of 1.875 million cubic metres per year is 25% higher than the current harvest level, as shown by the light, solid line. An increase to the long-term harvest level of 2.14 million cubic metres occurs in decade 18. This level is 49% higher than the base case level. The cumulative impact on timber supply can be summarized by the following features. Firstly, there is a lowering in the time required to reach a greened-up condition. As noted earlier in Section 5.7, "Uncertainty in green-up ages," the caribou corridor, partial retention and retention zones are constrained in the base case by the area that may be below the green-up age. With lower green-up ages, area within these zones will reach a greened-up condition earlier than in the base case. This will allow more harvesting activity to take place in these zones over time. Secondly, with significantly lower minimum harvestable ages in medium and poor site pine, the existing growing stock can be harvested at a faster rate than in the base case as merchantable pine stands will be available for harvest in 60 years. The minimum harvestable age of 60 years for pine stands is the age of maximum growth after the site index adjustments have been applied.

Each management zone has been developed to meet specific management objectives. For this reason, the Lakes Forest District staff are uncertain that the level of management needed to produce the high growth rates in pine will be practiced in all zones. The dark, solid line in Figure 22 represents the harvest forecast if the site index adjustments are only applied to the integrated resources management zone. The initial harvest level is 1.77 million cubic metres per year, 18% above the base case initial level. When the site index adjustment is applied to the entire land base, the increase is 25% above the base case. Therefore, applying the adjustment to only the integrated resources management zone, which accounts for 63% of the timber harvesting land base, has 72% of the total possible initial effect when the adjustment is applied to the entire timber harvesting land base. The long-term harvest level if the adjustment is only applied to the integrated resources management zone is 2.09 million cubic metres per year. This is 45% higher than the base case long-term level. Therefore, application of the site index adjustment to the integrated resources management zone has 93% of the long-term impact projected if site index adjustments are applied to the entire timber harvesting land base. This harvest forecast indicates that most of the potential timber supply response due to stocking management in pine stands is expected to come from the current integrated resources management zone.

The results of this sensitivity show a large potential impact to the timber supply in the Lakes TSA. The size of the impact is related to the features already mentioned and the fact that the Lakes TSA has a predominantly mature existing growing stock which can be harvested at a higher rate by taking into account the high productivity of pine stands. The Lakes Forest District staff have noted the high performance of managed pine stands at young ages. The performance of older pine stands is unknown, as there are currently no managed stands of merchantable size. Emerging forest practices which involve retaining the characteristics of the older forest in cutblocks may impact the actual growth captured in pine stands. For example, patch retention is a practice in which small patches of the existing forest are left within cutblocks to protect small wetland complexes and provide the forest structure required by some types of wildlife. However, the results do indicate a high degree of flexibility if managed pine stands perform as indicated in the paired plot study.

5.10 Uncertainty in the method used to represent adjacency objectives

The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* require that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. To ensure that harvesting does not become overly concentrated in a watershed, the guidelines set a maximum limit on the overall area that has not reached the green-up condition. Specifically, the regional harvesting guidelines require that a minimum of 3-passes be used in accessing the timber within a watershed. This analysis employs a forest cover requirement to represent the adjacency guidelines. The 3-pass system translates into a forest cover requirement of 33% of the area within the zone being covered with stands that have not met the greened-up condition. Because the forest cover requirement is an approximation, it is not certain how accurately it reflects how adjacency and the pass system guidelines affect timber supply. There is some evidence that 4- or 5-passes may be required to meet adjacency objectives (Nelson and Errico, 1993). The required height for each zone has been translated into an area-weighted green-up age based on the estimated growth of the stands found in each respective zone.

For the Lakes TSA, all zones other than the VQO zones and the caribou corridor are under a 3-pass harvesting system. Figure 23 shows the impact on the base case timber supply forecast of a forest cover requirement approximating a 6-pass harvesting system. If a 6-pass harvesting system were required to accurately reflect the harvesting restrictions that are required to meet adjacency objectives, the current harvest level could not be achieved in the first 2 decades. Instead the harvest level in the first decade would be 1.38 million cubic metres per year, followed by a 14% decline to 1.19 million cubic metres per year. After the third decade, the timber supply projection follows the base case harvest forecast.

If a 3-, 4- or 5-pass forest cover guideline for areas under general integrated resource management meet adjacency objectives, timber supply would not differ significantly from the base case. If more restrictive guidelines were needed, short-term timber supply would be substantially reduced.

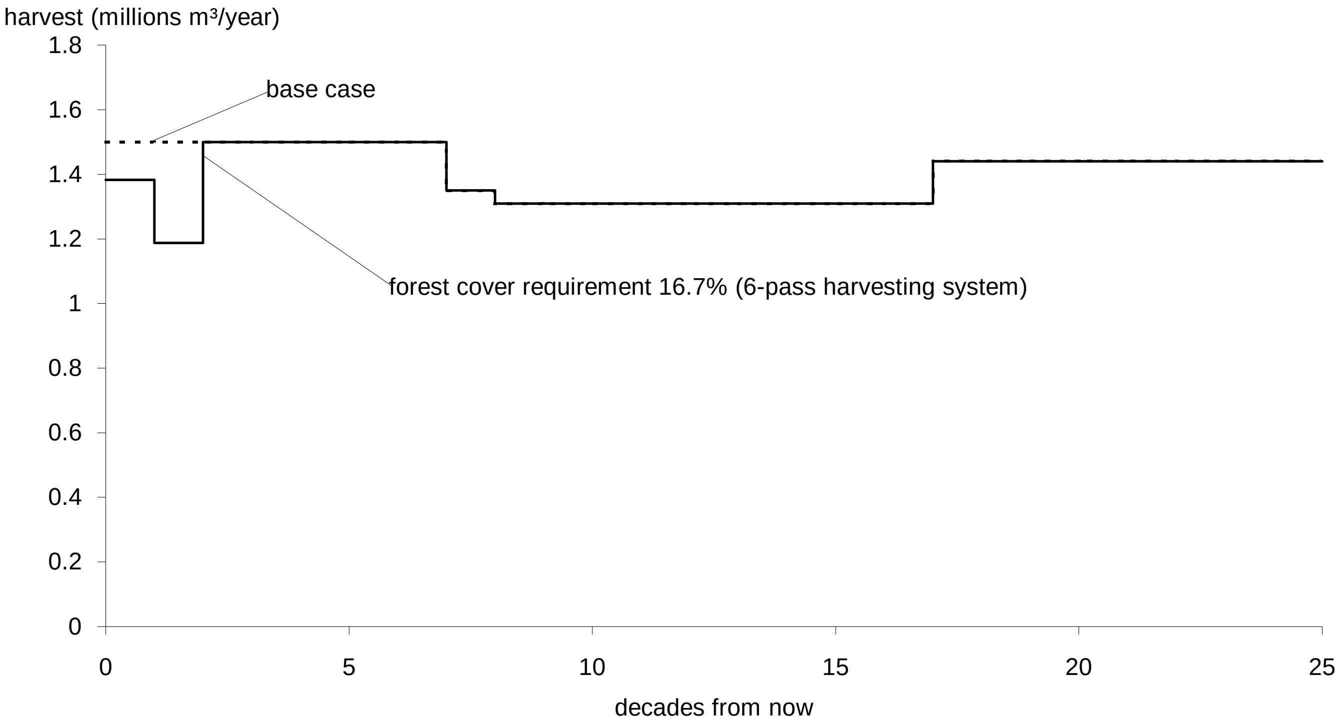

Figure 23. Harvest forecast with a 6-pass harvesting system — Lakes TSA, 1995.

5.11 Uncertainty in the forest cover objectives in the wildlife and riparian zones

The forest cover objectives for the special management zones, namely the riparian, caribou corridor and the moose and deer winter range, were modified to determine the impact on the harvest forecast. These 3 zones account for 12% of the timber harvesting land base.

If the forest cover guidelines on the special management zones can be met with an old-growth age 20 years lower in the riparian and winter range zones and a 6-pass harvesting system can adequately provide the forest structure necessary in the caribou corridor, timber supply would resemble the solid line in Figure 24. The projection under these conditions shows the current harvest level being maintained for 8 decades followed by a 10% decline. A new long-term harvest level of 1.46 million cubic metres is reached in decade 18. By relaxing the forest cover constraints, more stands become eligible for consideration as old growth, allowing a greater degree of freedom in scheduling stands for harvest. Reducing the number of passes from eight to six in the caribou corridor allows a greater area to be disturbed during each pass thus achieving a greater contribution to the requested harvest level.

To test the impact if the forest cover guidelines are underestimated in the base case, the old-growth age in the riparian and winter range zones was raised by 20 years and a 10-pass harvesting system was applied to the caribou corridor. The dashed line in Figure 24, shows that the current harvest level could be maintained for 7 decades before declining at 10% per decade to 1.215 million cubic metres per year by decade 9. The rise in decade 18 to the long-term level of 1.43 million cubic metres is 1% below the base case long-term level. An alternative harvest flow strategy would require declining from the current harvest level earlier in order to maintain growing stock for use between decades 9 and 17.

There is relatively small sensitivity to changes in the forest cover requirements in the wildlife zones due to the small amount of area in the timber harvesting land base that is affected.

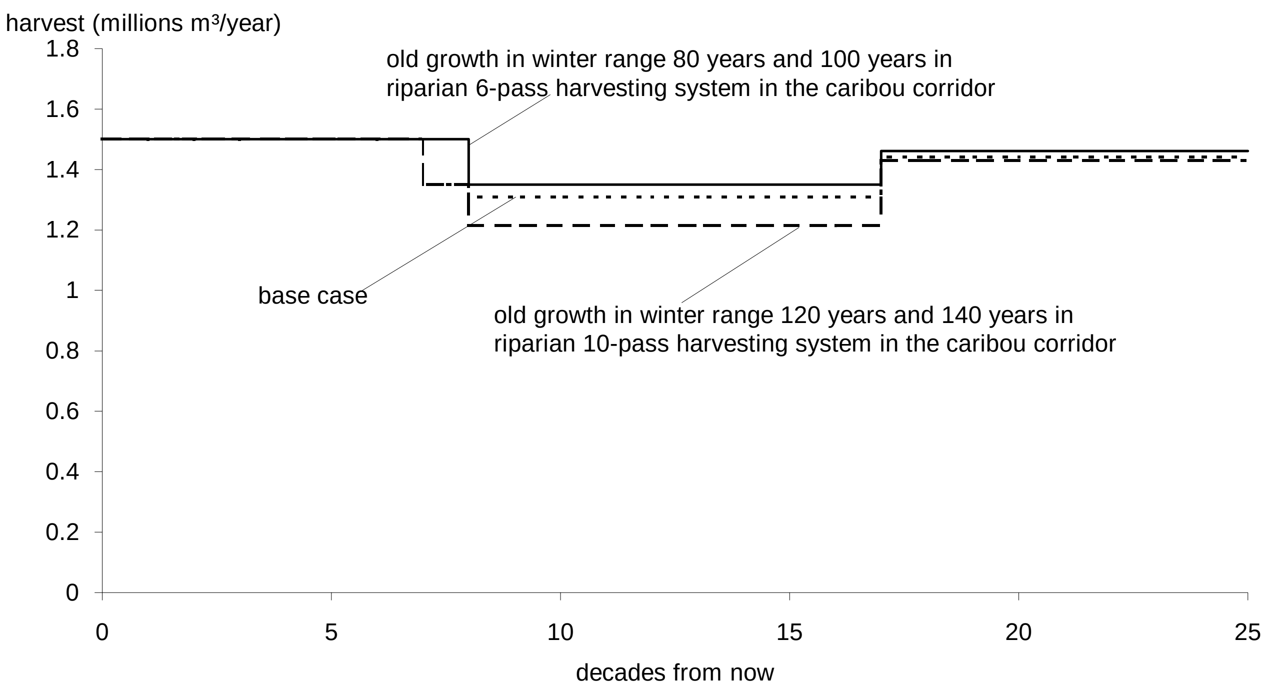

Figure 24. Harvest forecast with changes in forest cover requirements in the wildlife and riparian zones — Lakes TSA, 1995.

5.12 Deferral extension for the Sutherland valley

The Sutherland Valley was placed in a unique zone in order to estimate the impact of a 10-year deferral of timber harvesting in respect of a local resource use plan which identified the area as a no-harvest zone for the duration of the plan. As noted in the appendix, an Order-in-Council from Cabinet is required to permanently remove land from the timber harvesting land base. For this reason, a 50 year deferral was arbitrarily placed on the zone before timber harvesting was permitted. This had no impact on the base case harvest forecast due to the area contributing less than 1% to the timber harvesting land base and the fact that the standing merchantable volume is assumed to be retrievable in 50 years time.

6 Summary and Conclusions

The results of this analysis indicate that under current management assumptions, the current AAC in the Lakes TSA can be maintained for 7 decades before a decline is necessary. The base case harvest forecast for the next 20 years is quite robust to all of the uncertainties examined in the sensitivity analysis. The alternative harvest flows (Figure 14) support the flexibility of the current harvest level since a 10% increase in the current harvest level can be maintained for 6 decades before a decline is necessary. Raising the initial harvest level does not jeopardize the rise to the long-term harvest level in decade 18 nor does it lower the minimum harvest level of 1 310 000 cubic metres per year projected in the base case.

Clearly the largest potential increases to timber supply over the next 20 years are due to the uncertainty in site index for managed lodgepole pine, the estimation of existing volumes and the uncertainty in the requirements to achieve visual quality objectives. Increases in the site index of pine would enable an immediate increase of the harvest level by 25%. The higher productivity second-growth pine stands would grow faster, produce higher volumes and require less time to reach merchantable size than current estimates indicate and increase the rate of access to the VQO zones and caribou corridor. If existing volumes are currently under-estimated by 10%, the current harvest level could be raised by 10% with no decline below the long-term harvest level occurring in the future. If the requirements for visual quality objectives can actually be met by allowing more area to be below the green-up age, a constant harvest of 1.54 million cubic metres per year could be achieved.

Moderate impacts in the long-term timber supply may result due to uncertainty in several management assumptions. The uncertainties discussed result in a need to decline earlier than the base case or allow a decline further below the long-term harvest level than in the base case. The results for these uncertainties produce very similar impacts on timber supply but for slightly different reasons. If existing volumes are currently over-estimating the productivity of existing stands, the harvest level would have to decline earlier than the base case in order to reserve enough existing growing stock until second-growth stands are harvestable. If the timber harvesting land base is currently over-estimated by 5% due to inventory uncertainty, the existing growing stock is being over-estimated by 5% and the current harvest level can only be maintained for 4 decades in order to follow the harvest flow described in the base case. The result of older green-up ages than assumed in the base case is a reduction in the harvest contribution made by the caribou corridor, partial retention and retention zones because more time would be required for stands to reach a greened-up condition. These zones are always at the limit of their respective forest cover requirements. Longer minimum harvestable ages increase the time for stands to become harvestable which produces a need to allocate harvesting in existing stands over a longer time period. Uncertainty in forest cover guidelines for old growth produces a slight reduction in the area that is available for harvesting which creates a need to re-allocate the existing stands that are available until regenerated stands are harvestable. Lastly, if the requirements for meeting visual quality objectives have been underestimated, the current harvest level would decline at least one decade earlier than the base case as less area would be available for timber harvesting activity.

Conversely, many uncertainties could moderately increase timber supply over the long term. In this case, a common theme in the harvest forecasts involved extending the current harvest level beyond the base case. If the timber harvesting land base is currently underestimated by 5% due to inventory uncertainty, the existing growing stock is being underestimated and could therefore support the current harvest level longer than the base case. If green-up ages are actually lower than assumed in the base case, the caribou corridor and the VQO zones could contribute to extending the current harvest level as the areas in these zones could be accessed at a faster rate. If regenerated stand volumes are currently underestimated by 25%, the current harvest level could be maintained until a rise to a higher long-term level is reached in decade 18. Removal of the old-growth requirement on the riparian and moose and deer winter range zones enables the current harvest level to be extended by 4 decades. Lowering minimum harvestable ages by 10 years could enable both an extension of the current harvest level and enable the long-term level to be achieved by decade 15 rather than 18 as in the base case because regenerated volumes are available for harvest a decade earlier.

The long-term timber supply may be lower than projected due to uncertainty in the growth of managed stands. If regenerated volumes are currently over-estimated by 25%, the current harvest level could be maintained for 8 decades before declining at 10% per decade to a long-term harvest level 25% below the base case. Lower regenerated volumes would support a lower harvest level.

In conclusion, this analysis indicates that using current inventory and growth and yield information, the current harvest level can be maintained for the next 20 years without jeopardizing future opportunities in forest management. Several uncertainties important to timber supply produce moderate impacts which will deserve further discussion in the future. However the opportunities produced by high growth rates in managed pine stands provide a great deal of flexibility in the harvest level and may completely offset any negative impacts on timber supply due to other uncertainties. It will be important to determine if the growth response that has been observed to date will continue.

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8 Glossary

Allowable annual cut (AAC)	The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with *Section 7* of the *Forest Act.*
Clearcut harvesting	A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standard by appropriate means including planting and natural seeding.
Culmination age	The age at which a timber stand reaches its highest mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.
Cutblock adjacency	The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.
Forest cover requirements	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency guidelines and Green-up).**
Forest inventory	Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

8 Glossary

Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base and includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Modification VQO	Alterations may dominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service, Silviculture Branch. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Site index	A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species.

8 Glossary

Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 6* of the *Forest Act*.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

APPENDIX A

Description of Data Inputs and Assumptions

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Lakes TSA Timber Supply Review analysis. This information represents current forest management in the area. Current management is defined as the set of land use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. The purpose of the Timber Supply Review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices will be included in subsequent timber supply analyses after the Timber Supply Review project has been completed.

A.1 Zone and Analysis Unit Definition

A.1.1 Zone characteristics

Seven resource emphasis groupings, or zones, were defined for this analysis. Grouping is based on common forest management theme such as harvesting guideline or management objective. The following zones were identified for the purpose of modelling current forest management:

1. Sutherland Valley — this geographic area was identified as a no harvest zone within a local resource use plan which was signed off by the Lakes Forest District manager in 1992. Given that land can only be permanently removed from the timber harvesting land base by an Order-in-Council from Cabinet, this area has been deferred for one decade. After deferral, the area is managed under a 3-pass harvesting system with a green-up of 3 metres. The forest cover requirements were derived by determining how the majority of the land within the zone would have been managed in the absence of a unique zone specification.
2. Riparian — harvesting operations within wetlands are being carried out sensitively and receive special consideration. These sites are modelled with a maximum of 33% of the area being under 5 metres tall and a minimum of 50% of the area being older than 120 years old.
3. Entiako Caribou Migration Corridor — this area is located between Tweedsmuir Park and the caribou winter range south of Tetachuck Lake. Guidelines developed cooperatively between the Ministry of Environment and the Ministry of Forests are implemented within a total resource plan developed by a licensee. The forest cover requirement is an 8-pass harvesting system where a maximum of 12.5% of the area may be under 3 metres tall. This implies that 50% of the area will always be over 70 years of age.
4. Partial Retention VQOs — areas of moderate visual value were grouped. Timber harvesting may be visible in these areas but not be dominant on the landscape. After applying various factors as outlined later in the appendix, an area-weighted forest cover guideline was developed. The requirement allows a maximum 12% of the area below 6.5 metres in height.
5. Retention VQOs — areas of high visual value were grouped. These are areas adjacent to lakes and other thoroughfares which are highly visible due to slope and forest cover. Timber harvesting may be present but are not to be noticeable to the average viewer. After following a procedure identical to that performed for the partial retention zone, an overall forest cover requirement was derived allowing a maximum of 2% of the area to be below 6.5 metres in height.
6. Moose and Deer Winter Range — an intensive mapping program for the entire Lakes Forest District was completed in 1993. The prime winter habitat has been placed in a zone to ensure that the desired characteristics for these areas are maintained. The forest cover requirements allow a maximum of 33% of the area to be under 3 metres in height while a minimum of 35% of the area must be older than 100 years.
7. Integrated Resource Management — where a significant special management theme was lacking, the general integrated resources guidelines apply. A maximum of 33% of the area may be less than 3 metres in height.

The forest inventory data was grouped into the above zones in the order listed. For example, an area may have objectives for visual quality, wildlife and riparian management. Given the order, the area would be placed into the riparian zone. Zones with more restrictive forest cover requirements were generally placed earlier in the order. The retention zone follows the partial retention zone but no impact on the area in the respective zones is expected as VQO areas are mutually exclusive.

A.1 Zone and Analysis Unit Definition

A.1.2 Analysis unit characteristics

Due to the variety of species found within forested stands, stands were grouped into analysis units. The basis for each unique analysis unit was predominant species (inventory type group), site quality (site index range) and silvicultural prescription. Each analysis unit is assigned its own timber volume projection or yield table which may be found at the end of the appendix.

Site index was assigned to each polygon on the inventory file using a computer program called FREDTAB. This product is supported by the Ministry of Forests, Research Branch. Analysis units were grouped using site index ranges and not the site class field in the inventory file. Therefore the G - good, M - medium and P - poor designations relate to the site index range for the analysis unit in question. Using a site index range ensures that all stands assigned to a particular analysis unit receive a volume projection that relates closely to estimated future growth.

Where zones are defined as forests with a common forest management objective, analysis units are forests with a similar species composition and growing site. Each zone may have any combination of analysis units.

Table A-1. Analysis unit characteristics

Analysis unit	Species	Inventory type groups	Productivity rating assigned	Site index range (metres @ 50 years) (from FREDTAB)	Age range (years)
1	Fir, balsam	1,4,5,8,18-20	combined	F>=10.8 B>=8.5	0-140
401	Fir, balsam	1,4,5,8,18-20	combined	F>=10.8 B>=8.5	140+
2	Spruce	21-26	G	>=18	all
3	Spruce	21-26	M	12 - 17.9	0-140
403	Spruce	21-26	M	12 - 17.9	140+
4	Spruce	21-26	P	6 - 11.9	0-250
404	Spruce	21-26	P	6 - 11.9	250+
5	Pine	28	G	>=18	all
6	Pine	28	M	14- 17.9	all
7	Pine	28	P	10 - 13.9	all
8	Pine	29-31	G	>=18	all
9	Pine	29-31	M	14 - 17.9	all
10	Pine	29-31	P	10 - 13.9	all

The analysis units with a '400' series designation are those older age classes which have a lower site index assigned to them than the average for the analysis unit. It is recognized that the site index on these older sites may be underestimating the productivity of the sites however there are presently no conversion equations relating the existing site index to regenerated site index for spruce, fir or balsam in the Lakes TSA. The balsam and fir types were grouped due to the very limited area that both species cover within the Lakes TSA.

A.1 Zone and Analysis Unit Definition

Table A-2. Distribution of area and merchantable volume in the current timber harvesting land base by zone and analysis unit

			Zone (hectares)			
	Analysis unit	**Species**	**Sutherland valley**	**Riparian**	**Caribou corridor**	**Partial retention**
Natural	1	Fir, balsam	82	97	0	667
	2	Spruce	79	114	63	2 830
	3	Spruce	664	1 038	550	8 694
	4	Spruce	327	2 234	3 927	9 525
	5	Pine	375	367	148	5284
	6	Pine	1 012	3 571	3 503	28 780
	7	Pine	52	2 904	12 312	11 739
	8	Pine	342	340	2	5 250
	9	Pine	744	2 762	2 603	24 031
	10	Pine	186	1 666	3 829	9 458
	401	Fir, balsam	142	288	0	1 651
	403	Spruce	643	804	801	5 908
	404	Spruce	0	37	34	336
Managed	1	Fir, balsam	0	2	0	174
	2	Spruce	0	15	0	161
	3	Spruce	0	1	0	1 624
	4	Spruce	0	0	0	658
	5	Pine	0	0	0	434
	6	Pine	0	127	1 169	8 169
	7	Pine	0	3	0	823
	8	Pine	0	1	0	544
	9	Pine	0	74	92	3 626
	10	Pine	0	0	0	547
	2 regen to pine		0	6	0	25
	3 regen to pine		0	0	0	703
	Grand total		4 648	16 451	29 033	131 641
	Merchantable volume		1 190 837	3 233 365	5 843 931	22 990 803

continued

A.1 Zone and Analysis Unit Definition

Table A-2. Distribution of area and merchantable volume in the current timber harvesting land base by zone and analysis unit (concluded)

	Analysis unit	Species	Zone (hectares) Retention	Winter range	Integrated resource management	Grand total	Merchantable volume
Natural	1	Fir, balsam	160	6	2 738	3 750	160 037
	2	Spruce	430	647	4 260	8 423	1 015 115
	3	Spruce	1 854	3 605	22 934	39 339	4 563 233
	4	Spruce	1 605	1 859	32 489	51 966	9 990 009
	5	Pine	1 491	2 711	16 786	27 162	7 604 026
	6	Pine	5 100	6 700	101 098	149 764	32 116 233
	7	Pine	1 789	881	46 880	76 557	10 664 095
	8	Pine	1 626	2 172	11 637	21 369	6 378 467
	9	Pine	4 635	7 325	71 634	113 734	26 000 176
	10	Pine	2 204	1 214	32 258	50 815	7 932 538
	401	Fir, balsam	240	33	5 971	8 325	1 876 339
	403	Spruce	1 594	1 947	16 257	27 954	8 950 213
	404	Spruce	74	7	2 049	2 537	752 995
Managed	1	Fir, balsam	0	0	640	816	0
	2	Spruce	29	24	200	429	0
	3	Spruce	200	434	2 585	4 844	0
	4	Spruce	0	143	1 839	2 640	0
	5	Pine	214	300	2 118	3 066	0
	6	Pine	955	2263	26 141	38 824	0
	7	Pine	0	136	2 349	3 311	0
	8	Pine	78	262	1 315	2 200	0
	9	Pine	406	1 466	9 719	15 383	0
	10	Pine	96	112	1 912	2 667	0
	2 regen to pine		12	0	22	65	0
	3 regen to pine		86	173	1 108	2 070	0
	Grand total		24 878	34 420	416 939	658 010	
	Merchantable volume		5 424 080	6 827 895	72 492 565		118 003 476

A.2 Definition of the Timber Harvesting Land Base

A.2.1 Land not managed by the B.C. Forest Service

Ownership codes on the inventory file are used to determine which areas are not under B.C. Forest Service jurisdiction. Only the 62C and 69C ownership codes (where the C stands for contributing) are considered for inclusion as productive Crown land within this analysis.

Table A-3 Ownership codes for the Lakes TSA

Description	Ownership code	Area	Per cent
Crown grant	40N	70 739.8	6.30
Indian reserve	52N	2 335.1	0.21
Use, recreation and enjoyment of public (UREP)	61N	2 156.9	0.19
Forest management unit	62C	1 015 415	90.37
Timber agreement land	62N	88.6	0.01
Provincial park class A	63N	68.0	0.01
Government reserve	69C	21 971.3	1.96
Government reserve	69N	4 063.5	0.36
Woodlot licence	77N	6 768.2	0.60
Miscellaneous lease	99N	60.1	0.01
Total		1 123 667	100.0

A.2.2 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of the environmental sensitivity of forest area. Areas of high sensitivity are generally considered completely unavailable for timber harvesting. Areas of moderate sensitivity may receive a per cent reduction in availability to provide an estimate for what area would likely be unavailable. The ESA data for the Lakes TSA applies to public sustained yield units (PSYU), which were in use prior to the timber supply area designation. The ESAs from that time did not differentiate between high and moderate sensitivities. The following table outlines the environmental netdowns as applied to each public sustained yield unit.

Table A-4. Per cent of area considered unavailable for timber harvesting because of environmental sensitivity

PSYU	ESA code	ESA description	Per cent area unavailable
Babine #134	C	P, A, H, I combined	70
	R	recreation	100
	S	soils	90
Burns Lake #154	P	regeneration difficulties	70
	S	soils	70
	R	recreation	100
	H	watershed	70
Ootsa #155	A	avalanche	100
	S	soils	70
	P	regeneration difficulties	70
	R	recreation	100

A.2 Definition of the Timber Harvesting Land Base

In the last analysis, ESAs for wildlife were considered completely unavailable for harvest. With the creation of forest cover guidelines within the B.C. Forest Service timber supply model, the areas are no longer reduced but are modelled under guidelines specific to the habitat required.

A.2.3 Non-merchantable forest types

Table A-5. Per cent of non-merchantable forest cover considered unavailable for timber harvesting

		Criteria					
Netdown	**Inventory type group**	**Age class**	**Height class**	**Stocking**	**Age**	**Volume per hectare**	**Per cent area excluded**
Low site	1, 4, 5, 8, 18-20, 21-26, 28-30		3		200+	<140	100
Deciduous	35-42	all	all	all	all		100
Non-commercial	ID=3						100
Percentage of aspen in pine stands	27, 31	All stands with >30% At & Ct					100
Balsam types	18-19	9	all	all	all		100
	20	9	all stands with <30% Sx or Pl				100
Height class for pine	28-30	5-9	2	all	all		100
Stocking of pine	28-30	all	all	4			100
Height class	1, 4, 5, 18-20, 21-26	7-9	2				100

A.2.4 Deciduous and problem forest types

There is currently no harvesting of deciduous trees in the Lakes TSA. Deciduous leading stands are excluded from the analysis completely while the deciduous component of coniferous leading stands is excluded during yield curve creation.

A.2.5 Utilization levels

The utilization level defines the maximum allowable stump height and minimum merchantable diameter by species and is used to calculate merchantable volume. A 10 cm diameter top and a 30 cm stump height is assumed for all species. The utilization level currently practiced is 12.5 cm diameter at breast height for pine and 15 cm for all other species (i.e. spruce, balsam and fir).

A.2.6 Non-recoverable losses

Table A-6. Unsalvaged losses

Cause of loss	Gross losses in cubic metres per years	Salvaged volumes (cubic metres per year)	Annual unsalvaged losses
Insects			1 000
Fire	9746	6927	2 819
Wind damage			35 249
Total			39 068

The estimates for each category have been averaged by staff in the Lakes Forest District. The mountain pine beetle is currently the major pest. An aggressive control program has kept unsalvaged losses to normal endemic levels (< 2000 trees per year or approximately 1000 cubic metres per year). Fire losses are the average volume burned over the last 10 years. Wind damage is the major component of non-recoverable losses. The estimate was derived from two sources. The first came from historical evidence of three major catastrophic events which produced wind damage in the order of 2.5 million cubic metres over the past 10 years. It was estimated that 90% of the total volume was salvaged. The second source was a study conducted in 1994 which estimated unsalvaged losses along cutblock boundaries and road right-of-ways between 1985 and 1990.

For this analysis, non-recoverable losses have been estimated at 39 000 cubic metres per year. This amount is "harvested" above the harvest level seen in the harvest forecast, to simulate the removal of timber volume by sources other than timber harvesting.

A.2.7 Existing and future roads

The impacts on the timber harvesting land base of a loss in productive forest land due to existing and future road and trail development were estimated using two approaches. The existing roads and trails were estimated by removing 5.4% of the timber harvesting land base that is currently less than 80 years old. Future roads and landings were estimated by applying a 5.4% reduction within the model to all areas older than 80 years of age, upon harvest of that area.

A.2.8 Not satisfactorily restocked (NSR) areas

Some areas in the forest inventory file have been classified as not satisfactorily restocked (NSR). The NSR can be split into three categories: backlog, current and satisfactorily restocked. In order to add this area back into the timber harvesting land base, a zone and analysis unit designation was required. A summary of NSR by zone indicated that most of the NSR is found in the integrated resource management, partial retention and winter range zones. The analysis unit distribution in each zone was used to estimate the species distribution of the NSR area. The total of 22 350 hectares does not equal the area removed in the netdown process as Lakes Forest District staff believe that approximately 14% of the NSR is actually non-productive brush which is misclassified. The following table provides a breakdown for NSR returning to the timber harvesting land base.

A.3 Forest Management Assumptions

Table A-7. Not satisfactorily restocked areas

Zone	Backlog	Current NSR	Satisfactorily restocked	Total (hectares)	Per cent
Integrated resource management	1 484	6 228	7 096	15 168	66
Partial retention	517	2 168	2 470	5 287	23
Winter range	239	1 004	1 144	2 446	11
Total	2 240	9 400	10 710	22 350	

3.1 Regeneration assumptions

Table A-8. shows the species regenerated after harvesting occurs in existing analysis units in the Lakes TSA. All sites are planted, with an expected average regeneration delay of 2 years. Where an analysis unit is converted from an existing species to another species upon regeneration, a site index conversion equation was applied to derive an estimate of the growth of the regenerated species.

Table A-8. Regeneration assumptions by analysis unit

	Species regenerated (per cent of area)			
Existing analysis unit	Spruce	Pine	Stocking	Regeneration delay
1 Balsam/fir	100		1600	2
2 Spruce - G	70	30	1600	2
3 Spruce - M	70	30	1600	2
4 Spruce - P	100		1200	3
5 Pure Pine - G		100	1600	2
6 Pure Pine - M		100	1600	2
7 Pure Pine - P		100	1600	3
8 Pine leading - G		100	1600	2
9 Pine leading - M		100	1600	2
10 Pine leading - P		100	1200	3

SI (Spruce) = -1.95 + 1.16 * SI (Balsam)

SI (Pine) = 1.97 + .92 * SI (Spruce)

A.3 Forest Management Assumptions

3.2 Existing managed stands

The existing stands within the Lakes TSA have not all been naturally regenerated. Stands less than 20 years old are generally managed plantations that have been created through clearcutting and planting. All stands less than 20 years are assumed to be growing as indicated by managed stand yield tables. Table A-9. lists the area by analysis unit for existing managed stands.

Table A-9. Existing managed stands by analysis unit

Analysis unit	Area (hectares)
1 Balsam/fir	423
2 Spruce - good	153
Spruce site regenerated to pine	66
3 Spruce - medium	3 033
Spruce site regenerated to pine	1 300
4 Spruce - poor	752
5 Pine - good	1 904
6 Pine - medium	32 252
7 Pine - poor	946
8 Pine leading- good	1 368
9 Pine leading - medium	10 796
10 Pine leading - poor	974
Total area currently under management (not including NSR)	53 967

3.3 Minimum harvestable ages for each analysis unit

Minimum harvestable ages define the earliest age at which a particular analysis unit may be harvested. This does not imply that areas must be harvested at this age. The minimum harvestable age was set at the age when maximum average growth occurred (i.e. the culmination age).

Table A-10. Minimum harvestable age for each analysis unit

		Minimum harvestable age (years)	
Analysis unit		Existing stands	Regen stands
1	Balsam/fir	125	130
401	Balsam/fir	160	170
2	Spruce - good	105	80
3	Spruce - medium (0-140)	130	110
403	Spruce - medium (140+)	135	130
4	Spruce - poor (0-250)	165	170
404	Spruce - poor (250+)	210	220
5	Pine - good	90	70
6	Pine - medium	110	90
7	Pine - poor	130	120
8	Pine leading- good	80	70
9	Pine leading - medium	100	90
10	Pine leading - poor	130	120
2	regenerated to pine		60

3	regenerated to pine	90

A.3 Forest Management Assumptions

A.3.4 Forest cover requirements

This analysis did not involve an explicit spatial evaluation of timber supply. However, the computer model used (FSSIM Version 4.3) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition (usually defined by the height of young trees), or the minimum required area of old-age forest. Experience has shown that a certain number of entries or passes into an area may be necessary to meet adjacency guidelines. Forest cover guidelines can approximate the effect of adjacency guidelines, as well as broader forest level goals, using green-up or old-age requirements. For this analysis, forest cover requirements were assigned based on the *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region*, the visual quality management guidelines provided by the Recreation Branch of the Ministry of Forests and the professional judgment of the Lakes Forest District staff.

Table A-11. Forest cover requirements and green-up age

Zone	Green-up age (years and height)	Maximum per cent allowed below this age	Current state (per cent)	Old-growth age	Minimum per cent required above this age	Current state (per cent)
Sutherland valley	18 (3 metres)	33	0	none	none	
Riparian complexes	25 (5 metres)	33	1.4	120	50	62.43
Caribou corridor	18 (3 metres)	12.5	4.3	none	none	
Partial retention	27 (6.5 metres)	12	13.6	none	none	
Retention	27 (6.5 metres)	2	8.7	none	none	
Winter range	16 (3 metres)	33	14.4	100	35	66.28
Integrated resource management	17 (3 metres)	33	11.0	none	none	

In this table, the green-up objectives in the partial retention and the retention zones are currently in violation of the guidelines set out for visual quality objectives. While the forest cover objectives are not being met on average for these areas, this does not mean the objectives are not met in all landscapes within the zones. While existing alterations in some landscapes may exceed new management objectives, visual quality objectives will be met once the regenerated stands reach visual green-up conditions.

A.3.5 Explanation of development of visual quality objective forest cover guidelines

Visual quality guidelines were developed using the *Procedures for Factoring Recreation Input into Timber Supply Analysis*. An intensive mapping survey of the Lakes TSA was used to create a visual field on the forest inventory file for each polygon. The field contained various factors connected to visual quality but the keys for incorporating the information into this analysis were the visual quality category and the relative ranking of visual absorption capacity within the respective category. A weighted percentage disturbance was created with the latter information to produce a basic forest cover guideline for each category. This guideline was combined with the green to operable ratio (a factor which recognizes the contribution of unmerchantable forest component of the visual landscape) and the dispersion class (a factor identifying the spatial distribution of the operable timber). The following table identifies the various factors and the resulting forest cover guidelines.

Table A-12. Forest cover guidelines by VQO class (percentages)

	Visual absorption capacity				Dispersion factor			
VQO category	**H**	**M**	**L**	**Green to operable ratio**	**Dispersed**	**Clustered**	**Solid**	**Forest cover guideline**
Retention	5.3	4.3	90.3	1.67	50.7	6	43.3	2%
Partial retention	10.4	53.3	36.1	1.45	58.3	5.3	36.4	12%

A.4 Existing and Managed Stand Yield Curves

Table A-13. shows the existing and regenerated stand yield tables for all species and site types in the analysis. The appropriate regeneration delays are applied within the timber supply model and are not accounted for in these yield tables (Existing = VDYP / Regen = TIPSY). The operational adjustment factors(OAF) applied to regenerated stands are 15% for OAF 1 and 5% for OAF 2.

A.4 Existing and Managed Stand Yield Curves

Table A-13. Timber volume for existing and regenerated stands by analysis unit

Age	Analysis unit 1 Fir, balsam	Regenerated Spruce	Analysis unit 2 Spruce	Regenerated Spruce	Analysis unit 2 converted to pine
10	0	0	0	0	0
20	0	0	0	0	7
30	3	0	1	5	78
40	16	0	20	68	154
50	39	17	76	164	223
60	66	60	129	247	282
70	97	115	176	330	327
80	122	173	217	395	360
90	144	220	253	433	386
100	165	264	284	458	405
110	184	311	310	477	421
120	201	351	334	492	434
130	219	382	355	502	444
140	235	403	372	507	453
150	251	420	387	507	453
160	265	431	399	507	453
170	278	441	409	505	453
180	290	449	417	503	453
190	301	456	423	501	453
200	313	462	430	499	453
210	323	467	436	497	453
220	334	470	441	496	453
230	344	473	446	494	453
240	353	475	450	493	453
250	362	476	454	491	453
260	365	476	457	491	453
270	367	476	460	491	453
280	369	476	463	491	453
290	371	476	465	491	453
300	373	476	467	491	453
310	375	476	469	491	453
320	377	476	470	491	453
330	378	476	472	491	453
340	380	476	473	491	453
350	381	476	474	491	453

continued

A.4 Existing and Managed Stand Yield Curves

Table A-13. Timber volume for existing and regenerated stands by analysis unit

Age	Analysis unit 3 Spruce	Regenerated Spruce	Analysis unit 3 converted to pine	Analysis unit 4 Spruce	Regenerated Spruce
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	19	0	0
40	1	4	62	0	0
50	15	37	117	0	0
60	53	96	155	4	4
70	93	161	189	20	23
80	131	217	227	46	55
90	166	268	258	74	92
100	197	321	281	102	130
110	224	364	300	129	168
120	250	396	317	154	201
130	273	417	331	178	232
140	293	433	342	199	261
150	310	445	351	218	295
160	324	456	358	236	324
170	337	464	365	251	347
180	347	471	370	265	367
190	356	476	375	277	382
200	364	480	378	288	395
210	372	483	381	299	407
220	380	484	384	309	416
230	386	483	386	319	424
240	392	482	387	328	432
250	398	480	389	336	438
260	403	480	389	342	438
270	407	480	389	348	438
280	411	480	389	354	438
290	414	480	389	359	438
300	417	480	389	364	438
310	420	480	389	369	438
320	423	480	389	373	438
330	425	480	389	377	438
340	427	480	389	380	438
350	429	480	389	383	438

continued

A.4 Existing and Managed Stand Yield Curves

Table A-13. Timber volume for existing and regenerated stands by analysis unit

Age	Analysis unit 5 Pine	Regenerated Pine	Analysis unit 6 Pine	Regenerated Pine	Analysis unit 7 Pine	Regenerated Pine
10	0	0	0	0	0	0
20	0	4	0	0	0	0
30	23	60	1	23	0	2
40	78	135	36	70	5	24
50	128	191	77	125	35	55
60	172	254	115	164	66	92
70	211	297	150	201	96	124
80	246	332	181	240	123	147
90	277	359	210	269	149	170
100	306	380	237	292	173	189
110	333	396	262	312	196	212
120	358	409	285	328	217	232
130	382	420	307	341	237	248
140	397	428	322	352	252	260
150	409	436	333	361	263	271
160	417	442	341	368	271	280
170	421	447	346	374	276	288
180	422	447	348	379	279	295
190	420	447	347	383	278	302
200	422	447	349	387	281	307
210	424	447	352	390	284	312
220	427	447	354	392	287	316
230	430	447	357	394	289	319
240	432	447	360	396	292	322
250	435	447	362	397	294	324
260	437	447	364	397	297	324
270	440	447	366	397	299	324
280	442	447	368	397	300	324
290	444	447	370	397	302	324
300	445	447	372	397	303	324
310	447	447	373	397	305	324
320	448	447	374	397	306	324
330	450	447	375	397	307	324
340	451	447	376	397	307	324
350	452	447	377	397	308	324

continued

A.4 Existing and Managed Stand Yield Curves

Table A-13. Timber volume for existing and regenerated stands by analysis unit

Age	Analysis unit 8 Pine	Regenerated Pine	Analysis unit 9 Pine	Regenerated Pine	Analysis unit 10 Pine	Regenerated Pine
10	0	0	0	0	0	0
20	0	4	0	0	0	0
30	21	60	1	23	0	2
40	75	135	34	70	5	21
50	122	191	74	125	32	49
60	163	254	110	164	63	82
70	198	297	142	201	91	111
80	229	332	170	240	117	133
90	256	359	195	269	140	155
100	281	380	219	292	161	173
110	303	396	240	312	181	196
120	323	409	259	328	199	215
130	342	420	277	341	216	231
140	355	428	290	352	229	243
150	366	436	300	361	239	254
160	373	442	308	368	247	263
170	378	447	313	374	253	272
180	380	447	316	379	256	280
190	380	447	317	383	258	286
200	382	447	320	387	261	292
210	385	447	323	390	264	297
220	388	447	326	392	268	302
230	390	447	328	394	271	306
240	393	447	331	396	274	309
250	396	447	334	397	276	312
260	398	447	336	397	279	312
270	400	447	338	397	281	312
280	402	447	340	397	283	312
290	404	447	342	397	284	312
300	405	447	343	397	286	312
310	407	447	345	397	287	312
320	408	447	346	397	289	312
330	409	447	347	397	290	312
340	410	447	348	397	291	312
350	411	447	349	397	291	312

continued

Table A-13. Timber volume for existing and regenerated stands by analysis unit (concluded)

Age	Analysis unit 401 Balsam, fir	Regenerated Spruce	Analysis unit 403 Spruce	Regenerated Spruce	Analysis unit 403 converted to pine	Analysis unit 404 Spruce	Regenerated Spruce
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	0	9	0	0
40	4	0	0	1	47	0	0
50	12	0	6	20	92	1	0
60	27	4	35	65	132	2	0
70	49	22	74	121	163	7	2
80	69	52	111	179	191	17	8
90	86	90	145	227	223	34	28
100	102	130	176	271	249	54	54
110	117	170	204	319	269	75	82
120	130	204	229	358	286	96	112
130	144	235	252	388	300	116	143
140	158	264	273	408	312	136	172
150	170	297	290	424	322	153	197
160	182	327	305	435	331	170	222
170	193	350	319	445	338	185	245
180	204	370	330	453	344	200	270
190	214	385	339	460	349	213	296
200	223	396	349	465	353	226	318
210	233	407	357	469	356	238	336
220	242	414	365	472	359	249	352
230	250	420	372	475	362	260	365
240	259	425	379	477	364	269	376
250	267	430	385	477	365	279	386
260	269	430	390	477	365	285	386
270	271	430	394	477	365	291	386
280	273	430	398	477	365	297	386
290	274	430	402	477	365	302	386
300	276	430	406	477	365	307	386
310	277	430	409	477	365	312	386
320	279	430	412	477	365	316	386
330	280	430	414	477	365	320	386
340	281	430	416	477	365	324	386
350	283	430	418	477	365	328	386

APPENDIX B

Paired Plot Impacts

Paired Plot Impacts

As noted in the body of the analysis, a study conducted by the Research Branch of the Ministry of Forests has found that managed lodgepole pine stands are growing faster than the productivity of existing stands would indicate. This analysis includes a sensitivity test of extrapolating these assumptions across the Lakes TSA. The adjustment equations are unique to each biogeoclimatic zone. The lodgepole pine stands in the Lakes TSA are mainly found in the sub-boreal spruce zone. Each sub-zone within this zone receives a unique site index adjustment but the results are similar. The adjustment equations applied to the Lakes TSA inventory file are:

1. Regenerated pine site index (SBSdk) = existing site index + (14.243 — 0.60649 * existing site index)
2. Regenerated pine site index (SBSmc2) = existing site index + (20.157 — 1.0068 * existing site index)

The cumulative impact on site index is to produce an average site index of 20 metres across all regenerated pine types, as compared with an average SI of 15.3 before adjustment. The impact on minimum harvestable age for pine is to lower it to 60 years. The impact on green-up age can be seen in Table B-1. The lowering of green-up age in the caribou corridor and VQO zones allows more harvesting activity over time which enables these zones to contribute more volume than in the base case.

Table B-1. Green-up age changes due to site index adjustment on lodgepole pine

Zone	New green-up age	Old green-up age
Sutherland valley	16	18
Riparian complexes	21	25
Caribou corridor	15	18
Partial retention	23	27
Retention	23	27
Winter range	15	16
Integrated resource management	15	17