Quesnel TSA
Timber Supply Analysis

B.C. Ministry of Forests
1450 Government Street
Victoria, B.C.
V8W 3E7

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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 guidelines for the protection of forest resources. 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 early 1995. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called *sensitivity analysis*. Sensitivity analysis is the assessment of how results might be affected by uncertainties. The sensitivity analyses can be used to examine the timber supply implications of uncertainty in or changes to the definition of current management practices. 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 timber supply analysis for the Quesnel TSA began in January 1994. The information it contains is independent of the 1994 *Cariboo-Chilcotin Land Use Plan*. The land use plan will be discussed in the public discussion paper for the Quesnel TSA.

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 Quesnel Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the next 250 years. 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 harvest forecasts in this 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.** This report does not include an analysis of the potential timber supply impacts of the *Cariboo-Chilcotin Land Use Plan*, or timber harvesting requirements under pulpwood agreements in the Quesnel TSA.

The total area of the Quesnel TSA is approximately 1.65 million hectares. The area of the TSA that is considered available for timber harvesting under current management practices is approximately one million hectares. The total volume of standing timber in this area is currently about 180 million cubic metres, of which 160 million cubic metres are of harvestable age. The area available for timber harvesting is dominated by stands of lodgepole pine, with some spruce and Douglas-fir.

The current coniferous AAC for the Quesnel TSA (excluding the volume allocated to woodlot licences) is 2 265 500 cubic metres per year. The coniferous AAC is partitioned into two components: 1 965 500 cubic metres per year from traditional forest licence areas, and 300 000 cubic metres per year from high-density stands of lodgepole pine and other problem forest types. The Quesnel TSA also has a deciduous AAC of 50 000 cubic metres per year, but because no deciduous harvesting licences have been issued to date, the deciduous timber supply is not analysed in this report.

Using current forest management assumptions and timber volume estimates, the analysis results indicate that the current harvest level may be maintained for 70 years. To avoid major future shortfalls, the harvest level must then be reduced over a 20-year period to the long-term harvest level of 1 955 500 cubic metres per year, 14% below the current harvest level.

This analysis shows that the initial harvest level can be increased to 2.9 million cubic metres per year without causing future shortages in timber supply. However, this harvest level can only be maintained for 2 decades before declining by 10% per decade to reach the long-term harvest level 50 years from now. To attain this initial increase, harvest levels 40 to 80 years from now would be significantly lower than in the base case.

Several important assumptions affect the supply of timber over time. The most important factor is the contribution of problem forest types to the timber supply. Problem forest types have been harvested for the past 3 years. The analysis assumes that harvesting in these high-density pine stands will continue at an increasing rate. This analysis also assumes that 70 000 hectares of land not considered to be satisfactorily restocked with trees will be rehabilitated to productive forest over the next decade, and that no more of these areas will be created. Furthermore, the analysis assumes that skid trails, fireguards and landings will be reforested, without a loss in growing site productivity. Each of these assumptions influences the harvest forecast, and changes in these assumptions could affect how long the current harvest level can be maintained.

Uncertainty in the data and assumptions used in the analysis may affect results. The results of the sensitivity analyses indicate that a more restrictive, 5-pass harvest system may be adopted in the Quesnel TSA without requiring a reduction in harvest levels. A 10% reduction in the area available for timber harvesting would permit the current harvest level to be maintained for 4 decades, although the long-term harvest level would be reduced. Increases in mature forest cover requirements and green-up requirements would have an impact on the long-term harvest level, but would not have an impact on harvest levels for the first 3 decades. Eliminating forest cover requirements would permit the current harvest level to be maintained for 10 decades. The harvest forecast is

also sensitive to uncertainty in the estimates of existing stand volumes. If existing stand volumes are 20% greater than has been estimated, the current AAC may be maintained for up to 20 decades. However, if existing stand volumes are 20% less than has been estimated, an immediate 35% reduction in the harvest level would be necessary to avoid timber supply shortages in the future.

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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 depends 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 Quesnel 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 Quesnel Timber Supply Area

The Quesnel TSA covers the northern part of the Cariboo Forest Region, encompassing the Blackwater, Nazko, and Itcha-Ilgachuz areas west of Quesnel, and the Barkerville, Cariboo River and Quesnel Lake areas to the east (see Figure 1). The TSA covers approximately 1.65 million hectares and is administered from the Quesnel Forest District office.

The Quesnel TSA is bisected by the Fraser River flowing from north to south. The lands near the river are the main agricultural and rural residential area. The climate is dry to the west of the Fraser River, and the forest mainly consists of lodgepole pine stands. East of the Fraser River, the TSA borders onto the Quesnel Highlands, Cariboo Mountains, and Bowron Lake Provincial Park. This portion of the TSA receives more rainfall, and the forest contains more spruce and balsam.

The communities in the Quesnel TSA are predominantly resource based; the majority are dependent on the local forest industry. Ranching, mining and tourism are also important to the economies of several of the local communities. The Quesnel TSA offers excellent recreational opportunities for sport fishing, hunting and back country hiking.

Figure 1. Map of the Quesnel TSA.

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 the 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 (such non-contributing areas specific to the Quesnel TSA are described below). 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 may also be critical to wildlife habitat).

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. The timber supply analysis discussed in this report is consistent with this philosophy.

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 timber 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.

It is important to note that the timber harvesting land base recommendations in the *Cariboo-Chilcotin Land Use Plan* have <u>not</u> been included in this analysis. Also, this analysis does not take into account any harvesting that may occur under existing pulpwood agreements*, and does not reflect changes to management that may be required under the Forest Practices Code.

Areas which do not contribute to the timber supply in this analysis, or areas on which timber

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.

Pulpwood agreements
An agreement for a fixed geographic area that allows for harvesting of timber below sawlog standards if wood residues suitable for the facility under this agreement are not available.

harvesting is not expected to occur, given current forest management in the Quesnel TSA, are as follows:

- a portion of Tree Farm Licence 52 — this TFL, which is managed by West Fraser Timber Ltd., is not part of the Quesnel Timber Supply Area. It occurs on the TSA inventory file because the TFL has been awarded recently and the inventory file has not been fully updated;
- non-Crown areas — areas not managed directly by the B.C. Forest Service, such as private land, parks and Indian Reserves;
- Dragon Settlement Corridor — a corridor running from north to south along the Fraser River that has been excluded from the provincial forest;
- non-forest areas — areas not occupied by productive forest cover (for example rock, swamp and alpine areas);
- Alexander Mackenzie Heritage Trail (Grease Trail) — the trail is a 200-metre corridor. Timber harvesting is allowed only for addressing fire, insect and disease concerns;
- Cariboo River Wildlife Management Area — managed by the Ministry of Environment, Lands and Parks; commercial timber harvesting is excluded;
- non-commercial cover areas — areas occupied by non-commercial tree or brush species;
- inoperable areas — a small area of unstable soils not identified with an environmentally sensitive designation in the inventory file;
- environmentally sensitive areas* — portions of the areas classified as sensitive are considered unavailable for timber harvesting;
- critical wildlife habitat — habitat areas for eastern caribou, western caribou, and mule deer;
- non-merchantable forest types* — areas currently considered not suitable for harvesting because they are occupied by timber stands of low volume or non-merchantable species (deciduous and coniferous), or with low timber-growing potential;
- existing roads — the area of existing forest roads is deducted to account for the loss of productive forest land that has occurred during past timber harvesting and development. This total does not include the area of skid trails or landings, since these areas are assumed to be reforested without loss of site productivity;
- future roads — future losses of productive forest land due to road construction. These areas are projected and modelled as deductions over time as future harvesting occurs.

Table 1 summarizes the areas represented by each of the above criteria. Timber harvesting is expected to occur on the land base that remains after the areas listed above are deducted from the total area of the TSA. The timber harvesting land base is greater than estimated in the past, primarily due to the inclusion of a portion of the forest types previously classified as non-merchantable. These additional stands have become available for harvest in recent years due to advances in harvesting and sawmilling technology.

A detailed description of the removals and additions used to define the timber harvesting land base is provided in Appendix A, "Description of Data Inputs and Assumptions."

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 where timber harvesting may cause avalanches.

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.

2 Information Preparation

Table 1. Timber harvesting land base, Quesnel TSA.

Classification	Area (hectares)	Per cent of total TSA area	Per cent of Crown forest land
Total area on inventory file	1 714 269		
Tree Farm Licence 52	63 755		
Total TSA area	1 650 514	100	
Not managed by the B.C. Forest Service	117 453	7.1	
Dragon Settlement Corridor	12 216	0.7	
Non-forest land	183 080	11.1	
Crown forest land	1 337 765	81.1	100.0
Reductions to Crown forest:			
Alexander Mackenzie Heritage Trail	2 235	0.1	0.2
Cariboo River Wildlife Management Area	929	0.1	0.1
Non-commercial cover	1 259	0.1	0.1
Inoperable area[a]	29	-	-
Not satisfactorily restocked (NSR)*	77 576	4.7	5.8
Environmentally sensitive areas	21 733	1.3	1.6
Eastern caribou habitat	22 919	1.3	1.7
Western caribou habitat	79 976	4.8	6.0
Critical mule deer habitat	14 056	0.8	1.1
Non-merchantable forest types	150 657	9.1	11.3
Existing roads	18 264	1.1	1.4
Total reductions	389 633	23.6	29.1
Initial timber harvesting land base (less additions for restocking)	948 132	57.4	70.9
Additions:			
Not satisfactorily restocked	69 827	4.2	5.2
Current timber harvesting land base	1 017 959	61.7	76.1
Future reductions:			
Future roads	7 576	0.5	0.6
Future timber harvesting land base	1 010 383	61.2	75.5

(a) Other categories, such as environmentally sensitive areas and caribou habitat, also include areas of inoperability.

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.

2 Information Preparation

A breakdown of the Crown forest land, based on Table 1, is shown in Figure 2. The current timber harvesting land base comprises approximately 76% of the Crown forest land in the Quesnel TSA.

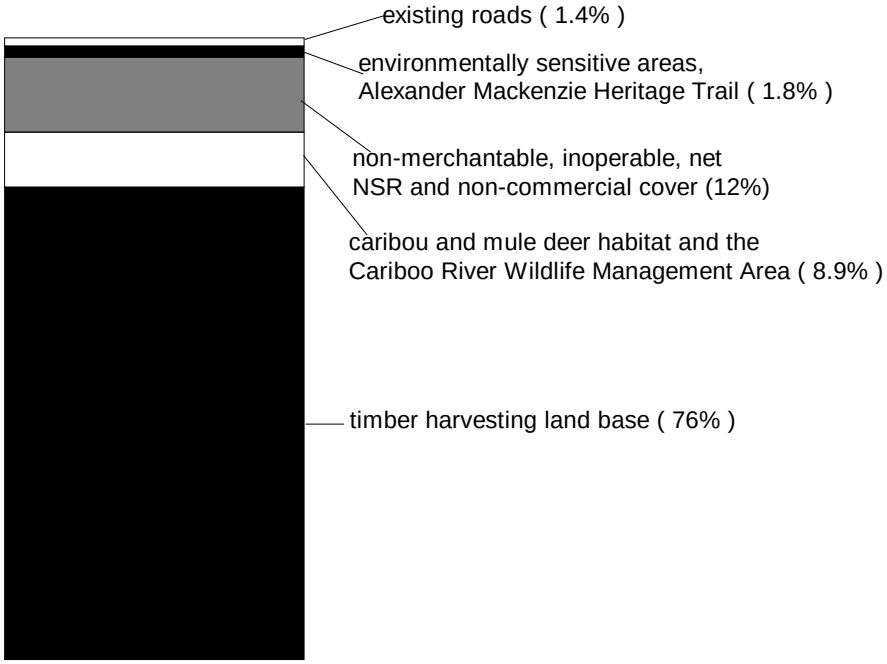

Figure 2. Classification of the Crown forest land, Quesnel TSA.

2 Information Preparation

Figure 3 shows the composition of the timber harvesting land base by tree species, quality of growing site (good, medium, poor, or low) and maturity. The timber harvesting land base in the Quesnel TSA is mainly occupied by stands of lodgepole pine (85%), with spruce (10%), Douglas-fir (3%) and hemlock and balsam species as minor components. Much of the existing forest, especially the pine, is between the ages of 60 and 120 years and will be the primary source of timber once the existing older forest has been harvested, in approximately 35 years.

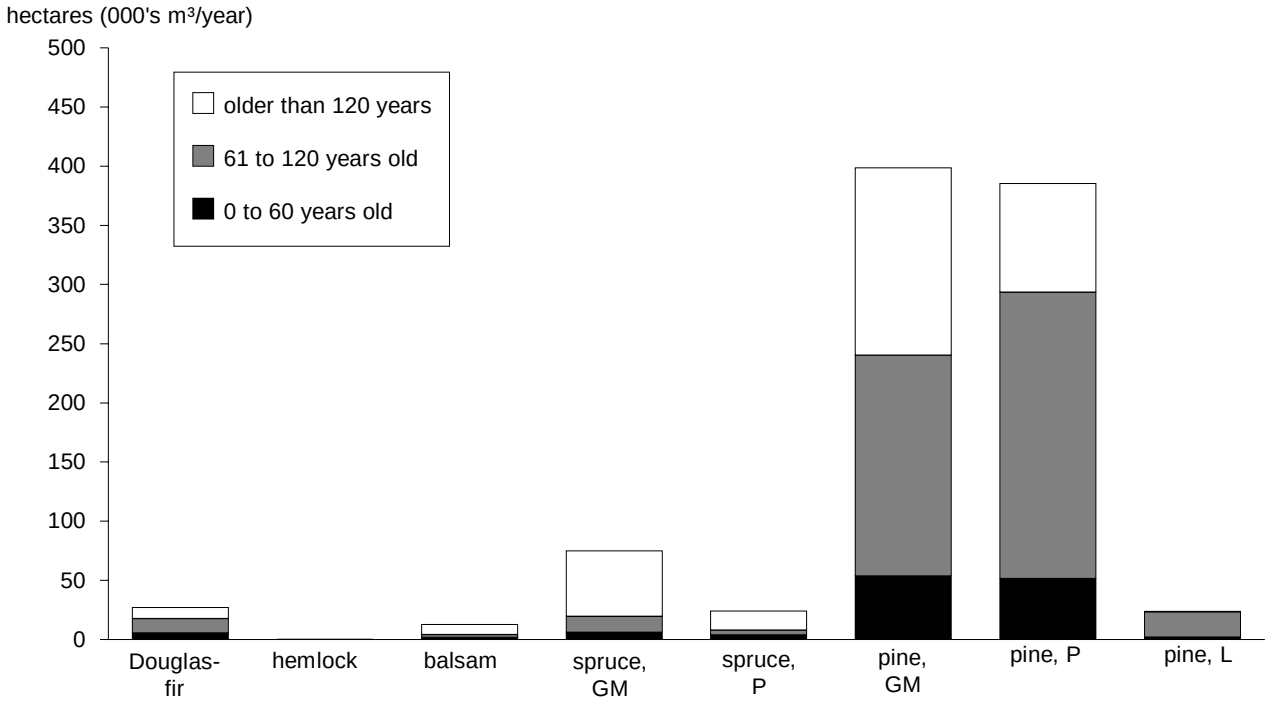

Figure 3. Area by dominant tree species, quality of growing site and age.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of individual forest stands over time. The most common measure of the amount of standing timber is volume per 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 are harvested and removed from a site. Utilization levels specify a maximum stump height and minimum diameters at the tree base and top. 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 future regenerated stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service, Research Branch. Sensitivity analyses address the possibility that stand volumes may be different from those predicted. Appendix A, "Description of Data Inputs and Assumptions" contains more information on the methods and models used to predict timber volumes.

2.3 Management practices

Timber supply is directly connected to forest management activity. The focus of the Timber Supply Review is to describe the timber supply based on current management practices, as implemented in plans for the area.

The following management assumptions* reflect current forest management in the Quesnel TSA, and are used in the timber supply analysis.

There are 7 management zones for the Quesnel TSA, as shown in the key map in the appendix (Figure A.1). These zones are as follows:

- Western caribou zone — managed to protect caribou habitat values adjacent to the Itcha-Ilgachuz area;
- Special sale area zone — managed to protect recreational use values in the vicinity of Quesnel and the Fraser River;
- Local resource use plans (LRUPs) / visual quality zone — managed with special regard for visual quality and recreation values;
- Streams and lakeshores zone — managed with recognition of the importance of water quality, wildlife and fish habitat, and recreation values of forest land immediately adjacent to class A streams and larger lakes;
- Kluskus supply block — currently undeveloped area where management is expected to be significantly influenced by first nations use;
- Integrated resource management zone — management is based on current *Cariboo Forest Region Harvesting Guidelines*;
- Problem forest types zone — managed under closer timber utilization standards than other areas in the Quesnel TSA.

A more detailed description of these management zones can be found in Appendix A.1, "Zone and Analysis Unit Definition." These zones are subject to forest cover requirements which vary depending on the resource emphasis in each zone.

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.

2.3.1 Forest cover requirements

- Cutblock adjacency* and green-up* — timber harvesting is generally not carried out on an area until any adjacent, previously harvested areas are covered with trees that are 3 metres tall. The length of time required for young stands to reach this height is usually referred to as green-up period. The cutblock adjacency guideline for the Quesnel TSA specifies that no more than 33% of an area being developed for timber harvesting is covered with stands of trees less than 3 metres tall. In areas with special management concerns for recreation and wildlife, no more than 25% of an area may be stocked with trees less than 3 metres tall.
- Visual quality of the landscape — for visually sensitive areas in the Quesnel TSA, the green-up requirement is achieved when the trees on a previously harvested area reach approximately 3 metres in height. At most 15% of these areas may be occupied by stands which have not yet achieved green-up.
- Mature forest cover requirements — mature forest cover contributes to wildlife winter habitat, water quality and fish habitat, aesthetics, and biodiversity. In this analysis, at least 10% of the timber harvesting land base, and in some zones up to 25%, must be occupied by mature forest.

All of the management zones for the Quesnel TSA have different forest cover requirements. Figure 4 shows the division of the timber harvesting land base by management zone. Figure A-1 in the appendix, is a map showing the location of the different management zones in the Quesnel TSA. Table A-10. in the appendix, provides details of the forest cover requirements specified for each management zone.

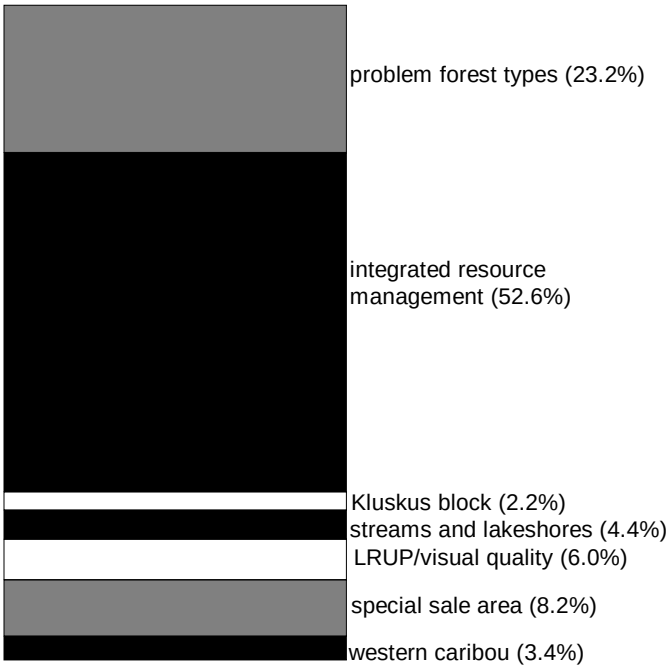

Figure 4. Proportion of the timber harvesting land base subject to each forest management consideration, Quesnel TSA.

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated 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.

2.3.2 Other management practices

- Basic silviculture levels — reforestation activities required to establish free-growing stands* of acceptable species. In the Quesnel TSA, most areas are harvested using a clearcut harvesting* system and restocked by planting or natural regeneration.
- Forest health and unsalvaged losses — unsalvaged merchantable timber lost due to insect, fire and wind damage are estimated to be 24 500 cubic metres per year in the Quesnel TSA.
- Minimum harvestable ages — the minimum harvestable ages used in this analysis are determined by the Quesnel Forest District staff to be 80 years for lodgepole pine and 120 years for other species. It is important to remember that these ages represent a minimum requirement. Management for non-timber forest values (such as visual quality, wildlife habitat and water quality) may necessitate harvesting stands at ages above the minimum, with associated losses in long-term timber yield. The effect that uncertainty in the minimum harvestable ages has on the timber supply forecast is examined in sensitivity analysis in Section 5.2, "Sensitivity to uncertainty in minimum harvestable ages."
- Current AAC — the total current AAC for the Quesnel TSA is 2.35 million cubic metres per year. This harvest level consists of 2.0 million cubic metres per year from traditional sawlog stands, plus 300 000 cubic metres per year from stands previously considered to be non-merchantable forest types. Woodlot licence areas, with an AAC of 34 500 cubic metres per year, have been excluded from the timber harvesting land base, so the AAC assumed in this analysis is 2 265 500 cubic metres per year. There is also a deciduous AAC component of 50 000 cubic metres per year which has not been included in this analysis.

Free-growing stands
Stands composed of sufficient seedlings of an acceptable commercial species that are 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.

3 Analysis Methods

The purpose of this analysis was to examine both the short- and long-term timber harvesting opportunities in the Quesnel 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 0 to 400 years. (Only the results for the first 250 years are shown graphically in this report because the harvest flow remains constant from 200 to 400 years from now.)

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 period, or that some minimum percentage of the forest must be older than a certain age. 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 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 this 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 Quesnel 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 harvest forecast* based on current forest management assumptions for the Quesnel TSA is shown in Figure 5. This harvest forecast will be referred to as the base case and will be used as the basis for comparison for all other harvest forecasts in this report.

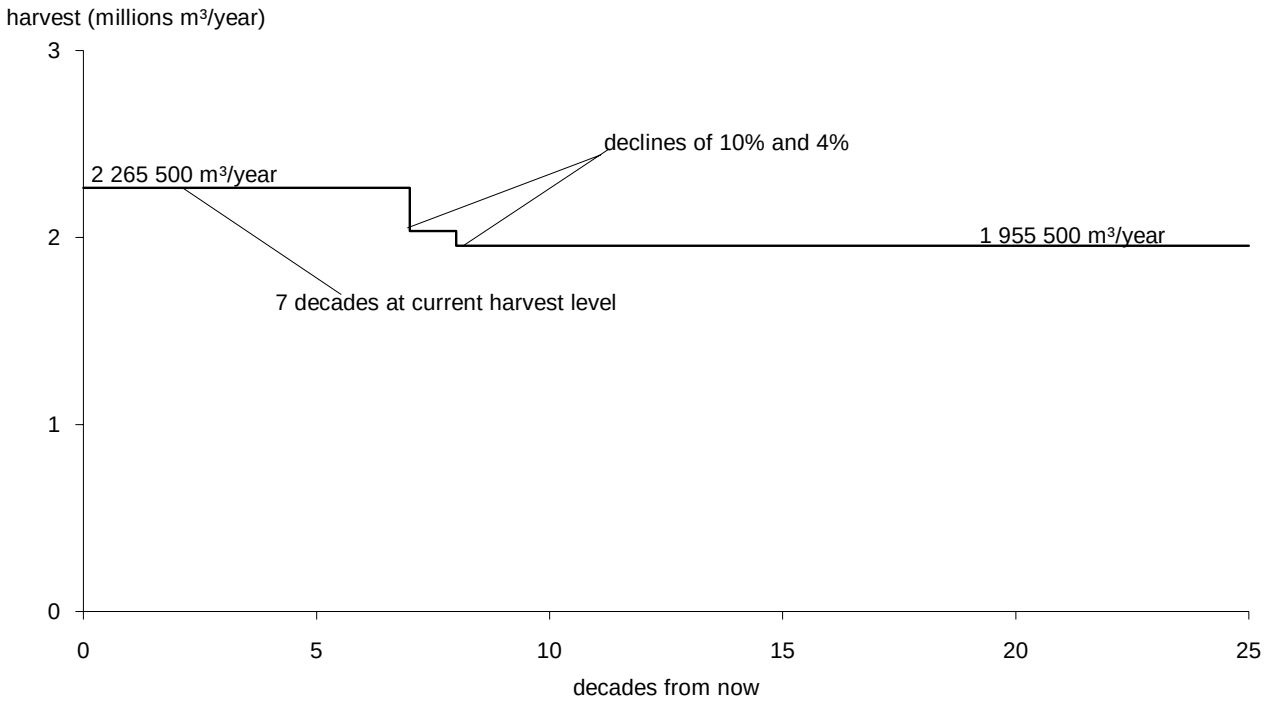

Figure 5. Base case harvest forecast for the Quesnel TSA.

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.

4 Results

The base case shows an initial rate of harvest of 2 265 500 cubic metres per year, which is equal to the current harvest level. This rate of harvest may be maintained for 70 years, followed by a decline of 14% over 2 decades to the steady long-term harvest level of 1 955 500 cubic metres per year.

As discussed in Section 2.3.2, "Other management practices" the current AAC is separated into a traditional sawlog forest type component and a small diameter lodgepole pine type component. A more detailed description of the partitioned harvest, and the contribution of these small diameter lodgepole pine types to the timber supply are discussed in Section 4.2, "Partitioned harvest."

An important factor to note is that the Quesnel TSA is currently stocked with an abundance of mature and near-mature forest, which permits the present rate of harvest to be maintained well into the future. However, the most important factor affecting the timber supply is the contribution of harvests from stands that were previously considered non-merchantable. In 1989, when the last analysis for the Quesnel TSA was done, problem (non-merchantable) forest types were not analysed as a part of the timber supply. Since 1989, a portion of these previously non-merchantable timber types formed the basis of an additional problem forest type AAC. The areas occupied by problem forest types are included in the timber harvesting land base in this analysis, and as a result, the land base is approximately 300 000 hectares larger than the land base in the 1989 analysis.

Figure 6 shows the growing stock projected over time. There is currently a total of about 180 million cubic metres of timber in the timber harvesting land base, as indicated by the solid line in Figure 6. Of the total, about 160 million cubic metres of timber is currently old enough to be considered harvestable. Approximately 130 million cubic metres of the mature growing stock is currently available for harvesting (unencumbered by mature forest cover requirements). This figure shows that by harvesting at the harvest levels indicated in the base case the total growing stock will decline over the next century to a long-term level that is 70% of the current level.

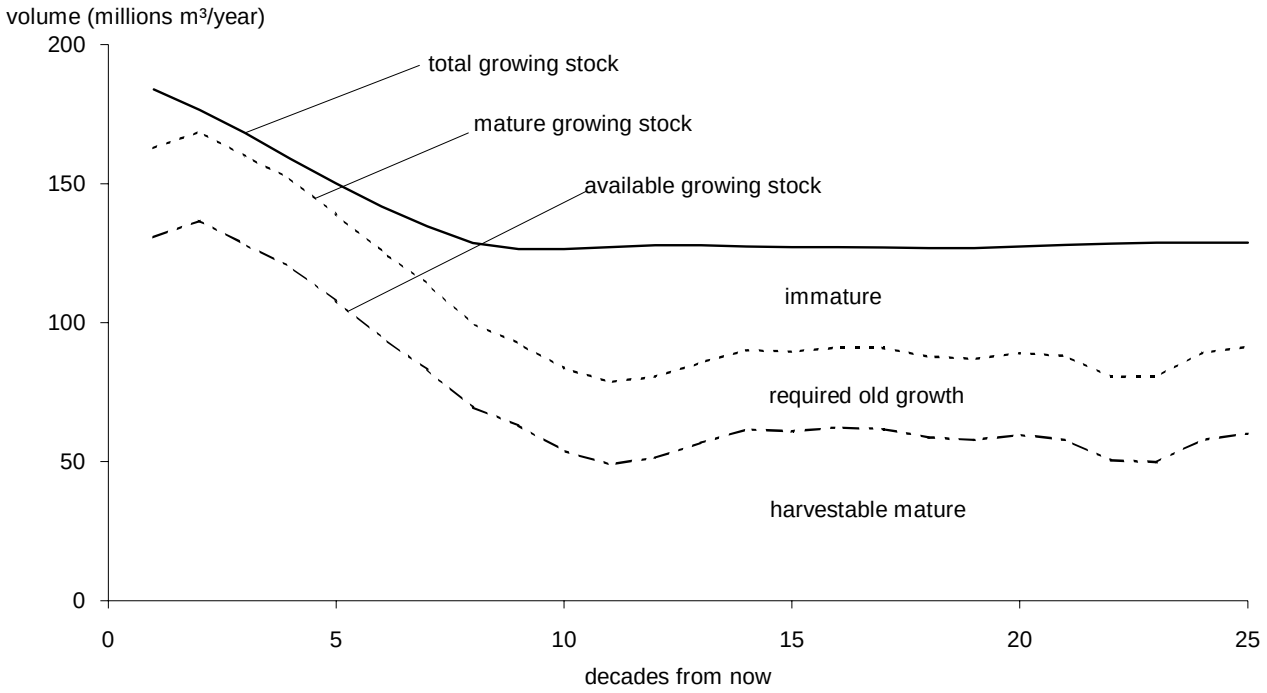

Figure 6. Growing stock over time for the timber harvesting land base, Quesnel TSA.

4 Results

Figure 7 shows that the harvests in the Quesnel TSA are expected to average approximately 310 cubic metres per hectare for the next 50 years. Subsequently, the average harvest volumes decline to between 240 and 275 cubic metres per hectare.

Although future forests are expected to grow faster than existing forests, they are scheduled to be harvested at younger ages (Figure 8). As a result, the volume per hectare harvested from these regenerated stands is significantly less than that of existing stands.

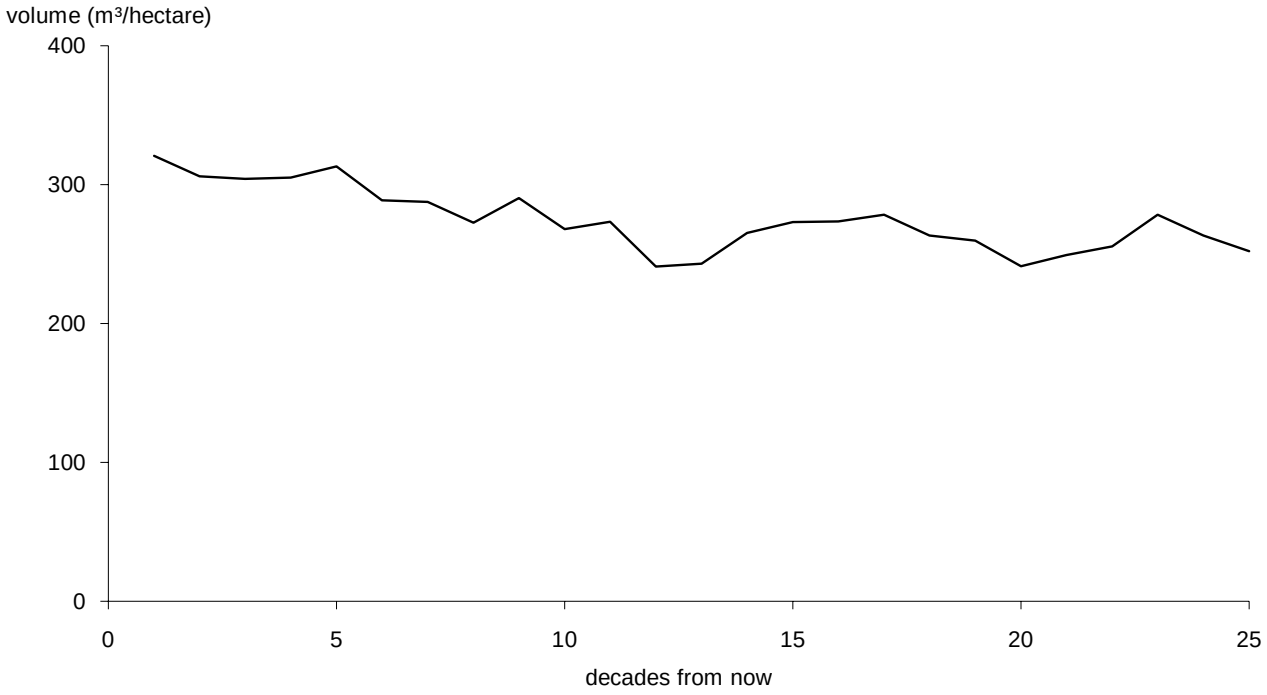

Figure 7. Average volume per hectare harvested over time, Quesnel TSA.

4 Results

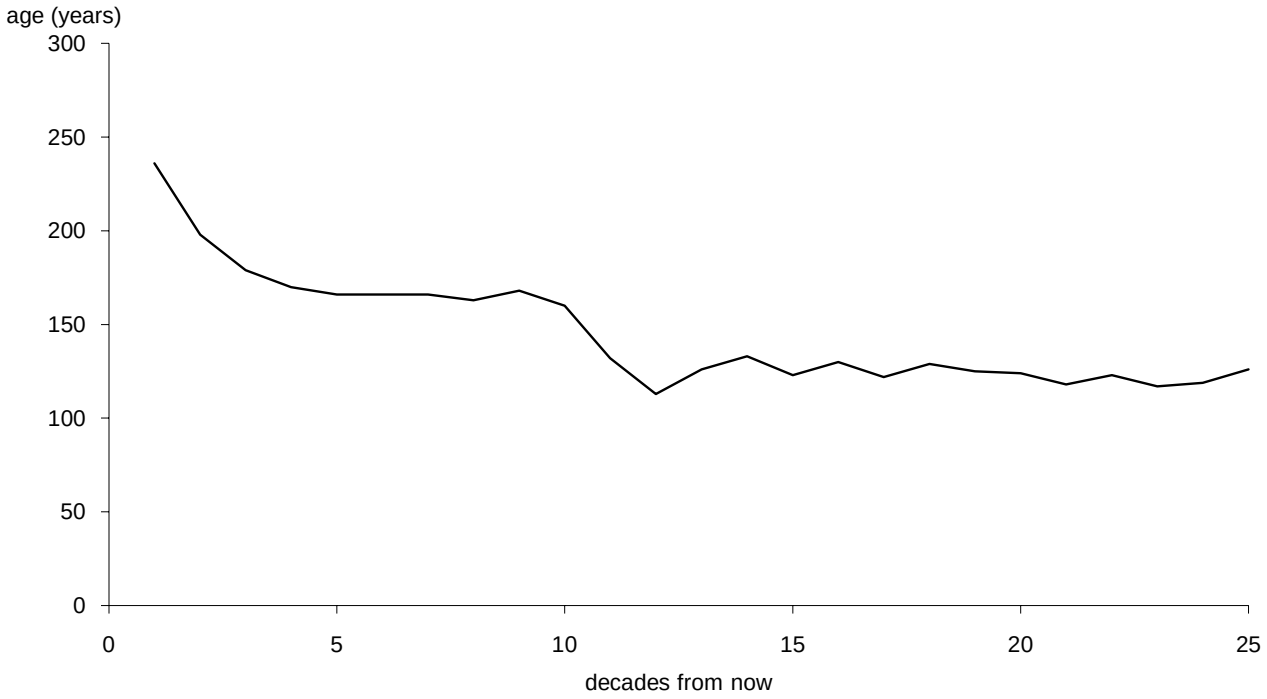

Figure 8. Average harvest age over time, Quesnel TSA.

Figure 9 shows the changes projected to occur in the age distribution of forest stands in the Quesnel TSA. The current growing stock in the Quesnel TSA is characterized by extensive areas occupied by stands aged 60 to 120 years. The abundance of timber that is near or at the age of maturity enables harvests to be maintained at the current harvest level for 70 years. Mature forest cover requirements during this period are met by existing older stands. After 100 years, a proportion of the area is occupied by older stands, which satisfy the mature forest cover requirements. At year 200, the age class distribution is very balanced, with some areas occupied by older stands, which are needed to satisfy mature forest cover requirements. The even-age class distribution, combined with a constant total growing stock, indicates that the long-term harvest level can be maintained in perpetuity.

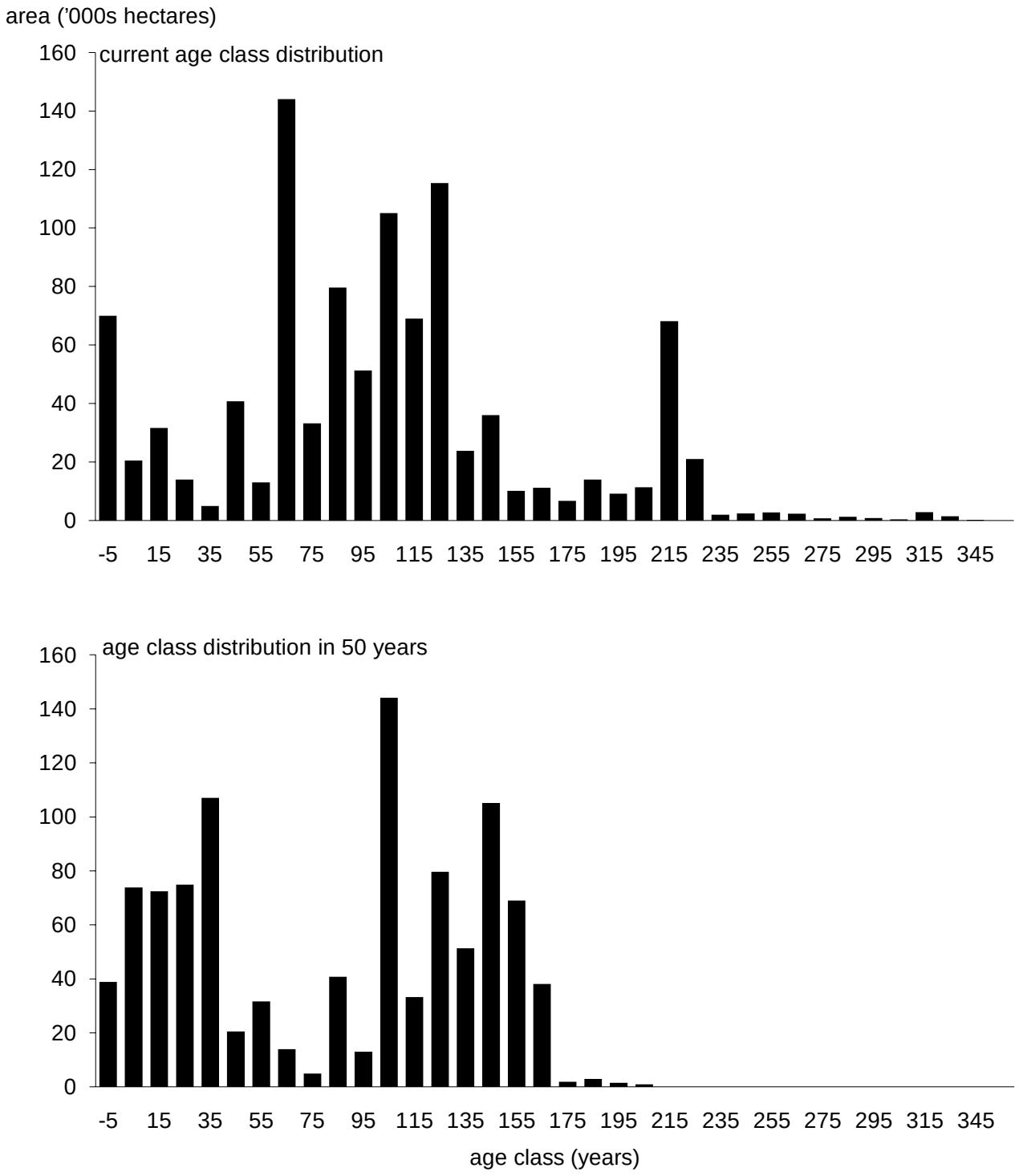

Figure 9. Stand age class distribution, Quesnel TSA (continued).

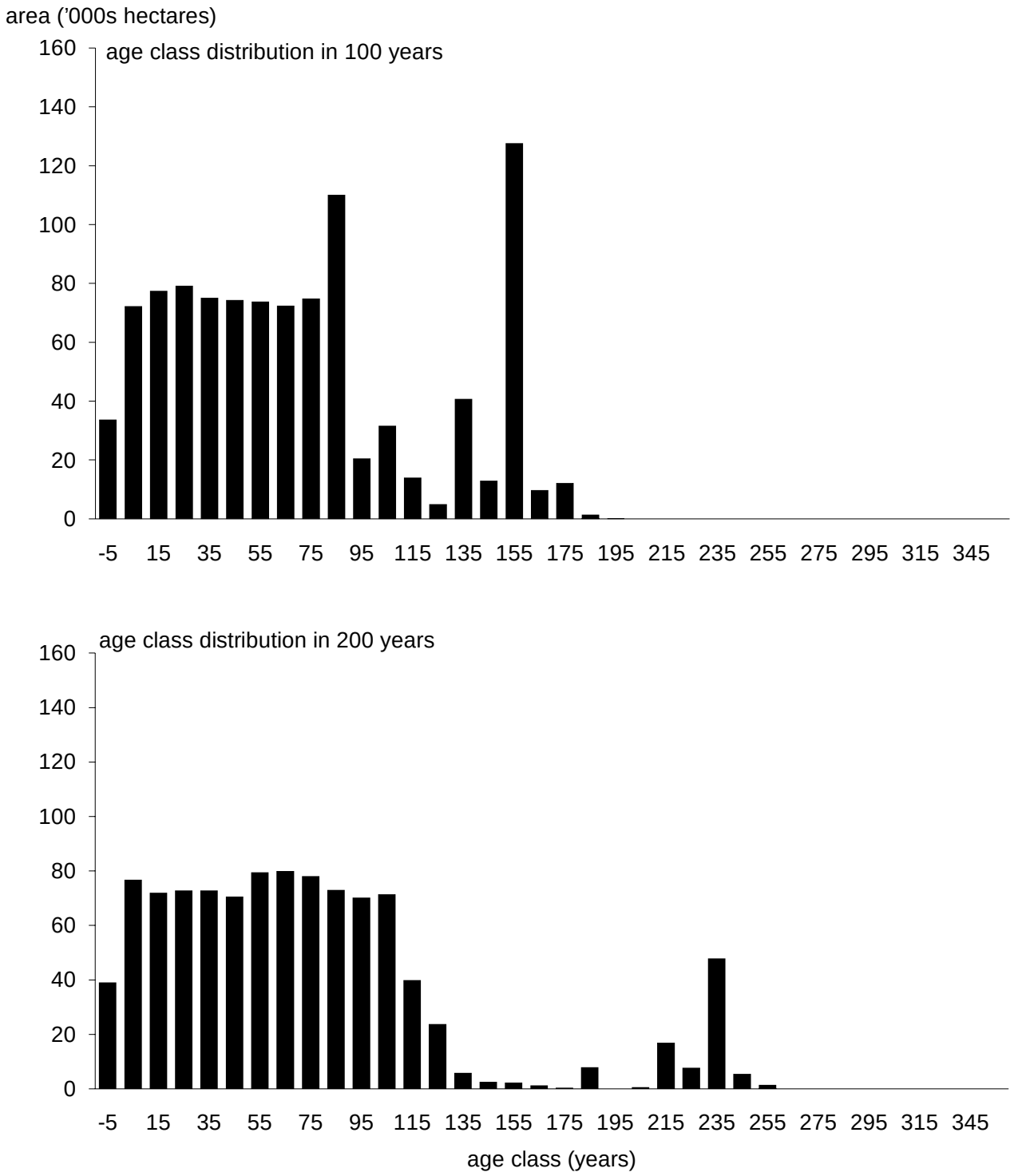

Figure 9. Stand age class distribution, Quesnel TSA (concluded).

4.2 Partitioned harvest

The current harvest in the Quesnel TSA is separated into a traditional sawlog component (1 965 500 cubic metres per year) and a problem forest type component (300 000 cubic metres per year). The base case reported in the preceding section includes harvest level contributions from both the traditional and the problem forest types (PFTs) land bases.

Problem forest types, consisting primarily of small diameter lodgepole pine stands, were not considered merchantable for sawlogs prior to 1990. Improvements in harvesting and sawmilling technology and changing product markets have enabled licensees to demonstrate that much of the timber on the previously excluded areas is merchantable as sawlogs. Although high stand densities have produced small trees, the timber is of good quality, with few knots and extremely tight growth rings. This timber is used by the value-added sawmilling industry for manufacturing furniture and Japanese housing components. The identification of PFT stands for this analysis is discussed in Section A.1.3, "Definition of the problem forest type analysis unit" in the appendix.

Figure 10 illustrates the harvest forecasts for the two components, with each starting at their current harvest level. About 50 years from now, there is a forecast decrease in the level of harvest from traditional sawlog types. The decrease may be offset by increased harvests from problem forest types. After 80 years, the long-term harvest level is reached, with 1 555 500 cubic metres per year harvested from traditional sawlog types and 400 000 cubic metres per year harvested from areas presently stocked with problem forest types.

Alternatively, the harvest level in problem forest types can be increased immediately by 100 000 cubic metres per year to the long-term harvest level of 400 000 cubic metres per year. Although this increased harvest of problem forest types would result in a higher overall harvest level in the short term, the harvest forecast would have to decline sooner (decade 5) and more severely than in the base case. To achieve the same harvest forecast as the base case, the sawlog harvest level would have to be decreased by 100 000 cubic metres to 1 865 500 cubic metres per year.

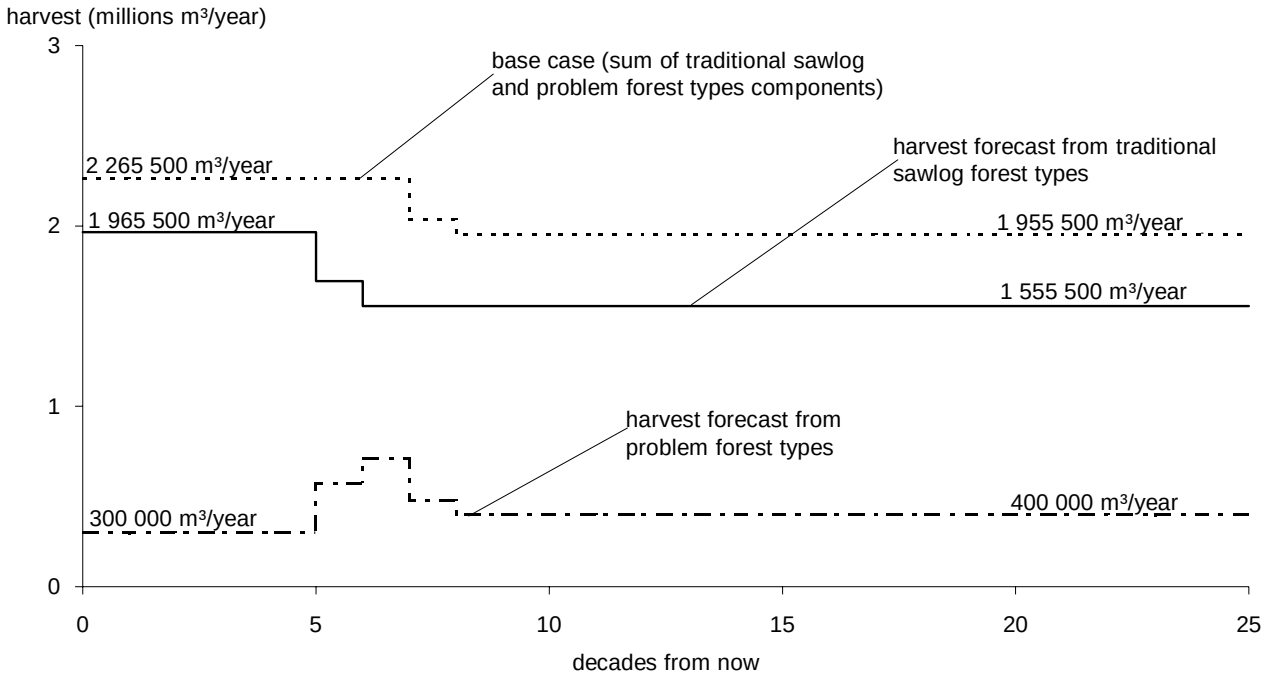

Figure 10. Partitioned harvest, Quesnel TSA.

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 its potential effects on values of interest, for example, timber supply. Every decision either implicitly or explicitly incorporates an attitude towards uncertainty. If we believe that existing information accurately reflects reality, we are being neutral to uncertainty, believing essentially that any inaccuracies probably balance out. Ignoring uncertainty is implicitly neutral. If maximizing timber supply were the goal, someone with an optimistic position towards uncertainty would believe that current information probably underestimates timber supply, and that problems can be resolved through human ingenuity and changes to practices. Someone with a pessimistic position towards uncertainty would believe 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.

Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately, decision-making. One purpose of sensitivity analysis is to highlight which variables most affect results. For example, it is possible that small inaccuracies in estimating some variable could have large effects on timber supply, or that fairly large inaccuracies in other variables could have negligible effects. Sensitivity analysis can therefore highlight priorities for collecting information for future analysis. It can also clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions are referred to as the base harvest forecast.

5.1 Alternative harvest flows given the base case forest management assumptions

For a given set of forest management assumptions, many different harvest flows are often possible. This section examines two alternative harvest flows to that shown as the base harvest forecast, given the same set of forest management assumptions.

The base case, shown in Figure 5, and discussed in Section 4, "Results" starts at the current harvest level. Figure 11 shows two alternative harvest flows. The solid line in the Figure 11 illustrates the harvest forecast that results from achieving the maximum harvest level in the short term, without large reductions in the harvest level or drops below the long-term level. The resulting harvest forecast has an initial harvest level of 2.9 million cubic metres per year, which is an increase of 28% from the current harvest level. To attain this initial increase, harvest levels 40 to 80 years from now would be significantly lower than in the base case.

5 Timber Supply Sensitivity Analyses

It is possible to raise the initial harvest level to 3.2 million cubic metres per year for 1 decade (not shown in Figure 11). However, a sharp decline would then be necessary in the second decade to avoid timber shortages in the future. Most of the extra volume harvested in the short term would have to come from problem forest type stands since by the second decade, harvesting in all traditional sawlog zones would be limited by either adjacency or mature forest cover requirements.

The dot-dash line in Figure 11 shows the harvest forecast that would result from lowering the initial harvest level to the long-term level. This reduced harvest level does not cause timber shortfalls in the future, but neither does it permit the long-term harvest level to be raised any higher than the level in the base harvest forecast. However, as shown in Figure 12, lower short-term harvest levels permit higher levels of growing stock to be maintained for several centuries, which would provide greater flexibility in scheduling harvests, and provide some insurance against catastrophic losses.

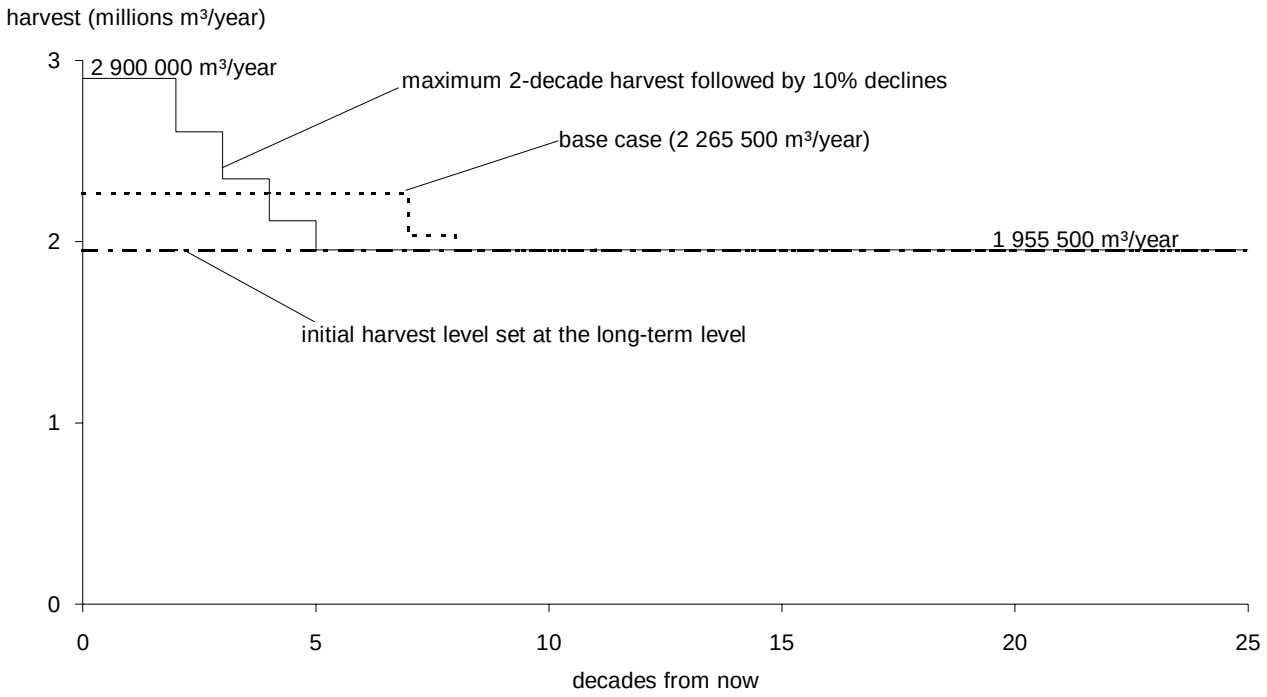

Figure 11. Alternative harvest flows from the timber harvesting land base, Quesnel TSA.

5 Timber Supply Sensitivity Analyses

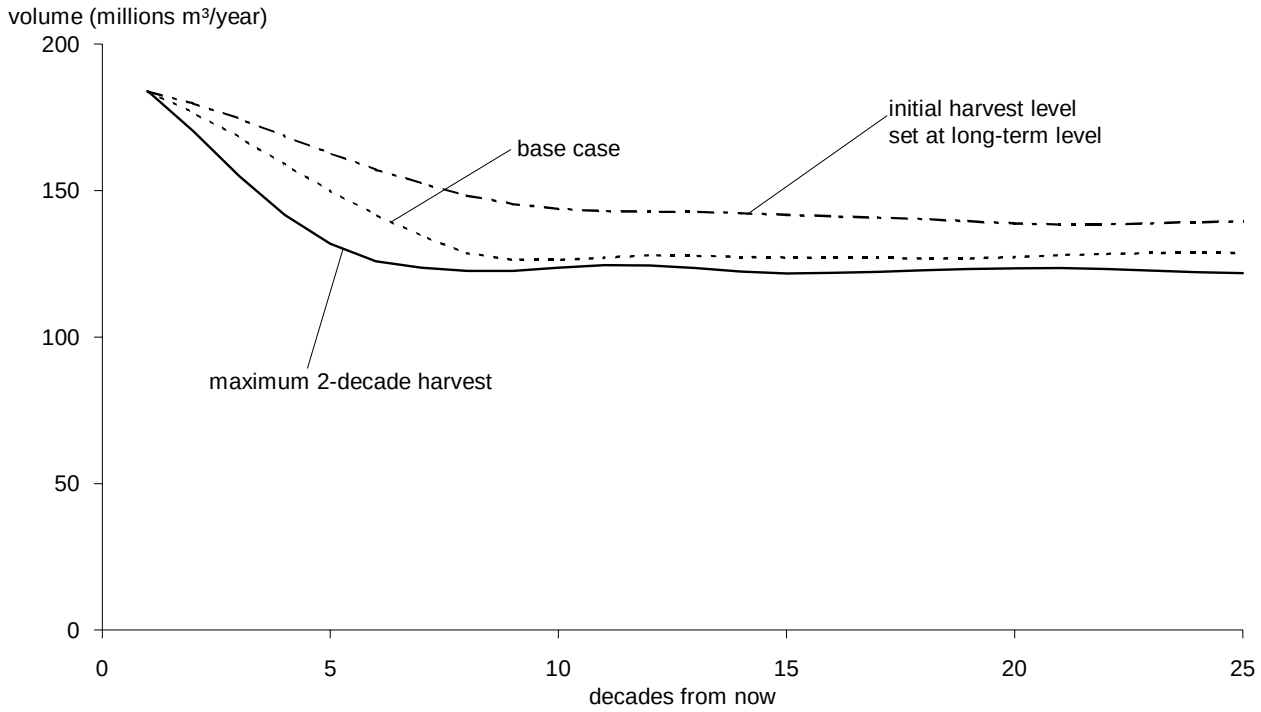

Figure 12. Total growing stock over time with alternative harvest flows, Quesnel TSA.

5.2 Sensitivity to uncertainty in minimum harvestable ages

In the base case, the minimum harvestable ages are 80 years for lodgepole pine and 120 years for other species. This section examines the sensitivity of the harvest forecast to changing the minimum harvestable ages for each forest type by 20 years.

The effect on the harvest forecast of increasing all minimum harvestable ages by 20 years is shown by the dash-dot line in Figure 13. The current harvest level may be maintained for only 5 decades, rather than 7 decades in the base case, since it takes longer for regenerating stands to be old enough to contribute to the harvest. Increasing minimum harvestable ages does not impact the long-term harvest level.

Decreasing minimum harvestable ages permits the current harvest level to be maintained for 8 decades, followed by a drop to the same long-term harvest level as in the base case.

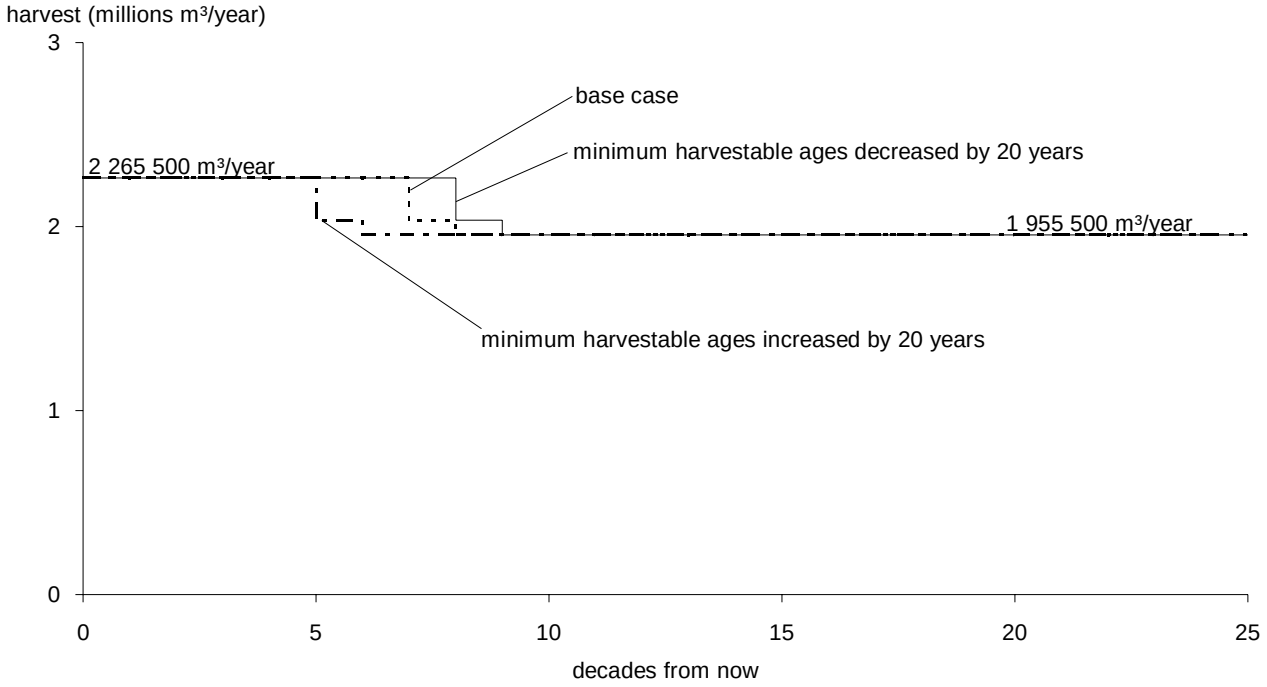

Figure 13. Harvest forecasts with increased and decreased minimum harvestable ages, Quesnel TSA.

5.3 Sensitivity to uncertainty in green-up periods

In the Quesnel TSA, previously harvested areas achieve green-up when the dominant trees in the regenerating stand reach 3 metres in height. Green-up periods for each management zone are listed in Table A-10. in the appendix. The average green-up period for all zones is approximately 17 years.

Increasing or decreasing the green-up period by 10 years has a small effect on the harvest forecast. If green-up periods are extended by 10 years, the current harvest level may be maintained for 6 decades, rather than 7 decades as in the base case, before declining to the same long-term harvest level as in the base case. If green-up periods are reduced by 10 years, the current harvest level may be maintained for 7 decades before declining to the long-term harvest level of 1.975 million cubic metres (an increase of 1% over the base case).

5.4 Sensitivity to uncertainty in cutblock adjacency requirements

To ensure that harvesting does not become overly concentrated in a management zone, guidelines establish a maximum limit on the overall area that has not achieved the green-up condition. In the base case, forest cover requirements used to model cutblock adjacency and green-up limit the area that may be occupied by stands less than 3 metres tall at any time to 33% in the integrated resource management and problem forest type zones, 15% in the LRUP/Visual zone, and 25% in the other zones.

This sensitivity analysis examines the impact of uncertainty in the cutblock adjacency requirements on the harvest forecast. If all management zones are limited to a maximum of 25% of the area occupied by stands less than 3 metres in height, there is no effect on the harvest forecast. If the cutblock adjacency requirement is made even more restrictive, by allowing no more than 20% of each management zone to be less than 3 metres height at any time, there is no impact relative to the base case. The current harvest level can be maintained for 7 decades, and the long-term harvest level remains feasible at 1.955 million cubic metres per year.

5.5 Sensitivity to uncertainty in mature forest cover requirements

In the base case, all management zones in the Quesnel TSA have a requirement that a certain percentage of the timber harvesting land base is stocked with mature forest. These older age classes were maintained in order to provide some protection for biodiversity in the TSA. The specific requirements for each zone are listed in Table A-10. in the appendix. The purpose of this sensitivity analysis is to show the effect on the harvest forecast of varying mature forest cover requirements.

5 Timber Supply Sensitivity Analyses

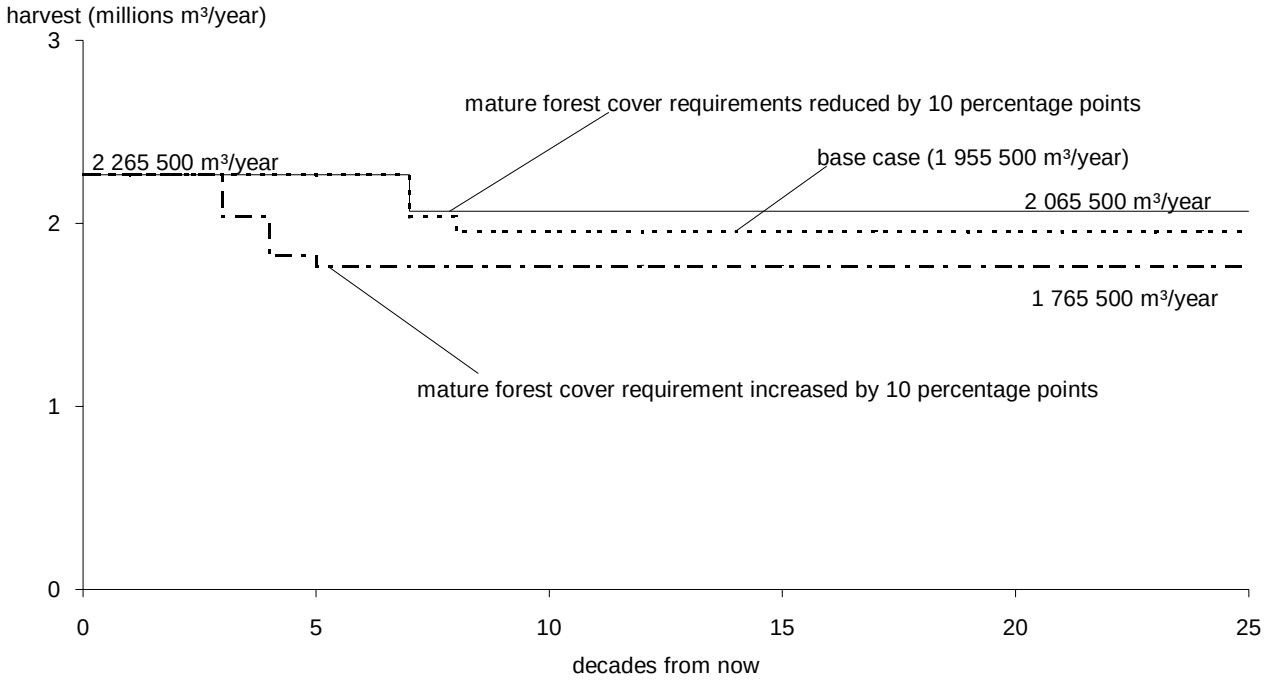

Figure 14. Harvest forecasts with increased and decreased mature forest requirements, Quesnel TSA.

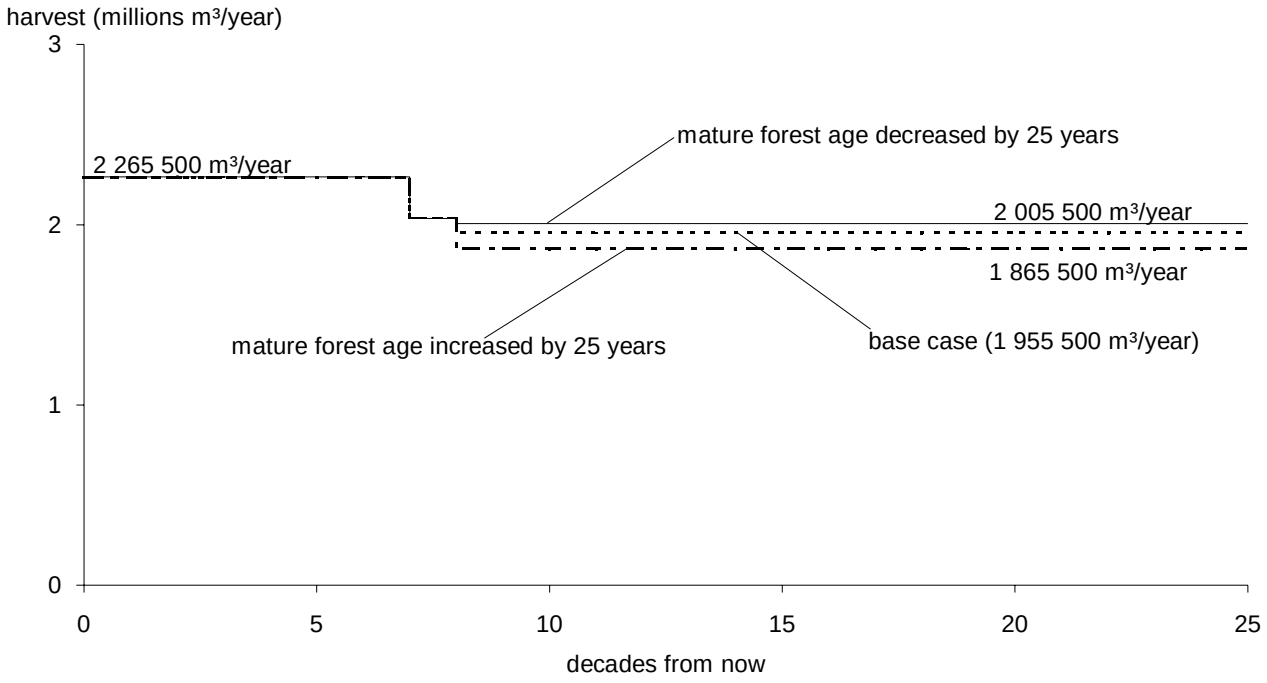

Figure 15. Harvest forecasts with increased and decreased mature age requirements, Quesnel TSA.

The percentage of area that must be occupied by mature forest varies from 10% in the integrated resource management zone to 25% in the streamside management zone. Figure 14 shows the impact on the harvest forecast of increasing or decreasing this requirement by 10 percentage points in all zones.

When the mature forest requirement is reduced by 10 percentage points, there is no impact on the number of decades that the present harvest level may be maintained; however, the long-term harvest level rises 5% to approximately 2 million cubic metres per year.

As shown in Figure 14, when the mature forest requirement is increased by 10 percentage points, the present harvest level may be maintained for only 3 decades. The harvest level must then decline to a long-term harvest level that is 10%, or 190 000 cubic metres per year, less than in the base case.

In the base case, a stand is considered mature when it is either 120 or 150 years of age, depending on the management zone (see Table A.10. in the appendix). Figure 15 shows the impact on the harvest forecast of increasing or decreasing the age of which a stand is considered mature by 25 years for all management zones. Neither change has an impact on the amount of time that the present harvest level may be maintained (7 decades). However, the long-term harvest level is affected in both cases.

This analysis also examines the impact on the harvest forecast if the age at which a stand is considered mature is 120 years for all management zones. In this case, the harvest forecast closely matches the solid line in Figure 15. The short-term harvest level is the same as in the base case, but the long-term harvest level is increased by about 2% over the base case.

5.6 Sensitivity to removing all forest cover requirements

The following sensitivity analysis examines the effect on the harvest forecast of removing all forest cover requirements for cutblock adjacency, green-up, mature forest and management of special values. The solid line in Figure 16 shows the harvest forecast with all forest cover requirements removed. The current harvest level may be maintained for 10 decades, and the long-term harvest level can increase by 7%, due mainly to the removal of mature forest requirements as discussed in Section 5.5, "Sensitivity to uncertainty in mature forest cover requirements."

5 Timber Supply Sensitivity Analyses

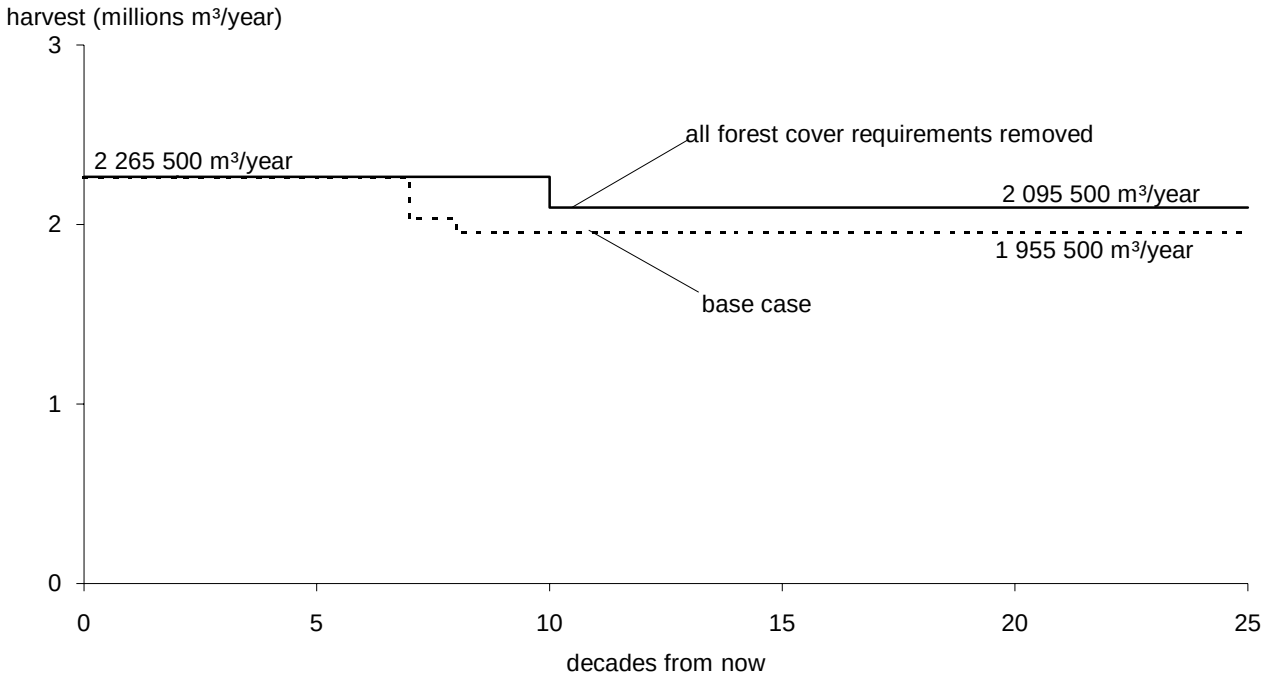

Figure 16. Harvest forecast with all forest cover requirements removed, Quesnel TSA.

5.7 Sensitivity to uncertainty in existing stand volume estimates

Stand volume estimates are subject to uncertainty due to such factors as the statistical process used to develop growth and yield models, uncertainty in the forest inventory, and changing timber utilization standards. The following sensitivity analysis examines the effect on the harvest forecast of uncertainty in the volume of timber that currently exists on the timber harvesting land base.

Figure 17 shows the effect on the harvest forecast of increasing the estimated volumes of existing stands by 10% or 20%. The present harvest level may be maintained for 14 or 21 decades, respectively, as compared to 7 decades in the base case.

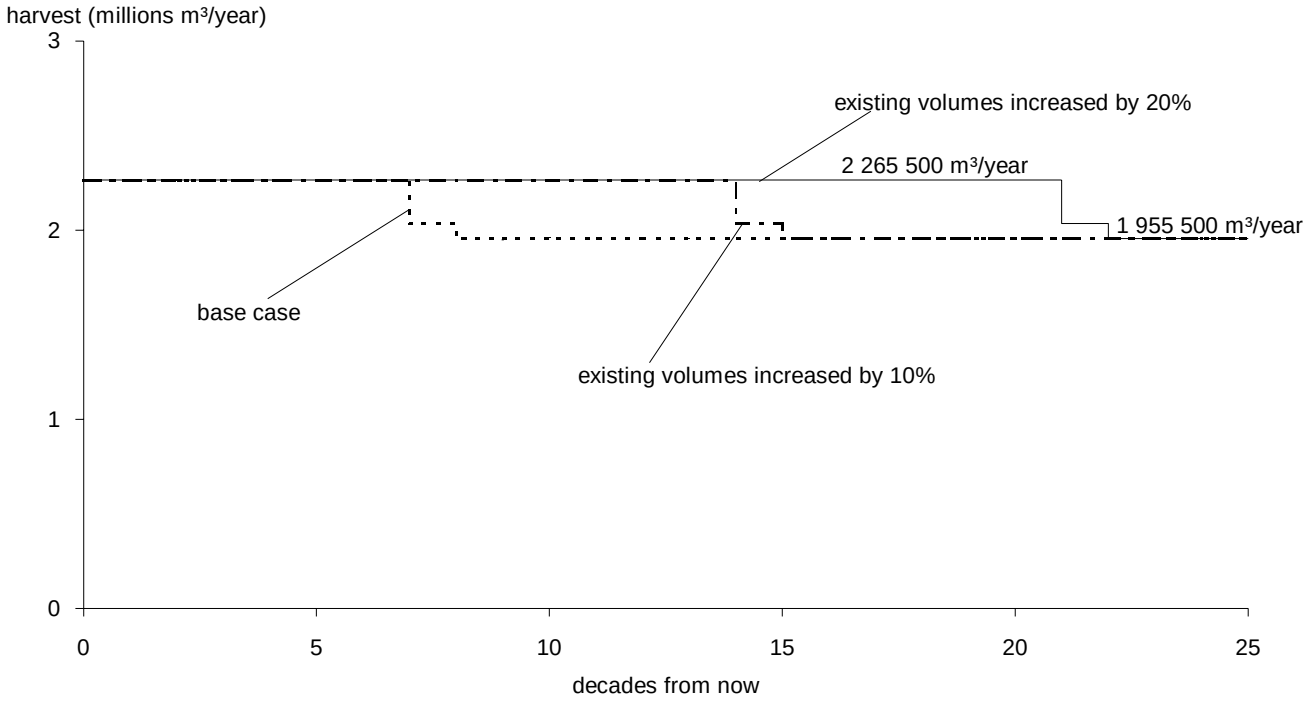

Figure 17. Harvest forecast with increased estimates of existing stand volumes, Quesnel TSA.

5 Timber Supply Sensitivity Analyses

The effect of decreasing existing stand volume estimates by 10% and 20% is illustrated in Figure 18. If existing stand volumes are 10% less than has been estimated for the base case, then the harvest level must be reduced immediately to the long-term harvest level, which is a reduction of 14% from the current harvest level, in order to avoid timber shortages in the future. If existing stand volumes are 20% less than has been estimated, then the short-term harvest level must be reduced immediately to 1.475 million cubic metres per year, 35% below the current harvest level. Eventually, the harvest level rises to the long-term harvest level. As with increasing existing stand volume estimates, the long-term harvest level is the same as in the base case.

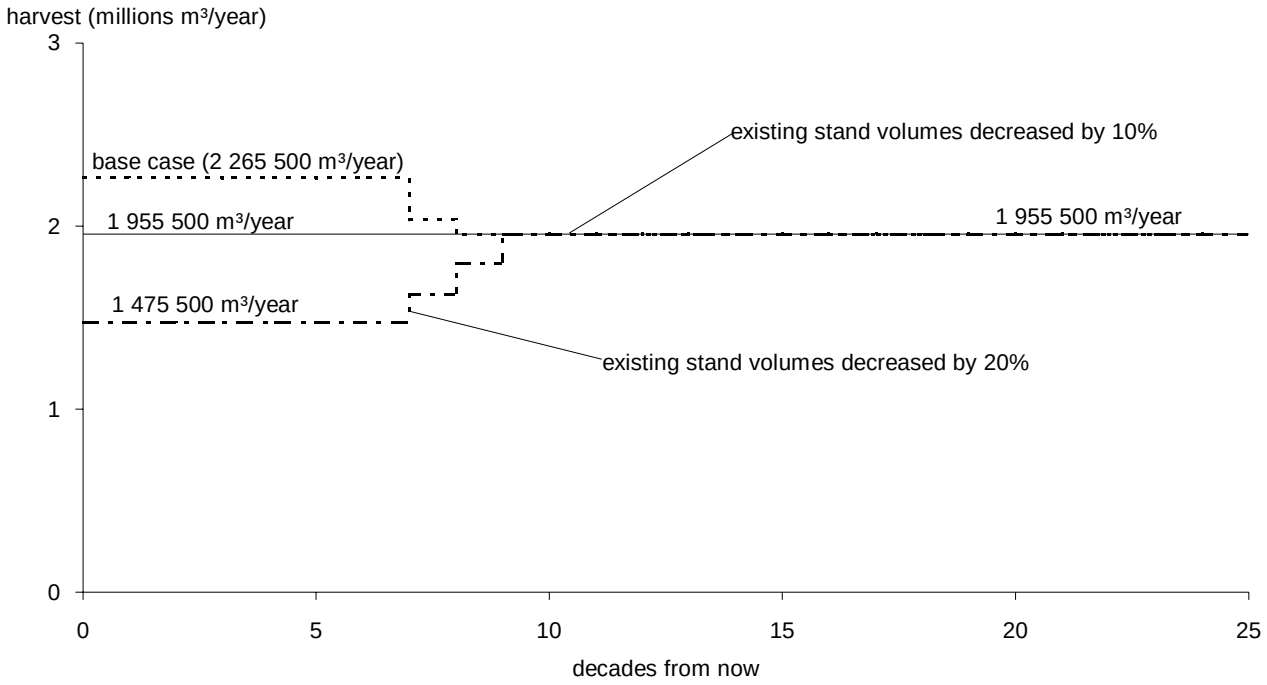

Figure 18. Harvest forecast with decreased estimates of existing stand volumes, Quesnel TSA.

5.8 Sensitivity to uncertainty in regenerated stand volumes and regeneration delay

This section examines the effect that uncertainty in estimated volumes for regenerated stands, and the length of the regeneration delay* have on the harvest forecast.

The solid line in Figure 19 shows the effect on the harvest forecast if regenerated stand volumes are 20% higher than estimated in this analysis. There is no effect on the harvest level for the next 15 decades. After decade 15, the harvest level can be increased to the long-term level, which is 20% higher than the long-term harvest level in the base case.

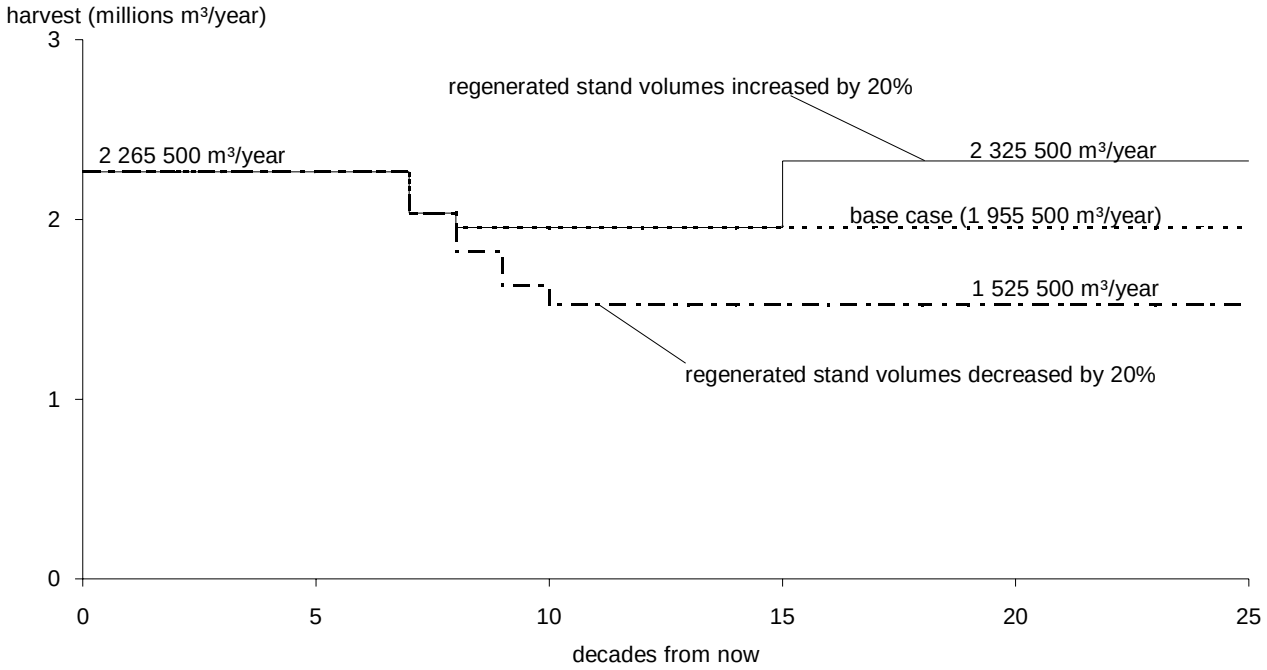

Figure 19. Harvest forecasts with regenerated stand volume estimates increased and decreased, Quesnel TSA.

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.

The dash-dot line in Figure 19 shows the effect on the harvest forecast if all regenerated stand volume estimates are 20% lower. The current harvest level may still be maintained for 7 decades; however, the harvest level declines for 4 decades to a long-term harvest that is approximately 20% below that of the base case.

The analysis uses the Table Interpolation Program for Stand Yields (TIPSY) managed stand yield curves for regenerated stands. If Variable Density Yield Prediction (VDYP) yield curves are used instead, on the assumption that future forests will grow at the same rate as existing forests, then the current harvest level may be maintained for 7 decades (not shown in Figure 19). However, the long-term harvest level is 12% lower than in the base harvest forecast.

Regeneration delay, which is the time between harvest of an existing stand and the successful establishment of a new tree crop, is from 4 to 7 years in the Quesnel TSA. The length of the regeneration delay determines how quickly a regenerated stand is established, and in this way, affects the length of time required for a stand to reach a harvestable condition. This analysis shows that immediate regeneration of all sites would increase the long-term harvest level by 4%. However, if regeneration delays were to average 10 years in the TSA, the long-term harvest level would be 4% lower than in the base case. Neither change would impact harvest levels for the first 7 decades.

5.9 Sensitivity to the definition of unmerchantable forest types

The problem forest type component of the timber harvesting land base consists of high density lodgepole pine stands that are excluded from the traditional sawlog land base. These stands must consist of trees that are at least 13.3 centimetres diameter at breast height for the stands to be merchantable. The 13.3 centimetre diameter was determined by a review of problem forest types licence information (see Appendix A.1.3). This diameter represents the minimum currently harvested, not the average. This sensitivity analysis examines the impact on the harvest forecast of uncertainty about the minimum diameter criterion for problem forest types. Figure 20 illustrates the results of varying the minimum harvestable diameter by approximately 25%.

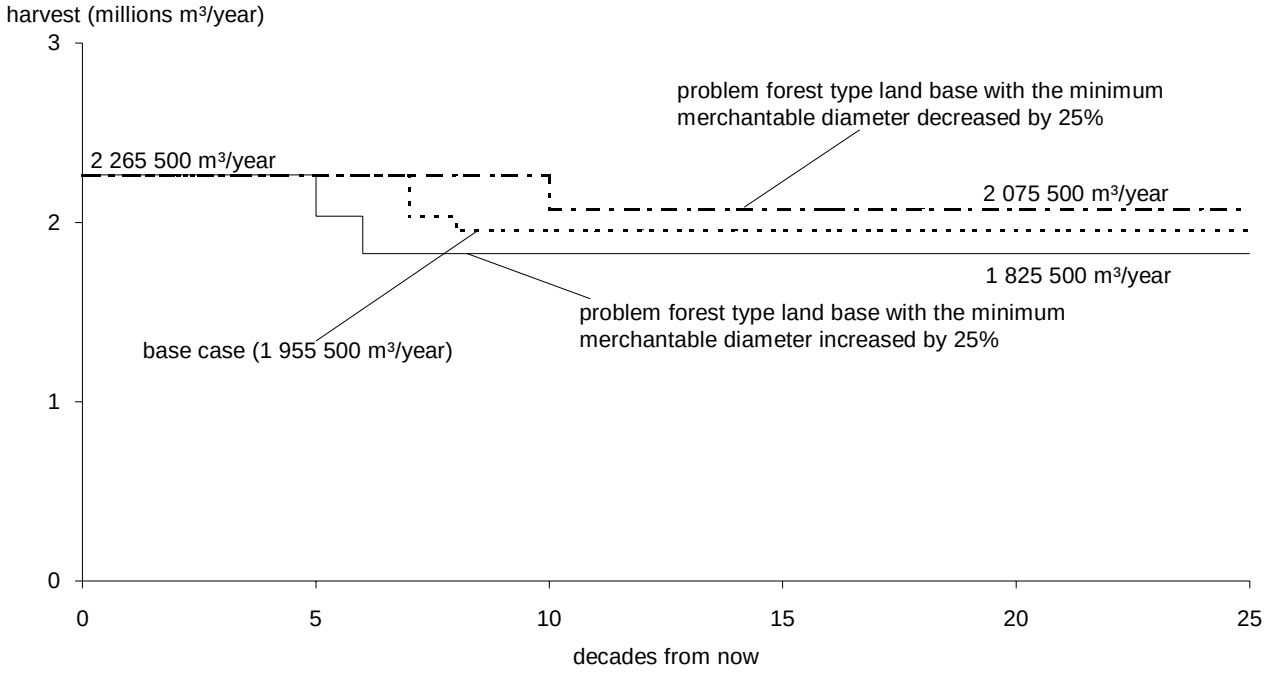

Figure 20. Harvest forecasts with the diameter criteria for defining problem forest types increased and decreased, Quesnel TSA.

If the minimum diameter of merchantable stands is reduced by 25%, then stands consisting of trees greater than 10.0 centimetres diameter are considered merchantable, and a larger area of the TSA is occupied by harvestable stands. The problem forest type zone land base increases by approximately 60 000 hectares. The current harvest level may be maintained for 10 decades, and the long-term harvest level rises by 6% relative to the base case.

If the minimum diameter of merchantable stands is increased by 25%, then stands consisting of trees greater than 17.0 centimetres are considered merchantable, and the problem forest type zone land base decreases by approximately 65 000 hectares. In this case, the current harvest level may be maintained for only 5 decades, and the long-term harvest level is reduced by 7% from the base case.

5.10 Sensitivity to changes in the area of the timber harvesting land base

The area that is assumed to be suitable and available for timber harvesting is one of the primary inputs into a timber supply analysis. In the Quesnel TSA the timber harvesting land base could be larger or smaller than expected if any of the areas listed in Table 1 are different, or if more areas are included in the table.

The following sensitivity analysis examines the effects on the harvest forecast if the area estimates for all zones are increased or decreased by 10%. The solid line in Figure 21 shows that with a 10% increase in the timber harvesting land base, across all growing sites and age classes, the current harvest level may be maintained for 20 decades before declining to a long-term harvest level that is an increase of approximately 10% over that of the base case.

If the timber harvesting land base is decreased proportionately by 10%, the current harvest level may be maintained for 4 decades, before declining to a long-term harvest level that is 10% lower than in the base case.

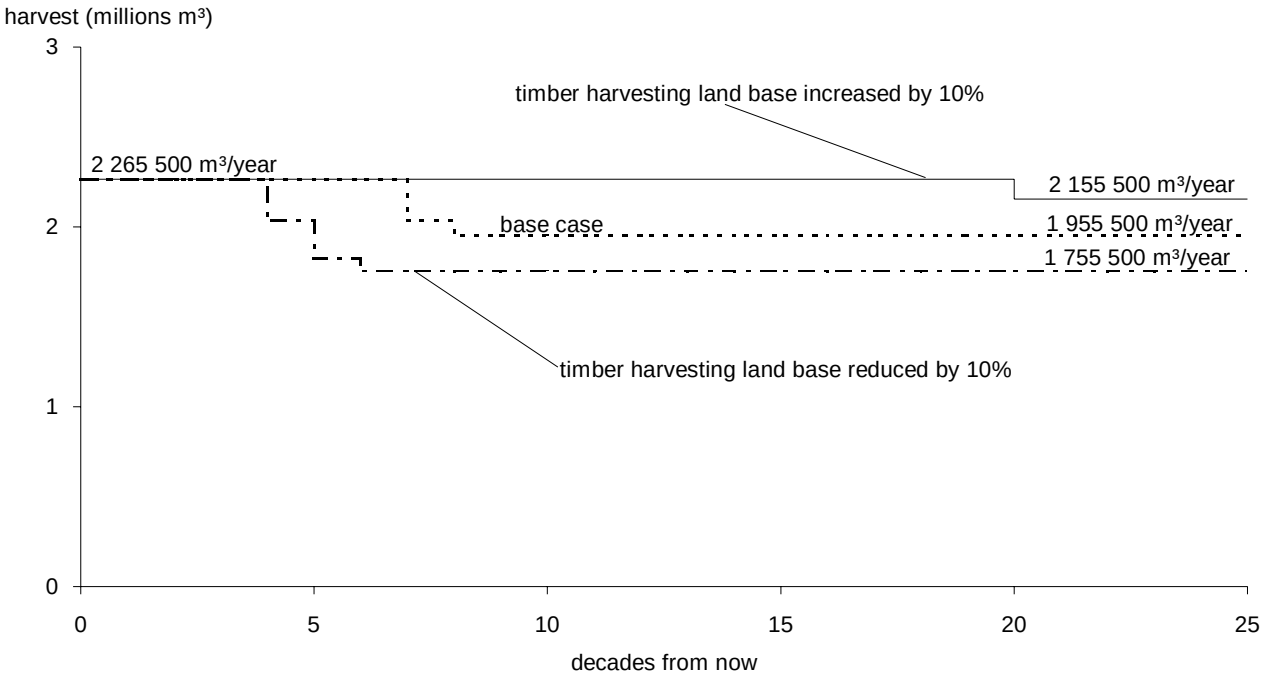

Figure 21. Harvest forecasts with the area of the timber harvesting land base increased and decreased, Quesnel TSA.

6 Summary and Conclusions

The base case forecast in this analysis indicates that the current harvest level in the Quesnel TSA can be maintained for 7 decades without causing a future shortage in the timber supply. The harvest level then declines over 2 decades to the long-term harvest level. The current harvest level is 14% above the long-term harvest level.

Several important factors affect the timber supply forecast. The most important factor is the inclusion of problem forest types in the timber harvesting land base. The timber harvesting land base in this analysis has increased by approximately 300 000 hectares over the 1989 analysis of timber supply in the Quesnel TSA. Also, the assumptions made about the restocking of not satisfactorily restocked young stands impact the harvest forecast. Furthermore, the present age class structure of the forest in the Quesnel TSA also affects the timber supply forecast. A majority of the forest in the Quesnel TSA is comprised of lodgepole pine stands aged 60 to 120 years. Pine grows quite rapidly in this age range, compared to other tree species. These stands will be approaching maturity as the existing older stands are harvested and additional harvestable timber is needed.

The results of sensitivity analyses indicate that uncertainty in the assumptions and data have little effect on the short-term timber supply. More stringent cutblock adjacency requirements may be adopted in the Quesnel TSA without reducing harvest levels, and a 10% reduction in land base area would still permit the current harvest level to be maintained for 4 decades. Increases in mature forest cover requirements and green-up requirements would impact long-term harvest levels, but would not impact harvest levels for the first 4 decades. Removal of all forest cover requirements would permit the current harvest level to be maintained for 10 decades.

Uncertainty in estimates of existing stand volumes may have a significant effect on the harvest forecast. If existing stand volumes are 10% greater than has been estimated, the current harvest level may be maintained for 14 decades. However, if existing stand volumes are 10% less than has been estimated, an immediate reduction in harvest levels to the long-term harvest level is indicated, in order to avoid timber supply shortages in the future.

7 References

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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.

Cutblock adjacency The desired spatial relationship among cutblocks as specified in integrated 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 where timber harvesting may cause avalanches.

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 stands Stands composed of sufficient seedlings of an acceptable commercial species that are free from growth-inhibiting brush, weed and excessive tree competition.

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.

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.

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.

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.

8 Glossary

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.

Pulpwood agreements An agreement for a fixed geographic area that allows for harvesting of timber below sawlog standards if wood residues suitable for the facility under this agreement are not available.

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.

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*.

Appendix A

Description of Data Input 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 Quesnel 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

For the purpose of the timber supply analysis, the timber harvesting land base is broken down into units with similar forest management. These units are referred to throughout this appendix as zones. The purpose of dividing the timber harvesting land base into zones is to facilitate modelling of the forest management concerns specific to each zone. The zones used in the timber supply analysis for the Quesnel TSA are listed in Table A-1. Figure A-1, a map of the Quesnel TSA, shows the location of the forest management zones.

A.1 Zone and Analysis Unit Definition

Figure A-1. Key map to the location of management zones in the Quesnel TSA.

A.1 Zone and Analysis Unit Definition

Zone 1: Western Caribou

The area identified as important caribou habitat by a joint habitat research project (Ministry of Environment, Lands and Parks/Ministry of Forests 1992) is included in this zone. This area is in addition to the current reduction of Western Caribou from the timber harvesting land base. There is a TSA Steering Committee short-term management agreement in place for a portion of this zone in the vicinity of Toil Mountain. There is also a TSA steering committee agreement in place for "4-pass" harvesting to accommodate other wildlife habitat concerns in the area between the Coglistiko and Kushya Rivers.

Zone 2: Special Sale Area (SSA) Supply Block

This zone encompasses all areas within the Special Sale Area (SSA) Supply Block (Supply Block D). It includes many areas that are forested predominantly with Douglas-fir leading types. The proximity to Quesnel, location of rural residents, and current recreational use of this zone are addressed through specific forest management practices. Recreational uses in this area focus on the high level of access, the distribution of small lakes, the hunting opportunities and the characteristics of the Douglas-fir forest type in general. Zone Z also includes all areas with ownership code = 61, which are designated for the use, recreation and enjoyment of the public.

Zone 3: Local Resource Use Plan (LRUP)/Visual Quality

This zone encompasses areas that receive special management, particularly for management of visual quality and recreation. The zone includes the Lower Blackwater LRUP, the Upper Blackwater LRUP, the Cariboo River Wildlife Management Area Buffer Zone B, the Quesnel-Barkerville Integrated Resource Management Plan (IRMP) and other areas requiring visual resource management in the Quesnel Forest District, as determined from existing landscape inventories and preliminary assessments of visual sensitivity conducted by the Quesnel Forest District staff.

Zone 4: Streams and Lakeshores

Based on a review of the district 1993-98 consolidated development plan and discussions with the Quesnel Forest District Timber and Recreation staff, it was determined that management practices immediately adjacent to class A streams and larger lakes were sufficiently distinct to warrant treatment as a separate zone. This zone is intended to encompass areas that receive special management because of their importance to water quality, wildlife and fish habitat, and recreational values. The zone which is currently defined for this analysis includes 30 metre wide areas adjacent to both sides of all rivers and streams, and surrounding all lakes which are contained in the inventory.

Zone 5: Kluskus Supply Block

The Kluskus zone encompasses the portions of the Kluskus supply block not already covered by other zones or deductions. The area is currently undeveloped and management in this zone is expected to be significantly influenced by traditional first nations use of the area.

Zone 6: Integrated Resource Management

This zone includes the balance of the timber harvesting land base. Management in this zone is based on current *Cariboo Forest Region Harvesting Guidelines.*

Zone 7: Problem Forest Types

This zone encompasses a portion of the timber profile in the TSA that is outside the traditional sawlog profile as described in Section 5.7, "Area Inclusion Factors for Unmerchantable Stands" in the 1990 AAC Rationale documentation. A separate component of the AAC in the Quesnel TSA has been assigned to Problem forest types (PFTs) and a number of non-replaceable forest licenses have been awarded based on PFT utilization. Problem forest types are analysed as a separate zone to accommodate the need for distinct information on this AAC component. After harvest the PFT stands are regenerated to normal sawlog stands.

Table A-1. List of forest management zones

Reference number	Zone name	Net area in the timber harvesting land base (hectares)	Existing merchantable volume ('000s m^3)	Per cent of total volume
1	Western caribou	34 543	6 586	4.1
2	Special sale area	83 880	16 451	10.2
3	LRUP/Visual quality	61 216	10 879	6.8
4	Streams and lakeshores	44 505	8 478	5.3
5	Kluskus	22 286	4 237	2.6
6	Integrated resource management	535 290	87 885	54.7
7	Problem forest types	236 238	26 192	16.3
Total TSA		1 017 959	160 710	100.0

Inventory Definition of Zones

The following tables and information describe the location of the forest management zones using variables on the inventory file. Forest management zones are defined before undertaking the netdown process described in Section A.3, "Definition of the Timber Harvesting Land Base."

Definition of Zones 1, 3 and 5

Zones 1, 3 and 5 are defined in the table as follows. Zone 3 includes the component identified in Table A-2(i). by region and compartment and the component identified in Table A-2(ii). by planning cell.

All timber types within supply block A not included in zones 1 through 4 are assigned to zone 5.

Table A-2(i). Zone definition by inventory region and compartment (per cent inclusion)

Region	Compartment	Zone 1 Western caribou	Zone 3 LRUP/visual quality	Zone 5 Kluskus
55	11		10	
55	15		10	
55	21		20	
55	25		20	
55	27		40	
55	28		30	
55	32		13	
55	33		10	
55	34		5	
55	52	40		
55	55		50	
55	56		5	
55	57		10	
55	60		21	
55	62	7		
55	64	79		21
55	65	95		5
55	68	24		
55	69	60		
55	70	91		
55	71	100		
55	72	100		
55	73		100	
55	74		50	
55	75		45	
55	76		75	
55	77		45	
55	81	72		28

continued

Note: The identified Western Caribou Habitat in the Quesnel TSA has been treated in two parts. The portion included in the 1989 analysis as a netdown remains a netdown and is included in Table A-6. The additional habitat identified in 1992 is treated as a zone and appears in Table A-2(i). above. Zone 5 includes the remaining portion of the Kluskus Supply Block not already included in the Western Caribou netdown or the Western Caribou zone.

Table A-2(i). Zone definition by inventory region and compartment (per cent inclusion) (concluded)

Region	Compartment	Zone 1 Western caribou	Zone 3 LRUP/visual quality	Zone 5 Kluskus
55	85	80		20
55	86	52		48
55	87	10		90
55	88		3	97
55	89	25	7	68
55	90		10	90
55	91		5	
55	92	56		44
55	93	65		35
56	18		45	
56	19		30	
56	22		25	
56	30		22	
56	32		8	
56	33		56	

Note: The identified Western Caribou Habitat in the Quesnel TSA has been treated in two parts. The portion included in the 1989 analysis as a netdown remains a netdown and is included in Table A-6. The additional habitat identified in 1992 is treated as a zone and appears in Table A-2(i). above. Zone 5 includes the remaining portion of the Kluskus Supply Block not already included in the Western Caribou netdown or the Western Caribou zone.

Table A-2(ii).Quesnel-Barkerville IRMP component of zone 3 (LRUP/visual quality)

Quesnel Barkerville IRMP	
new planning cell	**per cent inclusion**
012E	100
013E	100
014E	100
018E	100
020E	100
021E	100

Table A-2(iii). Upper Blackwater LRUP component of zone 3 (LRUP/visual quality)

Upper Blackwater LRUP component of zone 3	
new planning cell	**per cent inclusion**
001A	100
009A	100
010A	100
011A	100
018A	100
019A	100
022A	100
023A	100
024A	100
041A	100
043A	100
034B	100

Definition of Zone 2: Special Sale Area (SSA) Supply Block

This zone encompasses all remaining inventory types within the SSA supply block (supply block D) after zone 4 and zone 7 have been accounted for. Also, all areas in the TSA with ownership code = 61 (use, recreation and enjoyment of the pubic) are assigned to zone 2.

Definition of Zone 4: Streams and Lakes

The area of stream and lake shore influence to be included in this zone is defined as 30 metres wide either side of all creeks large enough to be mapped on forest cover inventories and 30 metres around the perimeter of all lakes large enough to meet the same criteria. To determine the area associated with this zone, 22 representative 1:20 000 mapsheets were surveyed. Measurements of river/stream length and lake perimeter were measured on the inventory digital files using a Geographic Information System (GIS). The average percentage of the gross TSA land base in stream and lakeshore buffers is 6.35%. This area was identified on the inventory file, and then reductions were applied to the gross area in the same manner as to the whole TSA.

This process results in the definition of an area which is larger than that which special management for streamside or lake shores is occurring on. This is due to the inclusion of all rivers, streams and creeks and all sizes of lakes included in the inventory files. The majority of special management is currently occurring adjacent to class A streams.

Definition of Zone 6: Integrated Resource Management

This zone includes all forest in the sawlog harvesting land base not included in zones 1 to 5.

Definition of Zone 7: Problem Forest Types

This zone is defined as the area excluded (considered unmerchantable) by Section 5.7, "Area Inclusion Factors for Unmerchantable Stands" (pp. 16 to 28) in the *1990 Quesnel TSA AAC Rationale Documentation*, and further refined as described in Section A.1.3, "Definition of the problem forest type analysis unit."

A.1.2 Analysis unit characteristics

Within each forest management zone, the area was divided into analysis units, based on leading tree species and site class (inventory variable SITE), as shown in Table A-3. Separate yield curves (existing and regenerated) were produced for each analysis unit, and are shown in Table A-15.

A.1 Zone and Analysis Unit Definition

Table A-3. Analysis unit characteristics

Zone	Analysis unit	Type groups	Species	Site class
1. Western caribou	1	28-31	pine	G/M/P
	2	18-26	balsam, spruce	G/M/P
2. SSA	3	1-8 (plus all others)	Douglas-fir	G/M/P
	4	28-31	pine	G/M
	5	28-31	pine	P
	6	18-26	balsam, spruce	G/M/P
3. LRUP/visual quality	7	1-8 (plus all others)	Douglas-fir	G/M/P
	8	28-31	pine	G/M
	9	28-31	pine	P
	10	18-26	balsam, spruce	G/M/P
4. Streams and lakeshores	11	1-8 (plus all others)	Douglas-fir	G/M/P
	12	28-31	pine	G/M
	13	28-31	pine	P
	14	18-26	balsam, spruce	G/M/P
5. Kluskus	15	28-31	pine	G/M/P
	16	18-26	balsam, spruce	G/M/P
6. IRM	17	1-8,27,33,34 (plus all others)	Douglas-fir	G/M/P
	18	9-17	cedar, hemlock	G/M/P
	19	18,19,20	balsam	G/M/P
	20	21-26	spruce	G/M
	21	21-26	spruce	P
	22	29	pine/Douglas-fir	G/M/P
	23	28,30-31	pine	G/M
	24	28,30-31	pine	P
7. Problem forest types	25	28-31	pine	all

A.1 Zone and Analysis Unit Definition

A.1.3 Definition of the problem forest type analysis unit

Analysis unit 25 contains all stocking class 4 types within the Problem forest type (PFT) zone, and an approximation of the balance of this zone which is considered to be currently harvestable.

To approximate the volume of timber within the PFT zone which is reasonably available for harvest given current harvesting and milling technology, the performance on PFT cutting permits completed to date was examined (Table A-4(i)). From this information it was determined that the lower limit of average net merchantable piece size has been approximately 0.10 cubic metre per tree. This limit was used to define the types to be included in analysis unit 25. It must be stressed that this lower limit is an approximation based on the initial few years of performance data. It is possible that the lower limit of merchantability may vary from this limit as time progresses and more experience with these types is gained.

Table A-4(i). Summary of problem forest type cutting permit data, Quesnel TSA, 1991-1993

Cutting permit 1992/93	Net m^3	m^3/hectare	Merchantable m^3/tree	DBH (cm)	Merchantable height (m)	Total height (m)	Stems per hectare
13U	17 954	243	0.14	16.9	12.8	17.8	1 711
52U	17 095	247	0.12	16.1	11.9	17.3	2 051
12U	32 089	305	0.17	17.6	14.3	19.2	1 835
51U	15 823	235	0.17	17.6	13.3	18.3	1 360
81U	29 094	229	0.16	17.6	13.5	18.6	1 395
76U	9 690	184	0.18	18.0	14.1	19.2	1 027
77U	5 393	214	0.11	14.8	11.6	17.9	1 975
75U	31 655	184	0.14	16.1	13.6	19.2	1 351
66U	25 363	256	0.13	16.3	13.0	18.3	1 929
002	70 666	301	0.16	16.7	16.8	19.2	1 870
Total 92/93	254 822	239	0.15	16.8	13.3	18.7	1 692
1991 data	113 196	248	0.14	15.8	12.7	(na)	1 859
Total 91/93	368 018	242	0.15	16.5	13.1	18.7	1 744

Notes:
1. Data is compiled to a utilization standard of 10.5 cm dbh, 20.0 cm stump height and 8.9 cm dib top.
2. 1991 data is from: Quesnel TSA Problem forest type, AAC Revision Information Package, October 1991.
3. Cutting permit 002 is compiled to closer utilization, and therefore not included in the m^3/hectare, merchantable m^3/tree and merchantable height averages.

Piece size must be approximated with an inventory attribute. Average diameter was chosen as the variable to be used and was derived from average piece size using the following formula:

whole stem volume = (taper coefficient) x (3.141 x (diameter/2)^2) x height.

A.1 Zone and Analysis Unit Definition

Examination of the cutting permit data indicates that there is a difference of approximately 0.01m^3 between the gross merchantable volume (whole stem) and the net merchantable volume per tree. The above formula was therefore solved for a whole stem volume of 0.11m^3 using several values of taper coefficient and height. The most reasonable solution in comparison to the cutting permit data appears to be 13.3 centimetres diameter, using a taper coefficient of 0.45. Therefore analysis unit 25 includes all lodgepole pine stands in the PFT zone that have an average stand diameter equal to or greater than 13.3 centimetres, in addition to all stocking class 4 stands.

The uncertainty associated with the definition of this limit is addressed with a sensitivity analysis. The minimum diameter criteria is varied by plus and minus 25%, testing cutoff levels of 10 and 17 centimetres average stand diameter at breast height. Table A-4(ii). lists the distribution of PFT areas by age and location within the timber harvesting land base.

Table A-4(ii).Location and age of problem forest type stands in the Quesnel TSA

	Area in hectares		
Location	**0 - 60 years**	**61 - 120 years**	**121+ years**
South Kluskus	4 694	35 816	20 575
Narcosli West	9 134	64 604	16 556
Narcosli East	8 481	58 470	7 629
SSA and East	2 063	7 021	1 194
Total	24 372	165 911	45 954

A.2 Utilization Levels

The utilization level defines the maximum allowable stump height and minimum merchantable diameter by species and is used to calculate merchantable volume.

Lodgepole pine in the Quesnel TSA is currently utilized to a 12.5 cm minimum diameter at breast height, a 10 cm diameter top (inside bark) and a 30 cm stump height in zones 1 through 6, and to a 10.0 cm diameter at breast height, 8.9 cm diameter top and a 20 cm stump height in zone 7. All other species, in all zones, are utilized to a 17.5 cm diameter at breast height, 10 cm diameter top and a 30 cm stump height.

A.3 Definition of the Timber Harvesting Land Base

The following area exclusions were used to define the timber harvesting land base.

A.3.1 Inventory file status

Forest cover polygon information in the Quesnel TSA inventory file is projected to January 1993.

A.3.2 Non-contributing ownership codes

All areas that are not designated as being ownership code 61C or 61N (use, recreation, enjoyment of the public), 62C (Crown forest management unit available for long-term integrated resource management) or 69C (miscellaneous reserves available for long-term integrated resource management) are excluded from the timber harvesting land base.

A.3.3 Non-forested and non-commercial/brush areas

Forest cover type identities 5 (NC/brush) or 6 (non-forest) are excluded from the timber harvesting land base.

A.3.4 Inoperable areas

0.2% of region 56 compartment 30 is removed as inoperable area.

A.3.5 Not satisfactorily restocked areas (NSR)

Areas designated as forest cover type identity 4 and 9 (NSR), and 7 (disturbed, stocking doubtful) are excluded from the timber harvesting land base. NSR areas are assumed to be restocked over time, according to the schedule shown in Section A.4.2, "Not satisfactorily restocked areas."

A.3 Definition of the Timber Harvesting Land Base

A.3.6 Environmentally sensitive areas

Table A-5. Per cent area reductions for environmentally sensitive areas

PSYU	ESA category	Per cent area reduction
Narcosli (SC #137)	Es1	90
	Es2	50*
	Er1	90
	Ep1	90*
	Ep2	50*
Chilko (SC #147)	Es1	90
	Ep1	90
Kluskus (SC #289)	Es1	90
	Ec1	90
	Ep1	90*
	Er1	90
	Er2	50*
Stum (SC #140)	Es1	90
	Es2	50*
	Ep1	90
	Ep2	50*
	Er2	50*
Prince George SSA (SC #251) (Quesnel Portion)	Es1	90
	Es2	50*
	Ep1	90
	Ep2	50*
	Er1	90
	Er2	50*
Cottonwood (SC #122)	Es1	90
	Ep1	90*
	Er1	90
	Er2	50
Quesnel Lake (SC #109)	Es1	90
	Ep1	90
	Ea1	90
	Er1	90
	Er2	50
Big Valley (SC #152)	Es1	90
	Es2	50*
	Ep1	90
	Er1	90
	Er2	70
Bowron (SC #151)	Es1	90
	Ep1	90

Information in the table above is derived from page 9 of the *1989 AAC Rationale* except where noted with (*). No distinction between high and moderate ESA classes was made for some PSYUs in the 1989 analysis. The high ESA classifications were assigned a 90% netdown and the moderate ESA classifications a 50% netdown in those cases where no previous distinction was made.

A.3 Definition of the Timber Harvesting Land Base

No wildlife ESAs are deducted from the timber harvesting land base because they are replaced by specific wildlife agreements regarding mule deer and caribou between the Ministry of Forests and the Ministry of Environment, Lands and Parks.

A.3.7 Netdown of specific, geographically defined areas

Table A-6. lists the percentage of inventory regions/compartments included in areas removed from the timber harvesting land base for specific resource values.

A.3 Definition of the Timber Harvesting Land Base

Table A-6. Reductions for specific geographic areas (per cent reduction)

Region	Compartment	TFL 52 (per cent)	Critical mule deer winter range (per cent of type groups 1-8 only)	Cariboo river WMA (per cent)	Eastern caribou (per cent)	Western caribou (per cent)
48	86					100
55	1		57			
	2		31			
	6		9			
	10		50			
	11		74			
	19		20			
	20		37			
	21		57			
	34		73			
	56		63			
	64					4
	71					55
	72					90
	79					100
	81					30
	93					73
56	5	19				
	6	97				
	7	35				
	8				41	
	9	52			13	
	10	100				
	11	100				
	12	100				
	13	100				
	15	80				
	16	10	65			
	17	30	90			
	18		43			
	19		44			
	20		59			
	21		73			
	22		60			
	30	3		3	37	
	32				25	
	33				31	
59	83	100				
	84	100				
	85	100				
	86	100				
	90	100				
	124	100				
	125	100				
	127	80				

Eastern and Western Caribou

Two areas have been identified as key caribou habitat in past TSA Steering Committee agreements. There is currently a 20 year deferral (until the year 2008) to allow for the study of caribou habitat needs and to design appropriate integrated forest management practices for a large portion of the Western Caribou habitat. There is also an additional area outside of the existing Western Caribou Deferral agreement which has been identified as important caribou habitat by research conducted since 1989. This area has been treated as a zone (as outlined in section A.11). The Eastern Caribou area is defined by a high elevation/habitat line. No specific agreement as to management strategy currently exists for this area. In the 1989 TSA analysis both the Western Caribou Deferral area (66 223 hectares) and the Eastern Caribou Habitat area (32 938 hectares) were treated as a deduction and this situation remains the status quo. The variance between 1989 areas and this report are due to conversion from planning cell to region and compartment identifiers.

Itcha-Ilgachuz Special Features Area

The Itcha-Ilgachuz special features area is a cabinet approved study area arising out of the *Parks and Wilderness for the 90's* process. This study area is located entirely within the Western Caribou netdown area. Therefore, no specific deduction has been applied for the area.

Upper Niagara-Matthew Wilderness Study Area

The Upper Niagara-Matthew wilderness study area (UNMW) is a cabinet approved study area arising out of the *Parks and Wilderness for the 90's* process. No specific deduction has been applied for the UNMW. However, this study area is almost entirely located within the Eastern Caribou area or areas identified as requiring visual resource management.

Cariboo Mountains Log Around

The provincial government established a "log around" strategy for the Cariboo Mountains in March of 1992 which would extend for 20 months. The log around area within the Quesnel TSA covers all of the Upper Niagara-Matthew study area and some additional area to the west. As in the UNMW this area is almost entirely contained within the Eastern Caribou habitat area and the area requiring visual resource management. No specific deduction has been applied for the Cariboo Mountains log around.

Critical Mule Deer Winter Range

Critical mule deer winter range was identified in a TSA Steering Committee agreement prior to the 1989 TSA analysis. This agreement deferred harvest in Douglas-fir leading types within the identified winter ranges until specific management plans could be developed. This situation still represents the status quo. The Douglas-fir leading component has been deducted in the TSR as it was in the 1989 TSA analysis. The total area netted down from Douglas-fir leading types for critical mule deer winter range in the 1989 analysis was 12 724 hectares. As with the caribou netdowns, the conversion from planning cells to region and compartment may have resulted in some changes.

Cariboo River Wildlife Management Area

The Cariboo River wildlife management area is managed by the Ministry of Environment, Lands and Parks for wildlife purposes and excludes commercial timber harvest.

Alexander Mackenzie Heritage Trail

The Alexander Mackenzie Heritage Trail (Grease Trail) management plan excludes commercial timber harvest from the majority of the 200 metre wide trail corridor within the Quesnel TSA.

Table A-7. Netdown of Alexander Mackenzie Heritage Trail (AMHT) within Upper Blackwater LRUP

New planning cell	Per cent netdown
001A	3.0
009A	4.4
010A	4.8
011A	2.9
018A	10.2
019A	2.0
024A	5.7

Note: The Upper Blackwater LRUP is a component of zone 3: LRUP / Visual Quality. The deduction comes out of this zone.

Table A-8. Netdown of Alexander Mackenzie Heritage Trail (AMHT) within Lower Blackwater LRUP

Region	Compartment	Per cent netdown
55	55	1.7
	75	2.1
	76	1.6

Note: The Lower Blackwater LRUP is a component of zone 3: LRUP / Visual Quality. The deduction comes out of this zone.

Dragon Settlement Corridor

The Dragon Settlement corridor is excluded from the provincial forest.

Table A-9. Netdown of Settlement Corridor

New planning cell	Per cent netdown
006D	100
009D	100
013D	100
015D	100
017D	100
020D	100
023D	100
029D	100
030D	100
033D	100
035D	100
051D	100
058D	100

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Unmerchantable forest types

The definition of unmerchantable forest types is based on Section 5.7 Area Inclusion Factors (AIFs) for Unmerchantable Stands (pp 16-28) in the *1990 Quesnel TSA AAC Rationale Documentation.* The objective in this analysis was to use the same sawlog merchantability definitions as were used in the 1989 analysis of the Quesnel TSA. However, it was necessary to make some adjustments to the AIF table:

- re-inventory and inventory projection have created age/height/stocking combinations that do not appear in the 1990 AIF table. These types were assigned AIFs based on the AIFs of similar types in adjacent supply blocks.
- an AIF = 0.0 was assigned to all leading deciduous types in supply block D. Deciduous types are excluded from the timber harvesting land base.

Two other potential adjustments were considered but not made:

- the AIF table includes a blanket 10% reduction in supply block D for a Deferred Planning Area Allowance. This reduction was maintained in this analysis, increasing the size of the reduction of sawlog types by 9000 hectares. Much of this area has been returned to the timber harvesting land base as problem forest types.
- some age/height/stocking combinations occur in both the mature and immature sections of the AIF table. With no instructions to the contrary, both sections of the table are applied to the inventory. Thus some types, for example pine-spruce, age classes 4 and 5, are assigned two merchantability reduction factors sequentially. This procedure was also followed in the 1989 analysis, and reduces the sawlog land base by approximately 35 000 hectares as compared to the land base if the immature AIFs were applied only to types that had not already been reduced. However, most of the area reduced from the sawlog land base is rolled back into the PFT land base and is included in the analysis.

  Many of the lodgepole pine stands determined to be non-merchantable using the 1990 AIFs are actually merchantable with current management, and have been included in zone 7 of the timber harvesting land base (refer to Section A.1.3, "Definition of the problem forest type analysis unit.")

A.3.9 Existing roads

Past timber harvesting operations have resulted in a loss of productive forest land. However, most of the existing roads are not accounted for in the inventory file. To account for this loss in the area available for timber harvesting a 2.5% reduction was applied to all areas. This value represents a TSA average and is based on a study completed for the 100 Mile House TSA in January 1987. This estimate is consistent with the Cariboo Forest Region road and bridge inventory of 1992.

A.3.10 Future roads

The Quesnel TSA is presently 75% accessed. Assuming that access of the remaining 25% will entail construction of roads of similar sizes and densities to those presently in place, an allowance for future roads of 0.83% (= 2.5% X 25/75) is made in the analysis. Future road areas contribute once to the harvest, and are assumed to be non-productive thereafter.

A.4 Forest Management Assumptions

A.4.1 Forest cover requirements

Table A-10. specifies the forest cover requirements used to model current forest management objectives defined for each forest management zone. Each forest management zone was defined in Section A.1, "Zone and Analysis Unit Definition," Table A-1.

Table A-10. Forest cover requirements for each forest management zone

Zone	Age 1 (years)*	Maximum per cent area younger than age 1	Age 2 (years)	Minimum per cent area older than age 2
1. Western caribou	20	25	120	25
2. SSA	14	25	150	10
3. LRUP/visual	17	15	150	15
4. Streams/lakeshores	16	25	150	20
5. Kluskus	19	25	120	15
6. IRM	17	33	150	10
7. PFT	17	33	120	10

*All zones: the zonal average for the number of years to reach 3-metre top height.

Note: The age 2 values used are derived from *An Old Growth Strategy for British Columbia*, May 1992. The age 2 cover requirement percentages used in zones 1, 3, 4 and 5 are higher than those used in the other zones in recognition of the fact that temporary reservation of mature timber is a more significant component of the management strategy in these zones.

Zone 1: Western Caribou

The area was identified as important caribou habitat by a joint habitat research project (1992). This area is in addition to the current Western Caribou deferral. There is a 1993 TSA Steering Committee short-term management agreement in place for a portion of this zone in the vicinity of Toil Mountain. There is also a 1989 TSA steering committee agreement in place for "4-pass" harvesting to accommodate other wildlife habitat concerns in the area between the Coglistiko and Kushya Rivers. The age 1 cover requirement is based on a continuation of this 4-pass agreement. The age 2 cover requirement is based on caribou habitat needs which include suitable areas of terrestrial lichen as a food source and adequate habitat size.

Zone 2: Special Sale Area (SSA) Supply Block

This zone encompasses all areas within the SSA supply block (supply block D). It includes many areas that are predominantly Douglas-fir leading types. The proximity to Quesnel, location of rural residents and current recreational use of this zone dictate specific forest management practices. Recreational uses in this area focus on the high level of access, the distribution of small lakes, the hunting opportunities, and the Douglas-fir forest type in general. Current management in the area is increasingly emphasizing partial cutting harvest techniques such as shelterwood and seed tree systems. The age 1 cover requirement reflects a 4-pass harvest pattern to accommodate these concerns. The use of partial cutting systems in this zone is expected to reduce the visual impact of harvesting and retain some cover on harvested areas at all times. The age 2 cover requirement is intended to account for management of non-timber values which require reservation of mature timber.

Zone 3: LRUP/Visual Quality

This zone encompasses areas that receive special management, especially for visual quality and recreation. The zone includes the Upper and Lower Blackwater LRUP, Cariboo River wildlife management area buffer zone B, the Quesnel-Barkerville IRMP and other areas requiring visual resource management in the Quesnel Forest District as determined from existing inventories. The age 1 forest cover requirement is based on management for an average partial retention visual quality objective over the entire zone. The age 2 cover requirement is intended to account for management of non-timber features which require reservation of mature timber. This zone typically includes numerous areas where significant non-timber values exist.

Zone 4: Streams and Lakeshores

Based on the review of the district 1993-98 consolidated development plan and discussions with Quesnel Forest District Timber and Recreation staff, it was determined that management practices immediately adjacent to class A streams and larger lakes were sufficiently different to warrant treatment as a separate zone. This zone is intended to encompass areas that receive special management because of their importance to water quality, wildlife and fish habitat, and recreational values. The process used to define the zone results in an area which is considerably larger than the area on which special management for streamside or lake shores is expected to occur. This is due to the inclusion of all rivers, streams and creeks, and all sizes of lakes in the inventory files.

The age 1 cover requirement is currently set to reflect a 4-pass harvest pattern which is representative of management on all of the area included in the zone. Forest cover requirements will vary across the areas included in this zone, depending on fisheries and water quality/quantity management concerns. The age 2 cover requirement is intended to account for the reservation of mature timber to accommodate management of the numerous non-timber values which occur in these areas.

Zone 5: Kluskus

The Kluskus zone encompasses the portions of the Kluskus supply block not already covered by other zones or deductions. The area is currently undeveloped, and management in this zone is expected to be significantly influenced by traditional first nations use of the area and other non-timber values. The age 1 cover requirement reflects a 4-pass harvest pattern. The age 2 cover requirement is intended to account for management of non-timber features which require reservation of mature timber.

Zone 6: Integrated Resource Management

A normal harvesting zone (3-pass system) is reflected in the age 1 cover requirement. This zone consists of all areas outside of special management zones otherwise identified. The age 2 cover requirement is intended to account for management of non-timber features which require reservation of mature timber.

Zone 7: Problem Forest Types

A normal harvesting zone with a 3-pass system, as reflected in the age 1 cover requirement. The age 2 cover requirement is intended to account for management of non-timber features which require reservation of mature timber.

A.4 Forest Management Assumptions

A.4.2 Not satisfactorily restocked areas

The area that has been harvested and is currently not satisfactorily restocked (NSR) is listed below. All NSR is assumed to be restocked in the first 10-year period in the model. This information was taken from History Record Reports dated 93/12/10 and MLSIS reports dated 93/12/17 and 93/10. The NSR total consists of 24 011 hectares backlog and 45 816 hectares current. All NSR has been distributed back to zone 6 on a proportionate basis by analysis unit.

Table A-11. Restocking of NSR areas

Analysis unit	NSR area restocked (hectares)
17	1 396
18	26
19	1 468
20	7 770
21	2 167
22	1 557
23	35 451
24	19 992
Total	69 827

A.4 Forest Management Assumptions

A.4.3 Unsalvaged losses

Timber that is killed by insects, fire or disease, and not harvested is referred to as unsalvaged losses. Estimated annual losses are deducted from the gross harvested volume in the model to determine the net volume of timber that will be harvested over time. Table A-12. shows the estimated average annual unsalvaged losses in the Quesnel TSA.

Table A-12. Unsalvaged losses

Cause of loss	Gross losses in cubic metres per year	Salvaged volume in cubic metres per year	Annual unsalvaged loss in cubic metres per year
Insects			15 000
Fire	9 306	7 445	1 861
Wind damage			7 800
Total			24 661

Insect loss estimates are from Quesnel Forest District staff. Fire loss estimates are from the Forest District Protection Program. Wind damage estimates are from the 1989 analysis. Unsalvaged losses have been rounded to 24 500 cubic metres per year in the analysis.

A.4.4 Minimum harvestable age for each analysis unit

Table A-13. lists the minimum harvestable age for each analysis unit. Minimum harvestable ages are based on the Quesnel Forest District priority cutting ages of 80 years for lodgepole pine and 120 years for other species. Culmination ages for existing stands are greater than minimum harvestable ages, for all analysis units except analysis unit 18.

A.4 Forest Management Assumptions

A.4.5 Minimum harvestable age for each analysis unit

Table A-13. lists the minimum harvestable age for each analysis unit. Minimum harvestable ages are based on the Quesnel Forest District priority cutting ages of 80 years for lodgepole pine and 120 years for other species. Culmination ages for existing stands are greater than minimum harvestable ages, for all analysis units except analysis unit 18.

Table A-13. Minimum harvestable age by species and site type

Analysis unit	Minimum harvestable age, existing stands (years)	Minimum harvestable age, regenerated stands (years)
1	80	80
2	120	120
3	120	120
4	80	80
5	80	80
6	120	120
7	120	120
8	80	80
9	80	80
10	120	120
11	120	120
12	80	80
13	80	80
14	120	120
15	80	80
16	120	120
17	120	100*
18	120	100*
19	120	110*
20	120	100*
21	120	100*
22	80	100*
23	80	80
24	80	80
25	80	80

*Weighted average minimum harvestable ages based on species conversion after first harvest.

A.4 Forest Management Assumptions

A.4.6 Basic silviculture and regeneration assumptions

Basic silviculture is assumed to be continued indefinitely into the future. Table A-14. lists the silviculture and regeneration assumptions used in this analysis.

Table A-14. Regeneration assumptions

Zone	Existing analysis unit	Regenerated analysis unit(s)	Per cent natural	Per cent planted	Target stocking (stems/ hectare)	Regeneration delay (years)
1	1	1	0	100	1200	7[a]
	2	2	0	100	1200	7[a]
2	3	3	75	25	1200	6
	4	4	40	60	1200	5
	5	5	60	40	1200	5
	6	6	0	100	1200	4
3	7	7	0	100	1200	4
	8	8	40	60	1200	5
	9	9	60	40	1200	5
	10	10	0	100	1200	4
4	11	11	0	100	1200	4
	12	12	40	60	1200	5
	13	13	60	40	1200	5
	14	14	0	100	1200	4
5	15	15	0	100	1200	7[a]
	16	16	0	100	1200	7[a]
6 (IRM)	17 F,Pw, LF,L(all)	17(20) 23(30) 22(30) 20(20)	0	100	1200	4
	18 C,H(all)	23(60) 20(40)	0	100	1200	4
	19 B(all)	19(40) 21(40) 24(20)	0	100	1200	7
	20 S(G/M)	23(60) 20(40)	0	100	1200	4
	21 S(P)	21(40) 24(60)	0	100	1200	4
	22 PlF	22(30) 20(20) 17(20)	50	50	1200	6
	23 Pl(G/M)	23	40	60	1200	5
	24 Pl(P)	24	60	40	1200	5
7 (PFT)	25 (PFT)	24(65)[b] 23(35)	60	40	1200	5

(a) Zone 1, analysis units 1 and 2 and zone 5, analysis units 15 and 16 are largely within the Montane Spruce very dry, very cold subzone which results in a long regeneration delay.

(b) PFT stands will be regenerated back to sawlog stands.

A.4 Forest Management Assumptions

A.4.7 Yield assumptions

Yield tables for all existing stands were developed using a batch processing of the Variable Density Yield Projection (VDYP) model provided by the B.C. Forest Service, Inventory Branch. All yield tables assume the utilization levels identified in Section A.2. All yield tables exclude any deciduous volumes in the forest stand. The data requirements for the VDYP model are from existing stand information on the 1993 inventory file provided by Inventory Branch. For all existing stands, aggregated waste and breakage (W2B) factors are developed from the Inventory Metric Diameter Class Decay, Waste and Breakage Factors Manual (B.C. Ministry of Forests 1976). A single W2B factor is developed for each of two age ranges for each Public Sustained Yield Unit (PSYU), species, and utilization level.

The closer utilization standards in problem forest type stands mean that the volume recovered from such stands is greater than is estimated with the VDYP model calibrated to interior close utilization standards. The B.C. Forest Service, Research Branch, used the Tree and Stand Simulator (TASS) to inspect the impact of the closer utilization on volumes recovered. Based on their study, 19 cubic metres per hectare have been added to the volumes predicted by VDYP for problem forest types.

Yield tables for all regenerated stands were produced using the Table Interpolation Program for Stand Yields (TIPSY) growth and yield model developed by the B.C. Forest Service, Research Branch. Regenerated stand yield tables are based on the assumptions listed in Table A-14. Mean area weighted site indices of the existing stands are assumed to apply to the regenerated stands. TIPSY reports potential yields for a specific site, species and management regime. Operationally these yields will be reduced if irregular stocking, disease, etc. reduce productivity. Operational adjustment factors (OAFs) alter the magnitude (OAF1) and shape (OAF2) of the base TIPSY yield curves. OAF1 reflects reduced productivity due to unproductive areas (e.g. swamps, rock outcrops) while OAF2 reflects losses towards maturity (e.g. diseases). For all regenerated stands waste and breakage factors are assumed to be included in the operational adjustment factor 2 used in the TIPSY model inputs. The specific operational adjustment factors used are:

Operational adjustment factor 1 : 15%

Operational adjustment factor 2 : 5%.

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. shows the existing and regenerated stand yield tables for all species and site types in the analysis. The appropriate regeneration delays, as discussed in Section A.4.6, "Basic silviculture and regeneration assumptions," are applied within the timber supply model and are not accounted for in these yield tables.

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types

Zone name:	Western caribou				Special sale area			
Zone:	1	1	1	1	2	2	2	2
Analysis unit:	Pine G/MP		Balsam/Spruce		Douglas-fir		Pine G/M	
Age	existing	regen	existing	regen	existing	regen	existing	regen
0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
20	0	0	0	0	1	0	13	0
30	3	0	0	0	14	0	57	22
40	15	3	1	0	38	0	101	74
50	33	20	3	0	64	15	139	126
60	52	41	7	0	90	47	173	171
70	73	64	16	0	115	87	204	220
80	95	90	30	2	139	128	232	256
90	116	110	46	16	161	163	257	287
100	135	126	66	41	183	194	281	312
110	154	141	87	70	202	226	303	335
120	172	154	110	101	220	255	324	352
130	185	166	131	134	234	280	338	368
140	196	181	151	164	247	302	348	381
150	204	194	169	191	259	325	356	392
160	210	206	186	217	269	345	361	401
170	213	216	201	241	278	363	362	410
180	214	224	215	268	285	380	361	417
190	217	231	228	295	294	395	364	423
200	220	237	240	317	301	407	366	428
210	223	243	252	335	309	418	369	432
220	226	248	263	352	316	429	372	436
230	229	252	274	365	322	438	374	439
240	232	256	284	376	328	446	377	442
250	234	259	293	386	329	455	379	442
260	236	263	301	395	329	462	381	442
270	238	265	309	402	329	469	383	442
280	240	268	317	409	329	475	384	442
290	241	270	324	415	329	481	386	442
300	243	272	331	420	329	485	387	442
310	244	272	337	420	329	485	388	442
320	245	272	343	420	329	485	389	442
330	245	272	348	420	329	485	390	442
340	246	272	353	420	329	485	391	442
350	253	272	351	420	325	485	389	442

continued

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types

Zone name:	LRUP/Visual Quality									
Zone	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Analysis unit:	**Pine P**		**Balsam/spruce**		**Douglas-fir**		**Pine G/M**		**Pine P**	
Age	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	8	0	0	0
30	14	1	7	0	12	0	43	14	14	1
40	42	17	32	2	39	0	82	54	39	17
50	72	42	69	48	68	12	118	104	65	43
60	99	77	108	118	97	41	150	144	89	78
70	124	107	144	188	125	79	179	183	112	107
80	147	132	176	250	151	121	206	222	134	132
90	169	153	206	315	175	155	231	251	154	153
100	189	178	233	365	197	185	254	276	173	179
110	208	200	257	401	217	212	275	297	191	201
120	226	218	279	429	236	240	295	316	208	218
130	238	233	297	451	252	266	309	332	220	233
140	248	246	313	469	267	288	319	344	229	246
150	256	257	326	484	280	307	327	356	236	258
160	261	268	338	495	291	327	331	366	241	269
170	264	277	348	503	301	345	333	374	243	278
180	264	285	356	510	310	362	332	381	242	285
190	266	292	364	511	320	376	334	387	244	292
200	269	298	372	510	329	389	337	392	247	298
210	272	303	379	509	338	401	339	397	249	303
220	275	308	385	508	347	412	342	401	251	308
230	277	312	391	505	355	420	344	404	254	313
240	280	316	397	502	362	428	347	407	256	316
250	282	319	400	499	363	436	349	410	258	319
260	283	321	404	495	364	442	351	412	259	322
270	285	323	407	492	364	448	353	413	261	324
280	286	325	409	489	365	454	354	414	262	326
290	288	327	412	486	365	460	356	415	264	328
300	289	329	414	483	365	465	357	416	265	329
310	290	329	416	483	365	465	358	416	266	329
320	290	329	418	483	366	465	359	416	267	329
330	291	329	420	483	366	465	360	416	267	329
340	292	329	421	483	366	465	361	416	268	329
350	284	329	423	483	363	465	354	416	251	329

continued

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types

Zone name:	Streams and lakeshores									
Zone:	3	3	4	4	4	4	4	4	4	4
Analysis unit:	balsam/spruce		Douglas-fir		pine G/M		pine P		balsam/spruce	
Age	existing	regen	existing	regen	existing	regen	existing	regen	existing	regen
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	1	0	9	0	0	0	0	0
30	2	0	14	0	45	13	9	0	3	0
40	12	0	37	1	85	53	32	8	16	0
50	34	0	64	14	123	103	58	28	39	1
60	62	4	90	47	156	143	83	53	67	27
70	91	27	116	87	186	182	107	82	96	74
80	119	65	140	130	214	221	130	106	124	127
90	145	114	163	164	239	250	152	126	150	178
100	169	160	184	195	263	275	173	144	175	223
110	191	201	203	224	285	296	193	161	198	265
120	212	242	221	253	306	315	212	180	219	312
130	231	280	236	278	320	330	225	197	239	346
140	247	313	250	300	331	343	235	210	256	375
150	262	341	261	322	339	354	243	222	271	396
160	275	364	271	342	344	364	248	232	285	415
170	287	384	280	361	345	373	250	240	297	429
180	297	401	289	377	344	380	250	248	308	441
190	307	415	297	392	347	385	253	256	318	452
200	316	427	305	405	349	391	256	262	328	461
210	325	437	313	417	352	395	258	267	337	469
220	333	445	320	427	355	399	261	272	345	475
230	340	453	327	436	357	403	264	277	353	479
240	347	460	333	444	360	406	266	281	360	483
250	351	466	334	451	362	408	268	284	365	486
260	355	472	334	458	364	410	270	286	369	489
270	359	476	334	465	366	412	272	289	373	487
280	363	477	334	471	367	413	273	292	377	486
290	366	477	334	477	369	414	275	294	380	484
300	369	478	335	482	370	414	276	296	383	482
310	371	478	335	482	372	414	277	296	386	482
320	373	478	334	482	373	414	278	296	389	482
330	376	478	334	482	374	414	279	296	391	482
340	378	478	334	482	374	414	279	296	393	482
350	376	478	331	482	372	414	265	296	392	482

continued

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types

Zone name:	Kluskus				Integrated Resource Management					
Zone:	5	5	5	5	6	6	6	6	6	6
Analysis unit	pine G/M/P		balsam/spruce		Douglas-fir		cedar/hemlock		balsam	
Age	existing	regen	existing	regen	existing	regen	existing	regen	existing	regen
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	1	0	0	0	1	0
30	5	0	0	0	13	9	9	8	9	0
40	19	4	2	0	34	35	45	31	23	2
50	38	26	9	0	59	69	82	65	44	6
60	57	49	21	0	85	108	116	105	70	15
70	79	76	37	1	110	152	147	151	93	34
80	101	102	55	17	133	194	167	198	115	63
90	122	121	76	46	155	229	180	235	135	98
100	142	138	99	81	176	260	189	270	153	134
110	161	154	122	117	195	288	194	303	171	168
120	180	167	144	154	212	313	210	329	188	201
130	193	184	165	185	227	333	226	351	204	233
140	203	199	184	215	240	350	241	368	219	262
150	212	212	201	243	251	364	256	382	234	286
160	217	223	217	274	261	377	269	394	247	309
170	221	232	231	304	269	388	282	404	260	330
180	222	240	243	328	277	398	294	413	273	348
190	225	246	255	348	285	406	306	420	284	362
200	228	252	267	365	293	414	318	427	296	373
210	231	258	278	378	301	420	331	431	307	384
220	234	263	288	390	308	425	344	435	317	393
230	237	267	297	401	314	430	357	439	328	401
240	240	271	306	409	320	433	370	441	337	408
250	242	274	314	417	321	435	372	441	340	413
260	244	277	322	424	321	438	374	442	342	417
270	246	280	329	430	322	440	376	442	344	421
280	248	282	336	435	322	441	377	442	345	425
290	249	284	342	440	322	442	379	442	347	428
300	251	286	348	444	322	443	380	441	349	430
310	252	286	353	444	322	443	381	441	350	430
320	253	286	358	444	322	443	383	441	352	430
330	254	286	363	444	322	443	384	441	353	430
340	254	286	367	444	322	443	385	441	355	430
350	269	286	367	444	320	443	385	441	339	430

continued

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types

Zone name:										
Zone:	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
Analysis unit:	**spruce G/M**		**spruce P**		**pine/Douglas-fir**		**pine G/M**		**pine P**	
Age	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**	**existing**	**regen**
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	14	0	8	0	0	0
30	3	8	0	0	50	11	45	13	11	0
40	19	31	2	6	88	38	86	52	36	10
50	48	65	7	19	122	73	124	102	65	32
60	82	105	15	36	151	112	157	142	93	59
70	116	151	29	54	178	158	188	180	119	89
80	149	198	46	75	202	201	216	219	143	113
90	180	235	65	99	224	235	242	248	166	133
100	207	270	86	124	243	266	266	273	187	151
110	231	303	107	151	262	295	288	294	208	172
120	254	329	127	177	279	320	310	312	227	191
130	274	351	146	199	291	340	324	328	240	207
140	292	368	164	219	301	357	335	341	251	220
150	307	382	180	237	308	371	343	352	259	231
160	321	394	194	255	314	384	348	362	264	241
170	333	404	207	273	317	395	349	371	266	250
180	343	413	219	287	318	405	348	378	266	258
190	353	420	230	299	321	413	350	383	268	265
200	363	427	241	309	324	421	353	389	271	271
210	371	431	251	318	328	427	356	393	273	277
220	379	435	261	326	331	432	358	397	276	282
230	386	439	269	332	334	436	361	401	279	286
240	392	441	277	338	337	440	363	404	281	290
250	397	441	284	343	338	442	366	406	283	293
260	401	442	290	348	340	444	368	408	285	296
270	405	442	296	352	341	446	370	410	287	299
280	408	442	302	355	342	447	371	411	288	301
290	411	442	307	358	343	449	373	412	290	303
300	414	441	311	361	344	449	374	412	291	304
310	417	441	316	361	345	449	375	412	292	304
320	419	441	320	361	346	449	377	412	293	304
330	421	441	324	361	347	449	377	412	293	304
340	423	441	327	361	347	449	378	412	294	304
350	422	441	327	361	345	449	376	412	273	304

continued

A.5 Yield Tables for Existing and Regenerated Stands

Table A-15. Yield tables for all species/site types (concluded)

Zone name:	**Problem forest types**	
Zone:	**7**	**7**
Analysis unit:	**pine**	
Age	**existing**	**regen**
0	0	0
10	0	0
20	1	0
30	9	5
40	28	25
50	53	56
60	77	88
70	99	121
80	120	150
90	140	173
100	159	194
110	177	215
120	194	233
130	206	249
140	215	262
150	222	273
160	227	283
170	229	292
180	229	300
190	232	307
200	234	312
210	237	318
220	239	322
230	241	326
240	243	330
250	245	333
260	247	335
270	249	338
280	250	340
290	251	341
300	252	342
310	253	342
320	254	342
330	255	342
340	255	342
350	292	342