Dawson Creek TSA
Timber Supply Analysis

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Preface

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

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

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

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province to be completed by the end of 1994. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called *sensitivity analysis*. Together, the sensitivity analyses and the assessment of the effects of current forest management on timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

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

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Dawson Creek Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood 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**. The total area of the Dawson Creek TSA is approximately 2 278 000 hectares. About 740 000 hectares of the area are considered available for timber harvesting under current management practices of which 529 000 hectares is composed of coniferous forest and 216 000 hectares is covered by deciduous forest. The estimated volume of timber that is currently old enough to harvest is about 87 million cubic metres in coniferous stands and about 22 million cubic metres in deciduous stands. Spruce and pine are the dominant coniferous tree species and aspen is the main deciduous tree species.

The Dawson Creek TSA has separate AAC levels for coniferous and deciduous stands. The AAC from coniferous stands (excluding designated woodlot areas) is currently 841 323 cubic metres per year. The current AAC from deciduous stands (again excluding designated woodlot areas) is 985 000 cubic metres per year.

The results of this analysis indicate that the coniferous timber supply in the Dawson Creek TSA is capable of supporting a non-declining harvest level that is 12% higher than the current AAC of 841 323 cubic metres per year. However, this analysis also indicates that the current AAC from deciduous stands cannot be supported, and that the rate of harvest from these stands must be reduced if we are to avoid severe drops below the long-term harvest level of deciduous timber supply.

The projected increase in the coniferous timber supply is due primarily to the inclusion of small pine types that have not been previously considered harvestable. Over the long term, these small pine types contribute about 16% of the total coniferous harvest. Another important factor contributing to the increase in the coniferous timber supply is increased timber volume for regenerated stands. In general, regenerated stands are assumed to produce more timber than the existing stands that they are replacing.

The results of sensitivity analysis indicate that the coniferous base harvest forecast shows almost no sensitivity to changes in forest management assumptions, especially in the short term. As a result of the even-flow harvest policy, the large inventory of older existing coniferous stands would be harvested relatively slowly over the next 150 to 200 years. Maintaining this large inventory over the short term provides a great deal of flexibility for dealing with changes in forest management assumptions. As a result, changes to forest management assumptions that reduce the maximum possible rate of harvest have no effect on the harvest forecast because the even-flow harvest level is already well below the maximum harvest rate.

The immediate and severe decline in the deciduous timber supply occurs in part because the deciduous timber harvesting land base is smaller than indicated in previous deciduous timber supply estimates. However, the most significant factor affecting the deciduous timber supply is that the estimated yield of timber from deciduous stands is now far less than previously estimated.

The deciduous timber supply is severely affected in both the short- and long-term by uncertainty in either the area of the deciduous land base or stand volume estimates.

Table of Contents

Table of Contents

Tables

Figures

Table of Contents

Introduction

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

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

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

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

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

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

**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 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 throughout 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.

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 Dawson Creek 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 Dawson Creek Timber Supply Area

The Dawson Creek Timber Supply area is one of six timber supply areas in the Prince George Forest Region. The timber supply area is located in the north-east portion of the province, stretching from the Peace River in the north to the Kakwa Recreation Area to the south, and extending from the Alberta border in the east to the Continental divide along the Rocky Mountains to the west. The timber supply area covers approximately 2 280 000 hectares and it is administered by the Dawson Creek Forest District office in Dawson Creek.

The major population centres in the Dawson Creek Timber Supply Area are Dawson Creek, Hudson's Hope, Chetwynd and Tumbler Ridge. Local industries are primarily resource based and include forestry, farming, petroleum exploration and mining.

Timber processing facilities in the Dawson Creek Timber Supply Area include two sawmills in Chetwynd, a waferboard plant in Dawson Creek, and a pulp mill at East Pine (east of Chetwynd). Most of the timber produced in the TSA is processed locally.

Forests of the Dawson Creek Timber Supply Area are dominated by spruce, lodgepole pine, and trembling aspen, with balsam and cottonwood as minor species. Topography varies from mountainous in the west, flat and gently rolling the north and east, to rugged and mountainous in the south.

Figure 1. Map of the Dawson Creek 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 1994. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

Initially, this file is a representation of the land base for the entire TSA. It includes data for areas on which timber harvesting operations are not expected to take place, and therefore do not contribute to the timber supply of the area. Examples include land that has been set aside for a park, or areas occupied by power lines, highways or town sites (such non-contributing areas specific to the Dawson Creek 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 also provides suitable habitat for wildlife).

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 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.

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.

2 Information Preparation

Areas on which timber harvesting is not expected to occur, under current forest management in the Dawson Creek TSA, are:

- areas not managed directly by the B.C. Forest Service — these include non-Crown land, areas managed by other agencies (for example, parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licences or TFLs);
- non-forest areas — areas not capable of growing productive forest (for example rock, swamp and alpine areas);
- non-commercial cover areas — areas occupied by non-commercial brush species;
- inoperable areas — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (for example presence of gullies or exposed rock), difficulty of road access, soil stability, elevation, timber volume and quality, and harvesting systems required;
- areas with sensitive soils that are susceptible to damage by timber harvesting activities;
- areas with important wildlife values — areas identified on the forest inventory as having important wildlife values are excluded from the timber harvesting land base. An additional 1% of the remaining area is excluded to account for the protection of riparian areas;
- non-merchantable forest types* — areas occupied by timber stands of low volume or non-merchantable species, or with low timber-growing potential;
- areas with important recreational or aesthetic values;
- existing roads, trails, landings and right of ways — forest land lost to future timber production due to past access development primarily for the timber harvesting, mineral, and petroleum industries;
- future roads, trails, and landings — to account for future losses of productive land to development. These areas are initially included in the harvesting land base, and are removed as part of the first harvest.

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

Operability
A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

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 summarizes the areas excluded from the total area of the Dawson Creek TSA, and shows the area of the timber harvesting land base.

Table 1. Timber harvesting land base for the Dawson Creek TSA.

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	**2 277 753**	**100.0**	
Not managed by B.C. Forest Service	408 776	17.9	
Non-forest	390 137	17.1	
Total productive forest managed by Forest Service (Crown forest)	1 478 839	64.9	100
Reductions to Crown forest:			
Non-commercial cover (brush)	-63 240	2.8	4.3
Inoperable	-213 736	9.4	14.5
Inoperable areas not identified on inventory file	-24 037	1.1	1.6
Not satisfactorily restocked*[a]	-54 999	2.4	3.7
Sensitive soils	-16 763	0.7	1.1
Important wildlife values	-8 428	0.4	0.6
Wildlife/riparian areas not identified on inventory file	-10 976	0.5	0.7
Non-merchantable forest types	-316 620	13.9	21.4
Mature overstocked pine stands	-15 587	0.7	1.1
High recreation value	-9 443	0.4	0.6
Preservation visual quality objective	-1 987	0.1	0.1
Existing roads, trails, landings and right of ways	-19 442	0.9	1.3
Total current reductions	- 755 259	33.2	51.1
Initial timber harvesting land base	723 581	31.8	48.9
Additions:			
Not satisfactorily restocked	+ 35 028	1.5	2.4
Total current timber harvesting land base	758 609	33.3	51.3
Future reductions:			
Future roads	19 987	0.9	1.4
Long-term timber harvesting land base	738 622	32.4	49.9

(a) NSR includes: current NSR; backlog NSR; NSR due to natural disturbances

Not satisfactorily restocked
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

The breakdown of the productive Crown forest is shown graphically in Figure 2. The two most significant area reductions used to define the timber harvesting land base are for inoperable areas and unmerchantable forest types.

Figure 3 shows a breakdown of the timber harvesting land base by tree species, quality of growing site and maturity. This figure indicates that the coniferous forests in the Dawson Creek TSA are comprised mainly of spruce and pine forests on medium and poor quality growing sites. The deciduous forests are comprised mainly of aspen, also on medium and poor quality growing sites.

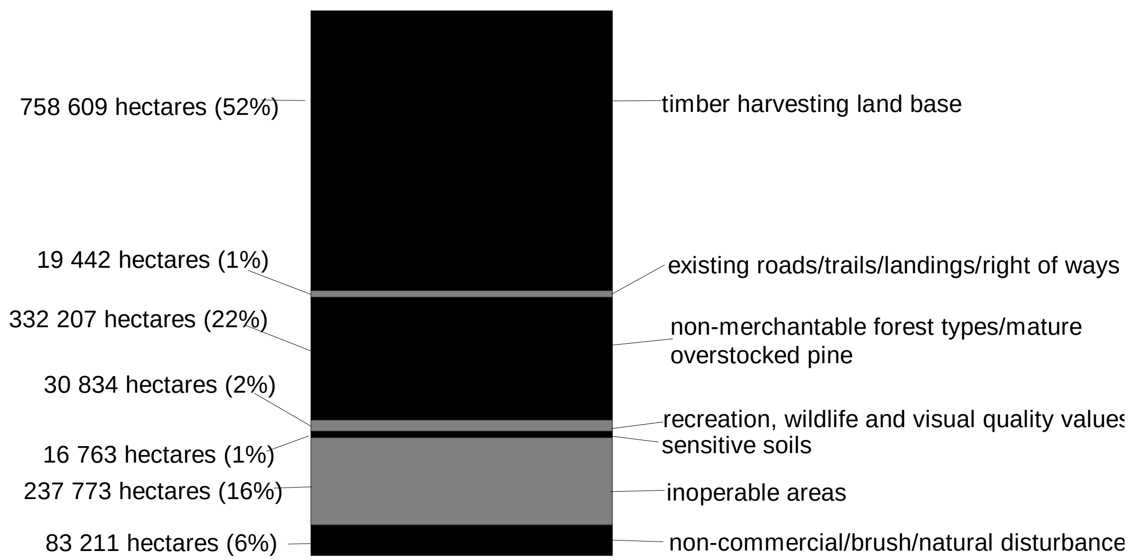

Figure 2. Breakdown of the productive Crown forest, Dawson Creek TSA.

In Figure 3, "old" refers to all stands older than 80 years for deciduous stands and stands dominated by pine. For all other species the "Old" label refers to stands older than 100 years. The designations "g", "m" and "p" in Figure 3 (e.g. spruce g) refer to good, medium and poor sites respectively. Note that a large proportion of the older forest, in which most timber harvesting is expected to occur over the short term is in spruce and balsam starting on poor growing sites.

Mature pine stands less than 19.5 metres tall (height class 2) are considered to be marginal for timber harvesting because they will just yield a log of merchantable length. These stands have been separated from other pine stands in the analysis so that the contribution of these marginal stands to the overall harvest level can be tracked over time in the timber supply model.

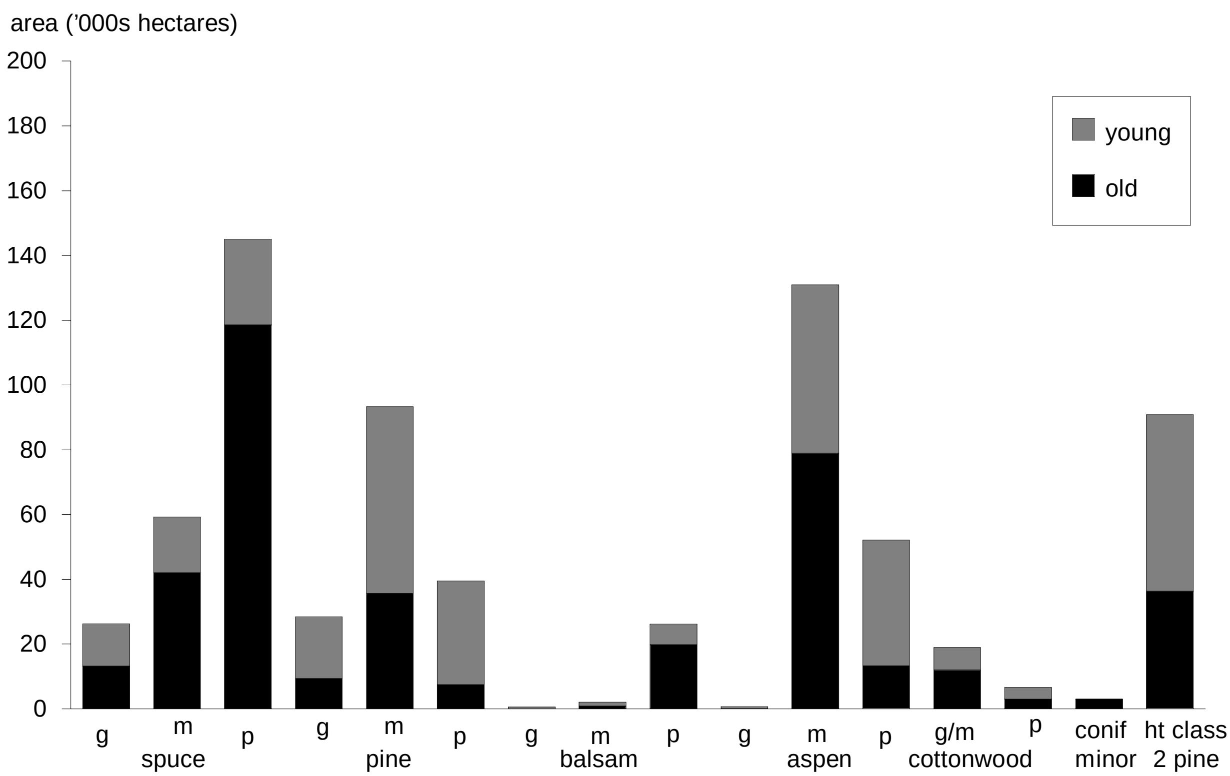

Figure 3. Area by dominant tree species, quality of growing site and maturity, timber harvesting land base, Dawson Creek TSA.

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 must be harvested and removed from a site. See Appendix A, "Description of Data Inputs and Assumptions" for more details on utilization.

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

2.3 Management practices

Timber supply is directly connected to forest management activity. The 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 harvesting and silvicultural assumptions reflect current forest management in the Dawson Creek TSA, and are used in the timber supply analysis.

2.3.1 Forest cover requirements

- Cutblock adjacency* and green-up* — timber harvesting is generally not carried out adjacent to a previously harvested area until the previously harvested area is covered with trees that are approximately 3 metres tall. The time required for the regenerated trees to grow to this height is referred to as the "green-up" period. In general, no more than 33% of an area being developed for timber harvesting may be occupied by stands that are not greened-up at any time. The purpose of this forest cover requirement is to prevent timber harvesting from becoming overly concentrated in an area at any time.

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., height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

- Visual quality — in visually sensitive areas, the green-up requirement is achieved when the trees on a previously harvested area reach approximately 5 metres in height. The proportion of each visually sensitive area that may be covered by recently harvested stands less than 5 metres in height depends on the specific visual quality objectives (VQO)*for the area. Visual quality objectives modelled in this analysis include retention* (most restrictive), partial retention* (less restrictive) and modification* (least restrictive). About 25% of the timber harvesting land base is being managed to meet specific visual quality objectives. The specific forest cover requirements applied to each category of VQO are explained in more detail in Appendix A, "Description of Data Inputs and Assumptions."

2.3.2 Other management practices

- Basic silviculture levels — reforestation activities required to establish free-growing stands* of acceptable tree species. Most areas in the Dawson Creek TSA are harvested using a clearcut harvesting* system and restocked by planting or natural regeneration.
- Forest health and unsalvaged losses — losses of merchantable timber to insects, fire and wind damage are expected to be 44 000 cubic metres per year. Unsalvaged losses are applied to coniferous stands only.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable size. Minimum ages for this analysis were set at the youngest age at which stands reach within 5% of their maximum average growth. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives (e.g. for adjacency, old growth and visual quality), and overall timber harvest targets.
- Current AAC — the current AAC for the Dawson Creek TSA, excluding designated woodlot areas, is 1 826 323 cubic metres per year, which is broken down into 985 000 cubic metres per year from deciduous stands and 841 323 cubic metres per year from coniferous stands.

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

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

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

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

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

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

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

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

4 Results

Because separate harvest forecasts* were modelled for the deciduous and coniferous components of the Dawson Creek TSA, this section is divided into two parts:

- Section 4.1, "Coniferous base harvest forecast" deals with only the coniferous harvest forecast;
- Section 4.2, "Deciduous base harvest forecast" deals with only the deciduous harvest forecast.

The harvest forecasts presented in this section are based on current forest management assumptions. These forecasts will be referred to as the base harvest forecasts and will be used as the basis for comparison for all other harvest forecasts throughout this report. The base harvest forecasts provide only a part of the timber supply picture in the Dawson Creek TSA, and should not be viewed in isolation of the sensitivity analyses completed in Sections 5.1, "Sensitivity of the coniferous timber supply to uncertainty" and 5.2, "Sensitivity of the deciduous timber supply to uncertainty."

4.1 Coniferous base harvest forecast

The coniferous harvest forecast based on current forest management assumptions for the Dawson Creek TSA is shown in Figure 4. The base harvest forecast shows an even-flow harvest level of 938 000 cubic metres per year, approximately 12% higher than the current AAC. This significant increase in the coniferous timber supply is due to the inclusion of forest types previously not considered harvestable (especially stands of small pine), and increases in the estimated timber yields from regenerated stands.

The dashed line in Figure 4 shows the average proportion of the total harvest that is expected to come from mature pine stands less than 19.5 metres tall, over time. These stands are expected to contribute, on average, about 155 000 cubic metres per year or 16.5% to the total annual harvest from coniferous stands.

The base harvest forecast shown is only one of many possible harvest flows given current forest management assumptions. Some of these alternative harvest flows are shown in Section 5.1, "Sensitivity of the coniferous timber supply to uncertainty." The even-flow shown in Figure 4 was chosen as the base case because it represents the most stable flow of timber over time.

> ***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.*

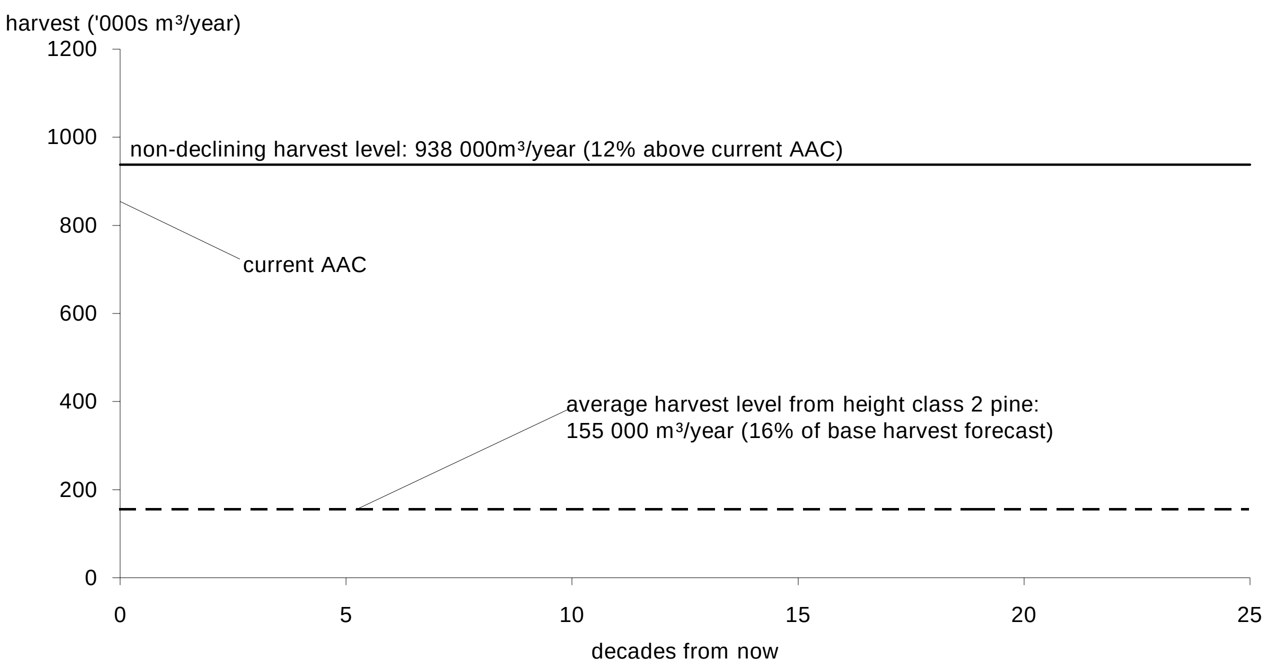

Figure 4. Coniferous base harvest forecast for the Dawson Creek TSA.

4 Results

Figure 5 shows both the total growing stock* and the proportion of the growing stock that is old enough to be harvested over time. There is currently a total of about 93 million cubic metres of coniferous timber on the timber harvesting land base, as indicated by the thick line in Figure 5. Of the total, about 87 million cubic metres of timber is currently old enough to be considered harvestable. Both the total and the harvestable timber inventory decline over the first 100 to 150 years modelled before reaching a steady long-term level. An even growing stock level would signify that timber harvesting can continue at that level in perpetuity.

The relatively slow rate at which the timber inventory declines is the result of the even-flow harvest level used in the base harvest forecast. Accelerating the rate of harvest in the short term (which is examined in sensitivity analysis in Section 5.1.1, "Alternative initial harvest levels and harvest flows over time, coniferous timber supply") would result in a much more rapid reduction of the timber inventory to a steady long-term level.

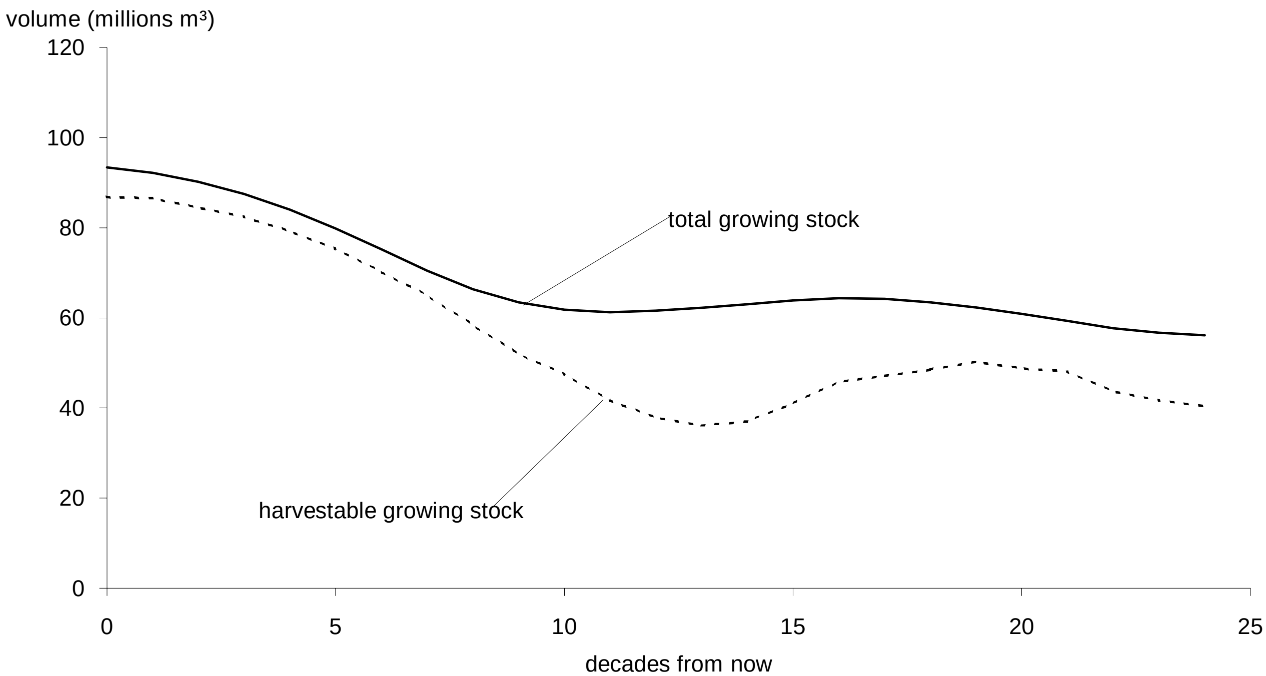

Figure 5. Total and harvestable growing stock over time, Dawson Creek TSA coniferous base harvest forecast.

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

4 Results

Figure 6 shows the average age of stands expected to be harvested over time. The average age of stands harvested in the base harvest forecast declines from about 280 years in the short term to about 130 years in the very long term (250 years plus). The average harvest age declines very gradually because the very large existing inventory of timber is harvested over a relatively long period of time due to the even-flow harvest level used in the base harvest forecast. Over the first 150 years modelled, the harvest is taken almost exclusively from the older existing stands of timber. Some regenerated stands are as old as 150 years before they are harvested a second time, far older than the minimum harvestable ages at which they could be harvested.

Figure 7 shows the average volume per hectare of timber harvested over time. The average volume obtained per hectare harvested is projected to remain relatively constant over time at about 250 to 300 cubic metres per hectare. The only significant change in the average volume per hectare harvested occurs at about 150 years when the large area of poor productivity spruce and balsam stands harvested in the short term (as discussed in Section 2.1, "Land Base Inventory" and shown in Figure 3) becomes available for a second harvest. The average volume of timber obtained from each hectare of these younger, poor productivity stands at the second harvest is only about 200 cubic metres per hectare.

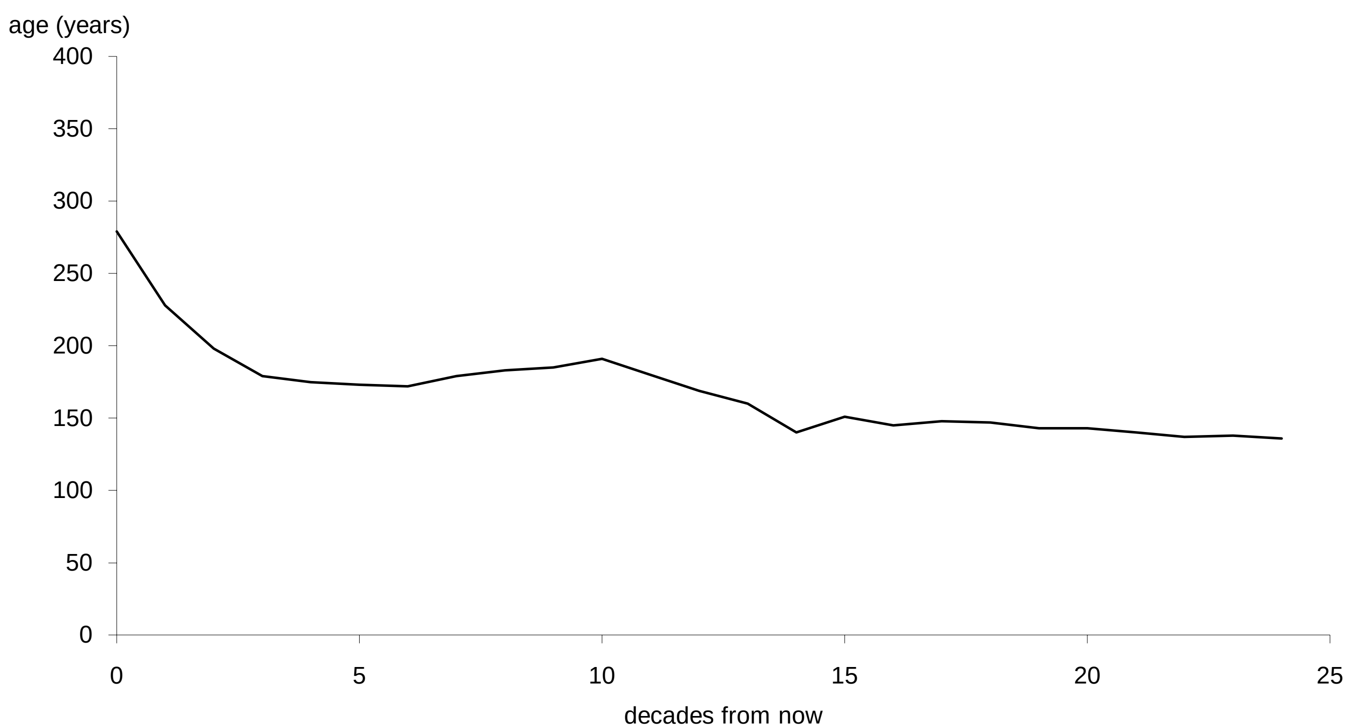

Figure 6. Average age of stands harvested over time, Dawson Creek TSA coniferous base harvest forecast.

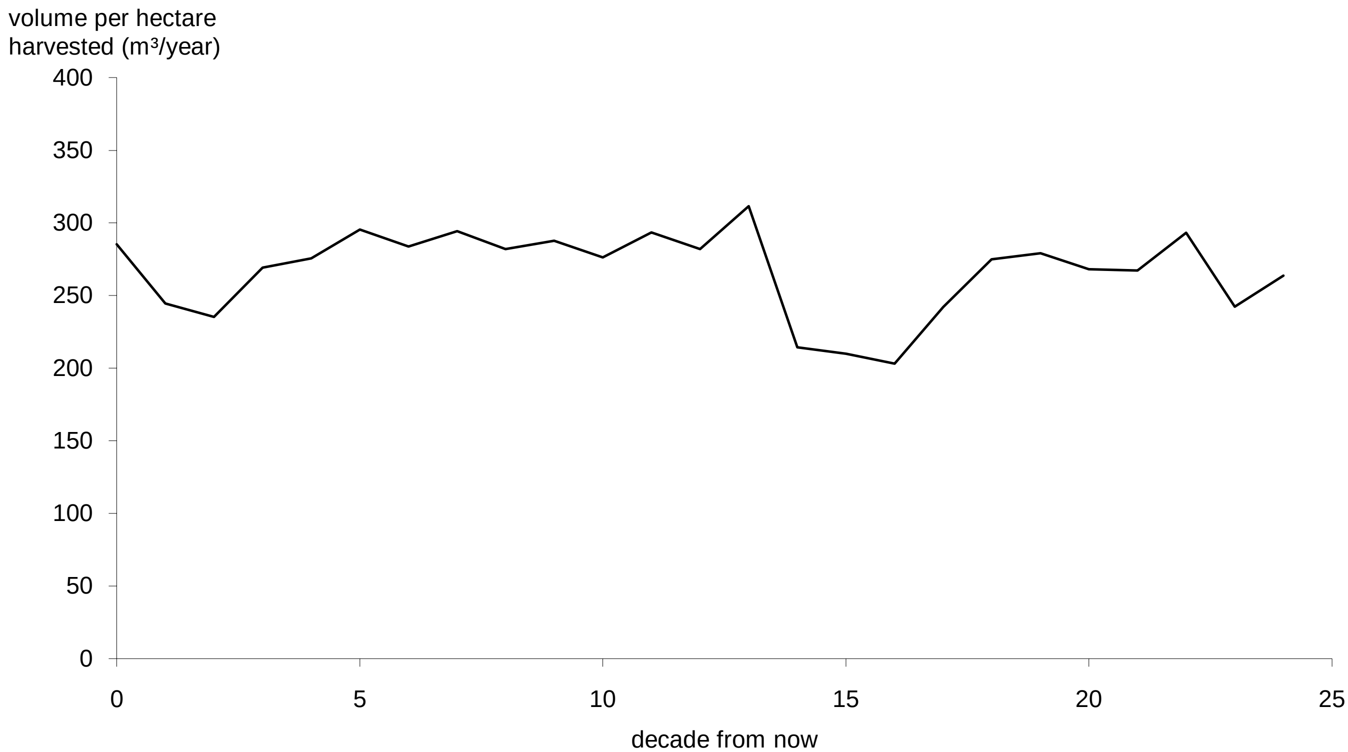

Figure 7. Average volume of timber obtained from each hectare harvested, Dawson Creek TSA coniferous base harvest forecast.

Figure 8 shows the changes projected to occur in the age composition of the coniferous forests in the Dawson Creek TSA base harvest forecast. At present, the majority of the coniferous forest is older than 90 years, with a large proportion between 90 and 120 years old. After 100 years of harvesting, a large proportion of these existing stands have still not been harvested and are then approaching 200 years of age. After approximately 150 years of harvesting, the majority of the original stands have been harvested and the amount of area at each age becomes more balanced. Older stands (up to 350 years old) are maintained throughout the 250 year period to accommodate forest cover requirements used to manage for visual quality of the landscape.

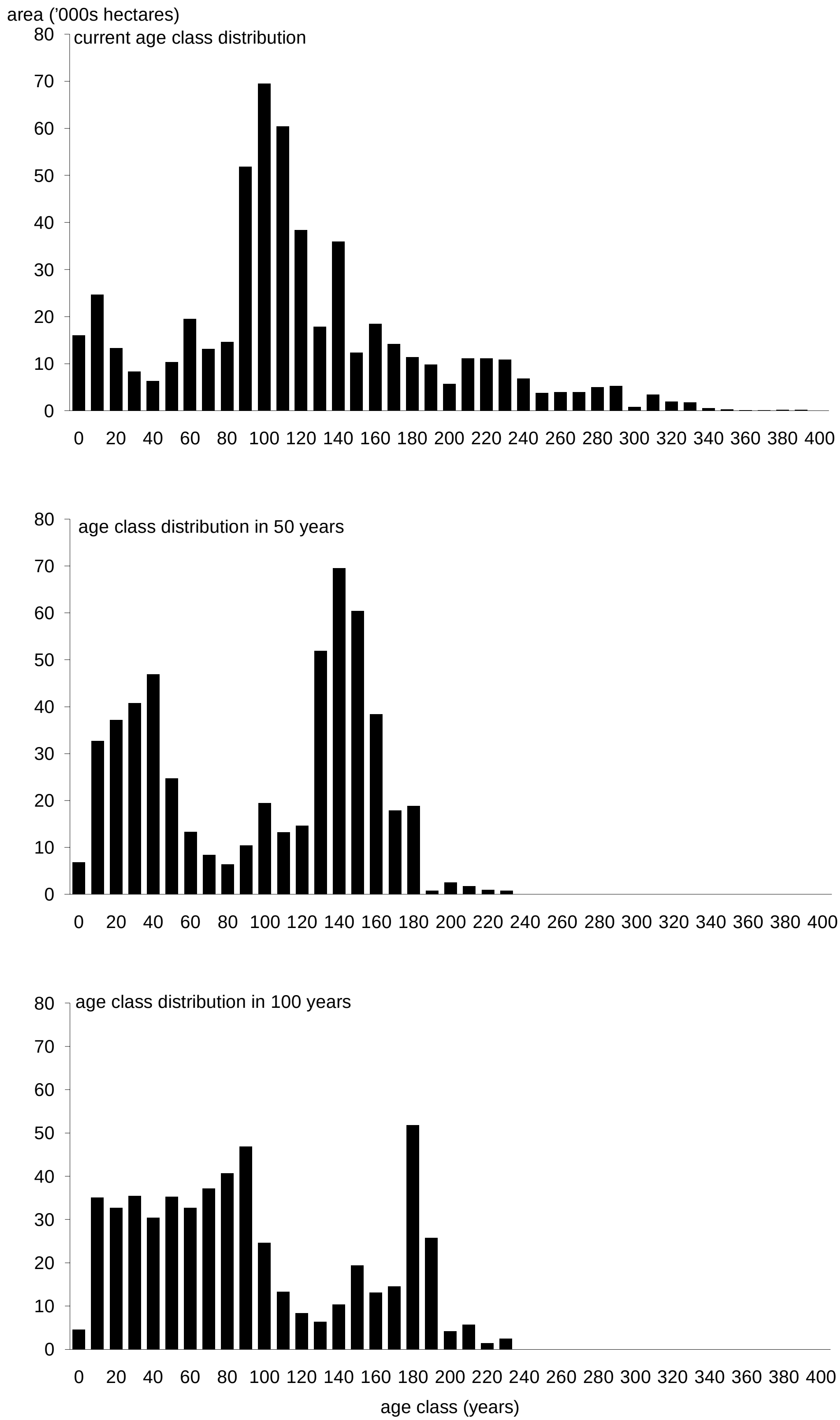

Figure 8. Stand age distribution over time, Dawson Creek TSA coniferous base harvest forecast.(continued)

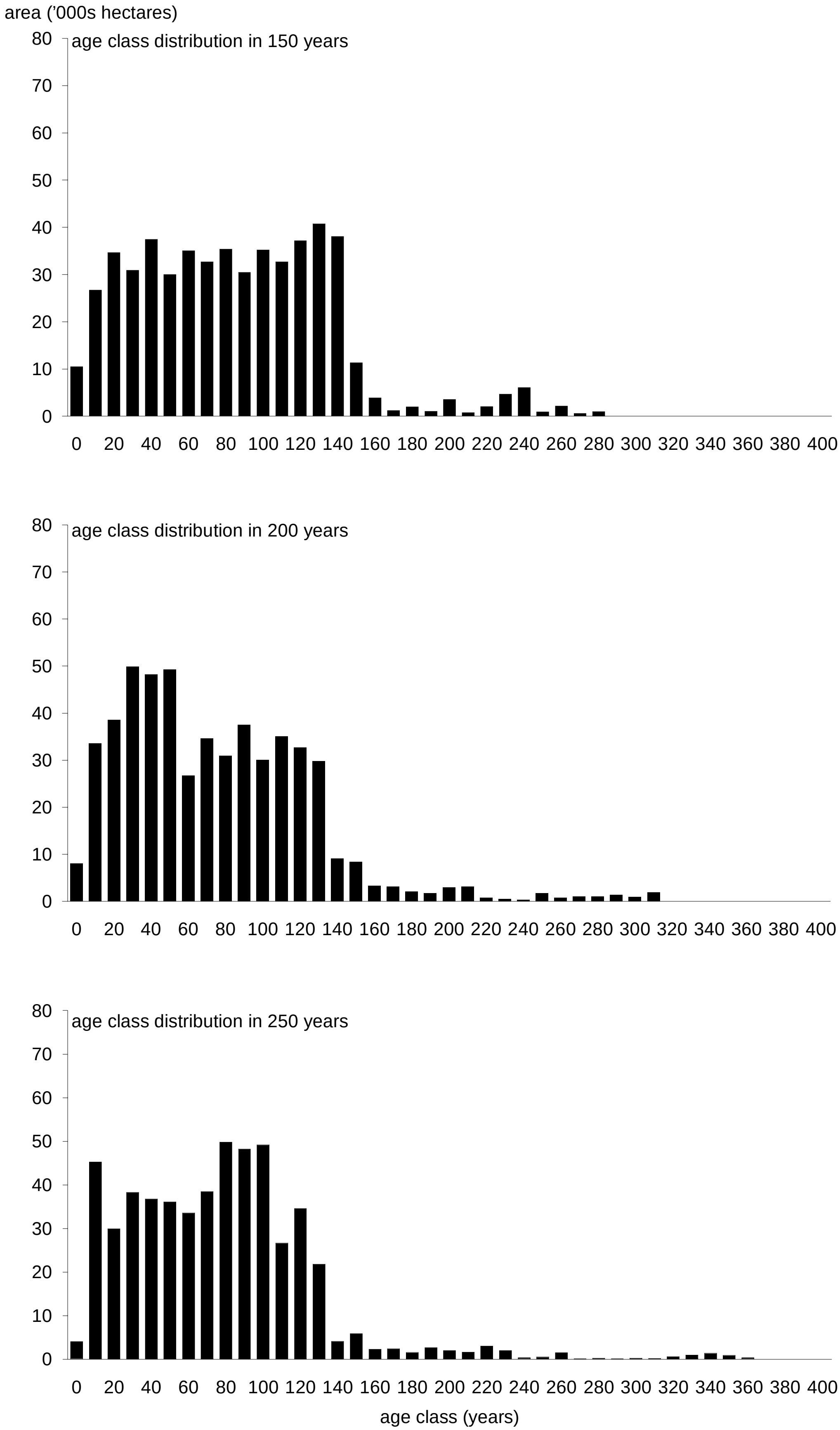

Figure 8. Stand age distribution over time, Dawson Creek TSA coniferous base harvest forecast (concluded).

4.2 Deciduous base case harvest forecast

The deciduous harvest forecast based on current forest management assumptions for the Dawson Creek TSA is shown in Figure 9. The starting harvest level shown in the base harvest forecast is 768 300 cubic metres per year. This harvest level would be 22% below the current deciduous AAC for the Dawson Creek TSA of 985 000 cubic metres per year (exclusive of designated woodlot areas). Despite this significantly reduced starting harvest level, the rate of harvest from the deciduous forest must still decline by 22% per decade to the steady long-term harvest level* of 328 000 cubic metres per year in order to avoid severe drops below the long-term harvest level in the future.

The dashed line in Figure 9 shows the average proportion of the total harvest that is expected to come from stands dominated by cottonwood. These stands are expected to contribute about 50 000 cubic metres per year or 15% to the total annual harvest from deciduous stands over the long term.

Two important factors are responsible for the steeply declining deciduous harvest forecast. The area of deciduous forest assumed to be available and suitable for harvesting is smaller than has been assumed in previous analyses. A more important factor, however, is the estimated productivity of these deciduous stands (in terms of timber volume) which is greatly reduced from previous estimates. The effect on the harvest forecast of uncertainty in both the area assumed to be harvestable and the productivity of deciduous stands is examined and discussed in Section 5.2, "Sensitivity of the deciduous timber supply to uncertainty."

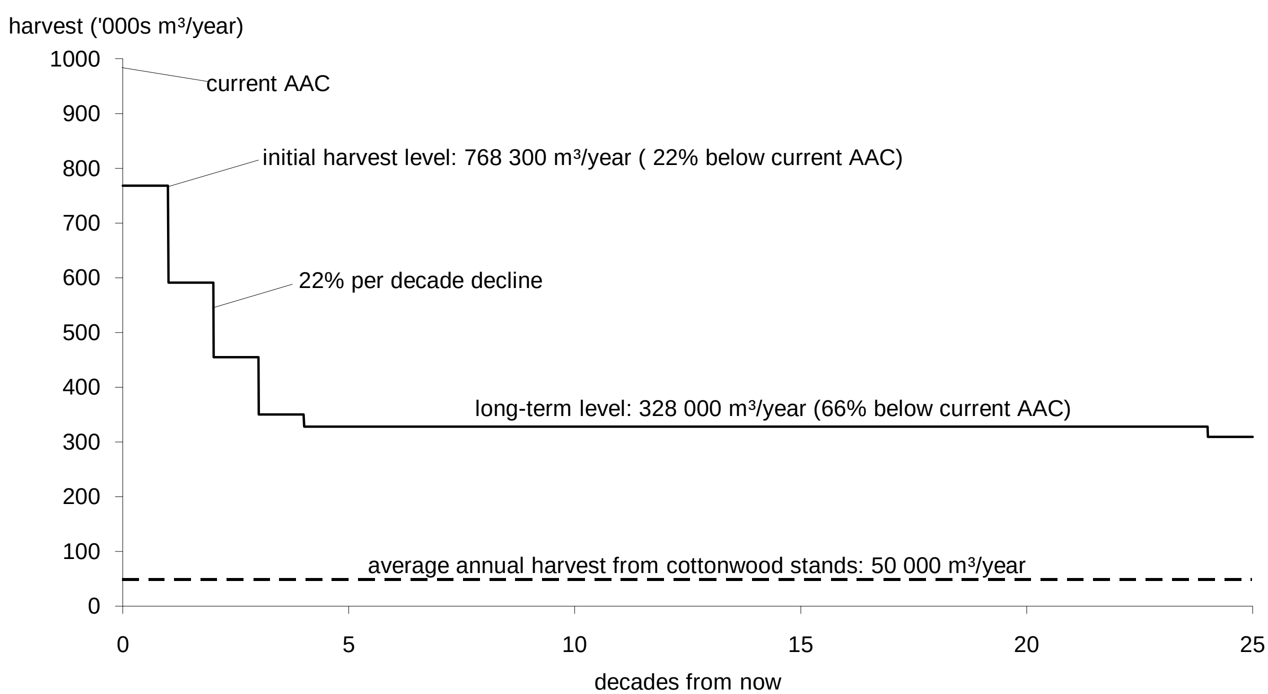

Figure 9. Deciduous base harvest forecast for the Dawson Creek TSA.

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

4 Results

Due to the rapid rate of decline in the short term deciduous base harvest forecast, the deciduous growing stock declines rapidly over the first 50 years, as illustrated in Figure 10. The total growing stock is reduced from a current estimated level of about 24 million cubic metres to a long-term level of about 10 million cubic metres. The harvestable growing stock (timber that is old enough to harvest) declines from a current estimated level of about 22 million cubic metres to about 5 million cubic metres as the rate of harvest reaches a level that can be maintained in perpetuity.

Figure 11 shows the average age of stands harvested over time in the deciduous base case. The average age of stands harvested in the short term is projected to be about 115 years, but declines to about 90 years as harvesting occurs in the younger regenerated stands.

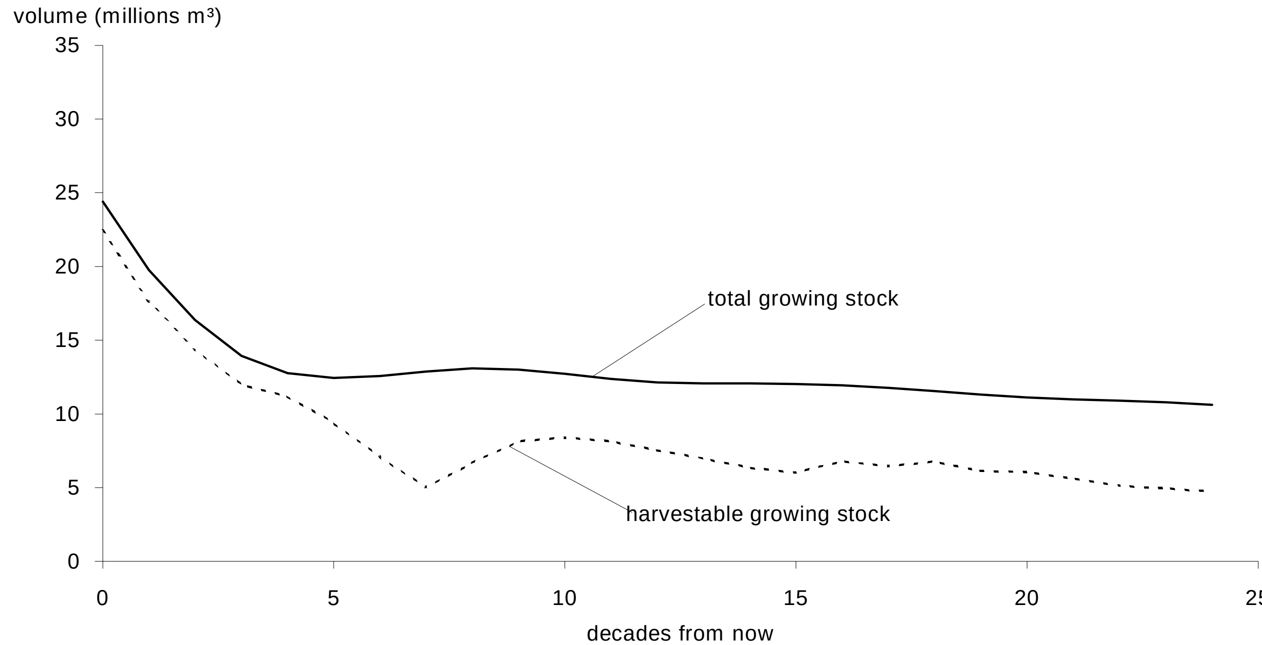

Figure 10. Total and harvestable growing stock over time, Dawson Creek TSA deciduous base harvest forecast.

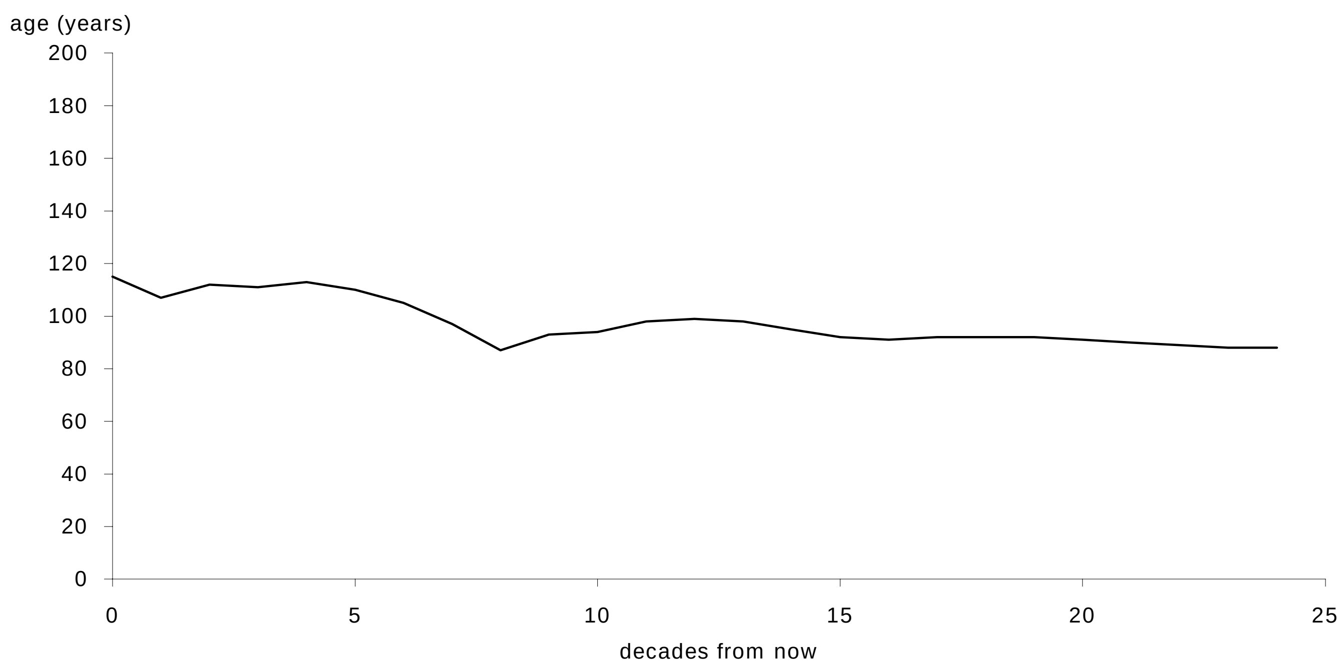

Figure 11. Average age of stands harvested over time, Dawson Creek TSA deciduous base harvest forecast.

Figure 12 shows that the average volume of timber obtained from each hectare of deciduous forest harvested in the deciduous base harvest forecast is about 185 cubic metres per hectare over the short term. This volume is less than what recent scale returns (actual measurements of the volume of timber removed from a site, provided by the Dawson Creek Forest District staff) indicate is being harvested in reality (about 220 cubic metres per hectare). This difference may mean that the growth and yield of deciduous stands has been underestimated in this analysis. However, the forest profile harvested in the deciduous base harvest forecast in the short term includes equal representation of both aspen and cottonwood leading stands on good, medium and poor growing sites. The harvest volume estimates based on recent scale returns are predominantly aspen leading stands on medium growing sites. Therefore, any comparisons between the two figures must take into account the differences in site quality and species harvested.

Over the long term, the volume of timber obtained from each hectare of deciduous forest harvested is projected to decline to about 140 cubic metres per hectare as harvesting activities move from the older existing stands to younger regenerated stands.

The effect on the deciduous harvest forecast of uncertainty in estimated timber yields is examined in Section 5.2.2, "Uncertainty in deciduous stand volume estimates."

Figure 13 shows the changes projected to occur in the age distribution of deciduous forest stands in the Dawson Creek TSA. Over the first 50 to 100 years, almost all of the existing stands are harvested and the amount of area occupied by stands at each age becomes more balanced.

Note that the current stand age distribution shows a great deal of area at 80 to 120 years of age. The incidence of decay in both aspen and cottonwood stands increases significantly after about 120 years of age. Therefore, a rapid short-term rate of harvest, as modelled in the deciduous base case, is an important management consideration. A reduced rate of harvest in the short term, as discussed in Section 5.2, "Sensitivity of the deciduous timber supply to uncertainty," may allow a more gradual decline in the rate of harvest in the future, but may also allow a proportion of the deciduous forest to become unharvestable due to excessive decay.

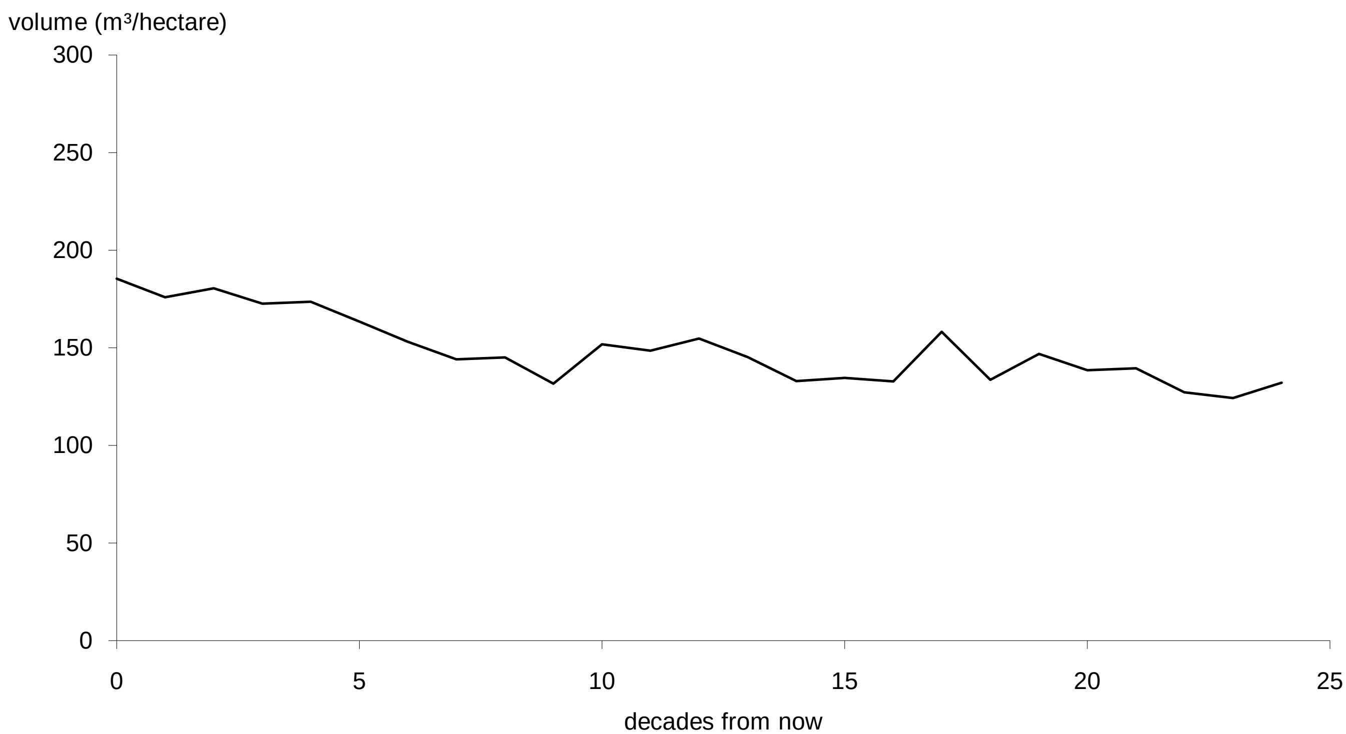

Figure 12. Average volume of timber obtained from each hectare harvested, Dawson Creek TSA deciduous base harvest forecast.

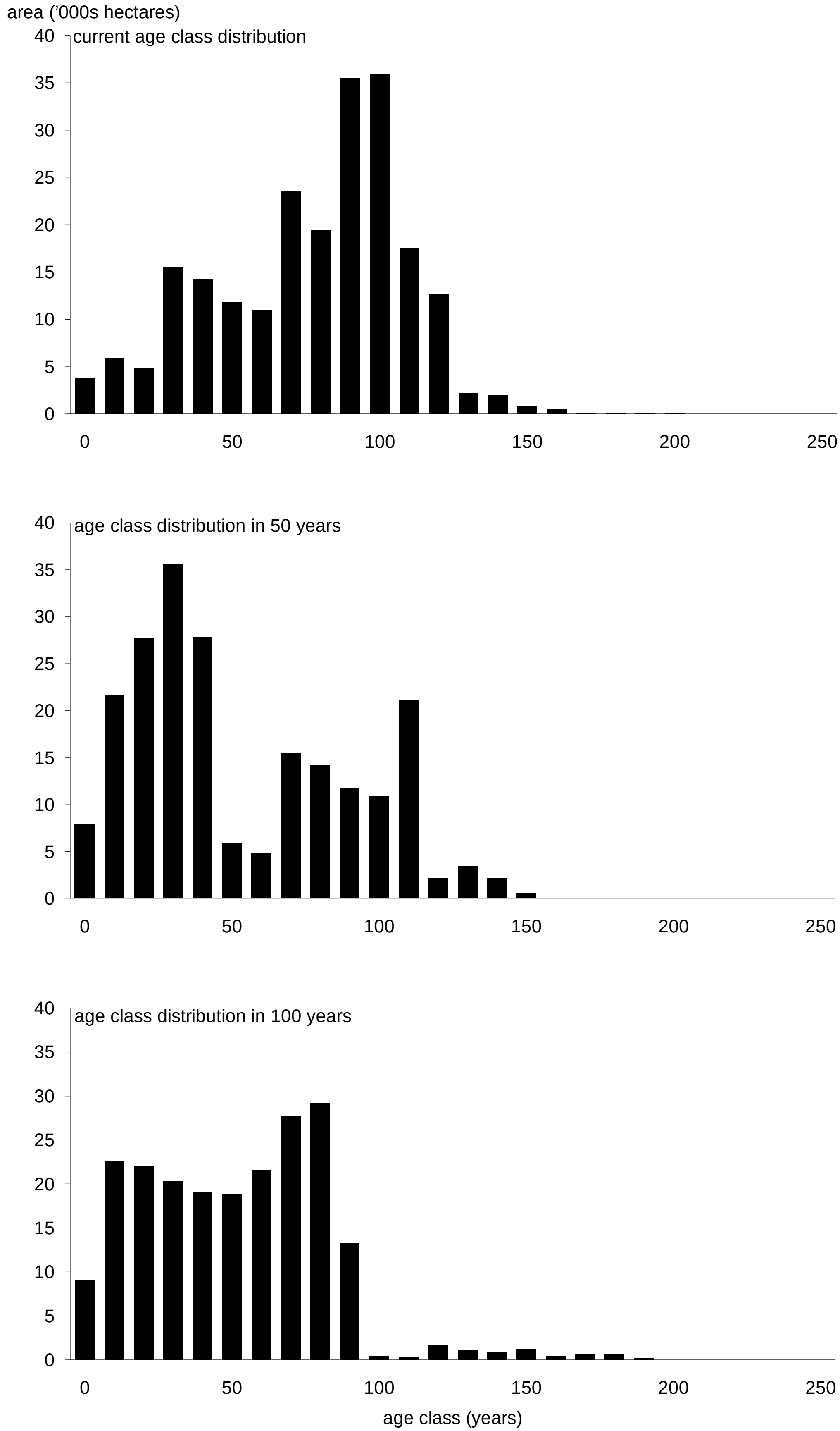

Figure 13. Stand age distribution over time, Dawson Creek TSA deciduous base harvest forecast.(continued)

4 Results

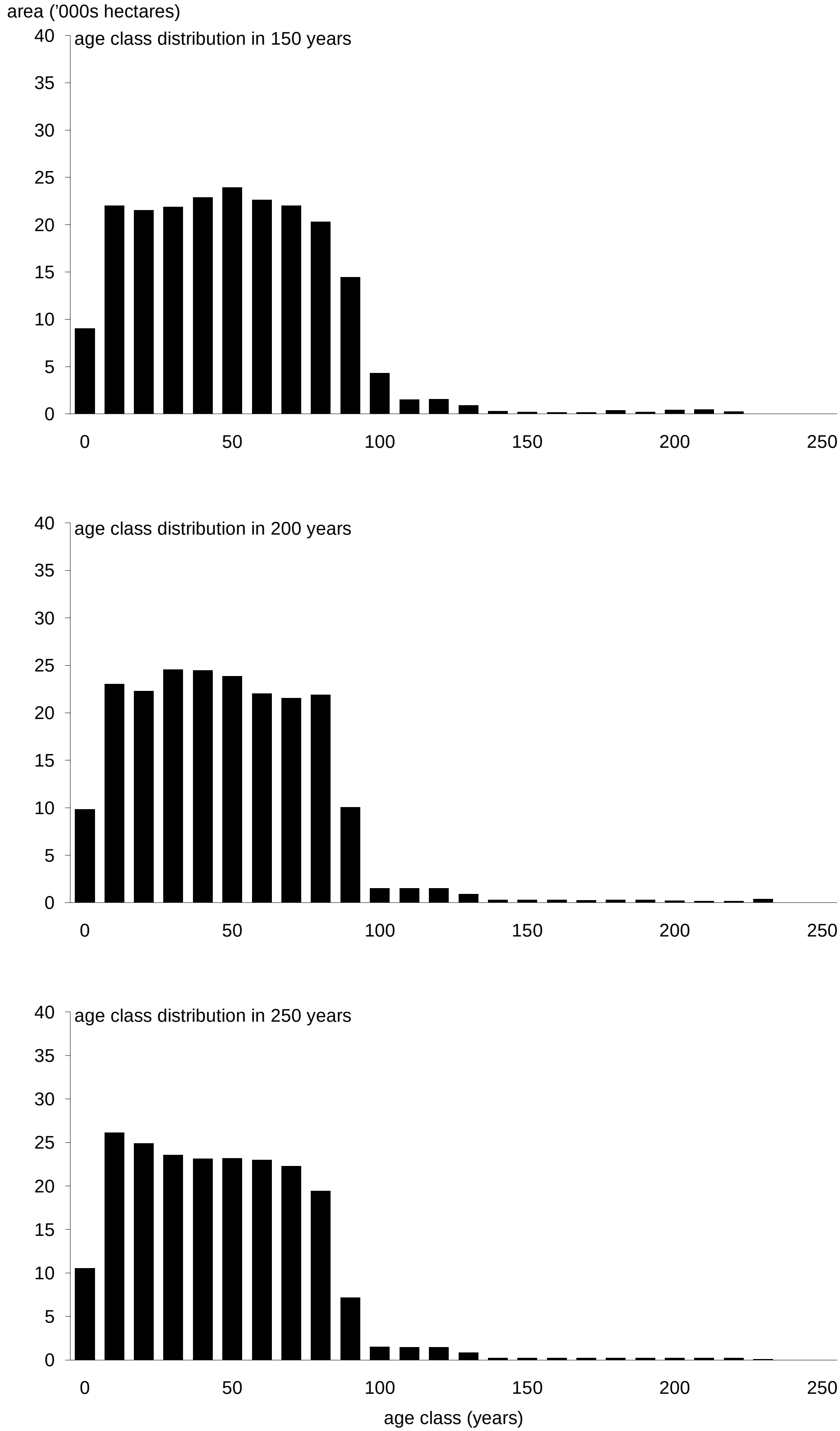

Figure 13. Stand age distribution over time, Dawson Creek TSA deciduous base harvest forecast (concluded).

5 Timber Supply Sensitivity Analyses

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

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

Another important way of dealing with uncertainty is to assess 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. A conservative position would be that current information probably overestimates timber supply, and that decisions should minimize the potential for future timber supply shortages, or negative effects on other values.

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

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 variables 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. In Section 5.1, "Sensitivity of the coniferous timber supply to uncertainty" the results of sensitivity analyses carried out on the coniferous harvest forecast are discussed. Section 5.2, "Sensitivity of the deciduous timber supply to uncertainty" deals with sensitivity analysis carried out on the deciduous harvest forecast.

The results that are based on current forest management assumptions (Figure 4 - 8 for the coniferous component of the timber supply; Figures 9 - 13 for the deciduous component)are referred to as the base harvest forecast.

5 Timber Supply Sensitivity Analyses

5.1 Sensitivity of the coniferous timber supply to uncertainty

5.1.1 Alternative initial harvest levels and harvest flows over time, coniferous timber supply

For a given set of forest management assumptions, many different harvest flows are possible. This section examines alternative harvest flows to that shown in the base harvest forecast given the same set of forest management assumptions for the coniferous timber supply.

The coniferous base harvest forecast shown in Figure 4 maintains an even-flow harvest level. The solid line in Figure 14 shows the harvest forecast if the starting harvest level is set at 1.14 million, approximately 35% higher than the current AAC. The harvest level can be maintained at this higher rate for 70 years before declining by 10% per decade to the steady long-term harvest level of 938 000 cubic metres per year. Alternatively, the initial rate of harvest can be increased to 1.47 million cubic metres per year, 70% above the current AAC, as shown by the dashed line in Figure 14. However, this greatly increased rate of harvest can only be maintained for 20 years before declining by about 11% per decade to the steady long-term harvest level.

These higher rates of harvest in the short term are achieved by depleting the large existing inventory of mature coniferous timber more rapidly and harvesting regenerated stands sooner and much closer to their minimum harvestable ages than in the base harvest forecast (shown as the dotted line in Figure 14).

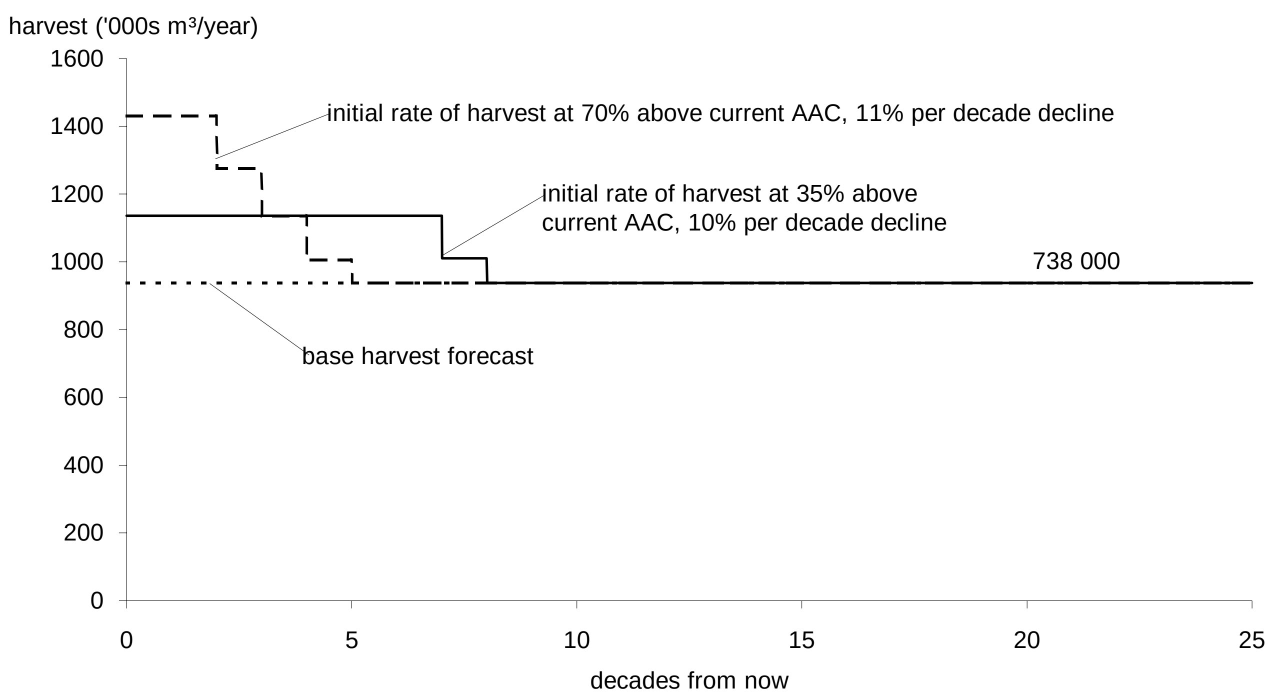

Figure 14. Alternative harvest flow patterns using coniferous base case data, Dawson Creek TSA.

5.1.2 Uncertainty in existing coniferous stand volume estimates

Timber yield 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 analyses examine the effect on the harvest forecast of uncertainty in the volume of coniferous timber that currently exists on the timber harvesting land base.

The solid line in Figure 15 shows an effect on the coniferous harvest forecast of increasing the estimated existing stand volume by 10%. The steady long-term harvest level, which is entirely dependent on regenerated stand timber volume, is not affected by the change in existing stand volume yields. Therefore, if an even-flow harvest level is desired, no increase in the initial harvest level is possible. However, if the existing inventory is to be depleted in approximately the same time frame (200 - 250 years) as in the coniferous base harvest forecast, the initial rate of harvest can be increased to about 1.06 million cubic metres per year, 12% higher than the initial rate of harvest in the coniferous base harvest forecast (shown as the dotted line in Figure 15). This higher initial rate of harvest can be maintained for 230 years before declining to the steady long-term harvest level of 938 000 cubic metres per year, which is unchanged from the base harvest forecast.

Decreasing the estimated timber yield from existing stands by 10% has no effect on the coniferous harvest forecast. Even with a 10% reduction, the inventory of existing timber is large enough to sustain the steady long-term harvest level until a large proportion of regenerated stands is old enough to be harvested.

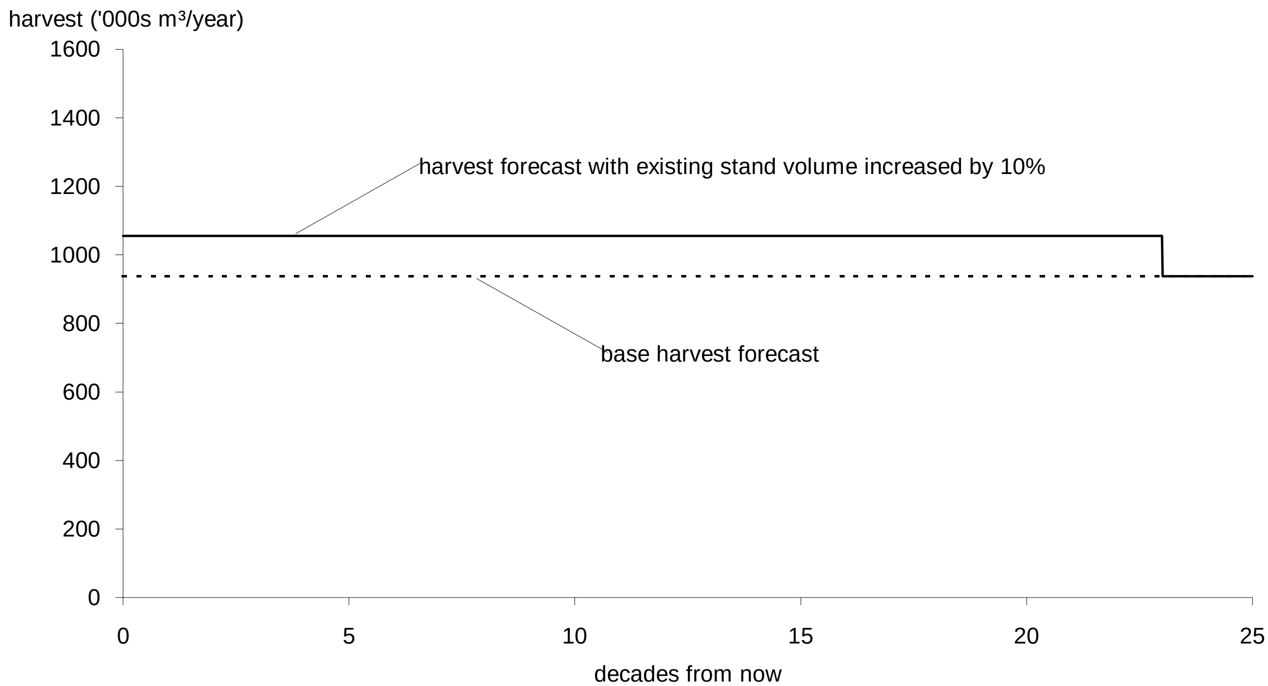

Figure 15. Harvest forecast with existing coniferous stand timber volume estimates changed by 10%, Dawson Creek TSA.

5.1.3 Uncertainty in regenerated coniferous stand timber volumes

Uncertainty in regenerated stand volume estimates is due to numerous factors such as using inventory data from existing mature forests to predict the growth and yield of future regenerated stands, uncertainty about the effect of replacing existing forests with different tree species after logging, and the effects of soil degradation, pests, and forest disease on future forest productivity.

The following sensitivity analyses examine the effect that uncertainty in estimated volumes from regenerated coniferous stands has on the coniferous harvest forecast.

The dashed line in Figure 16 shows the effect on the coniferous harvest forecast of increasing estimated timber volumes of regenerated coniferous stands by 20%. As a result of this change, the rate of harvest can eventually be increased to the steady long-term harvest level at about 20% above the base harvest forecast but not until almost all harvesting is occurring in the more productive regenerated stands. The initial rate of harvest can be increased to about 1.04 million cubic metres per year, 10% above the coniferous base case, while still maintaining a non-declining harvest flow policy. This increase in the initial rate of harvest is accomplished by harvesting existing mature stands more quickly, as was shown to be possible using base case assumptions in Section 5.1.1, "Alternative initial harvest levels and harvest flows over time, coniferous timber supply."

The solid line in Figure 16 shows the effect on the harvest forecast of reducing the estimated volumes from regenerated coniferous stands by 20%. The steady long-term harvest level, which is reached in 230 years, is reduced by 20% from the base case to about 750 000 cubic metres per year. The initial rate of harvest is unaffected, as long as a later decline to the lower long-term harvest level is accepted. If an even-flow harvest level is still to be achieved, the initial harvest rate would also have to be reduced to the lower long-term level.

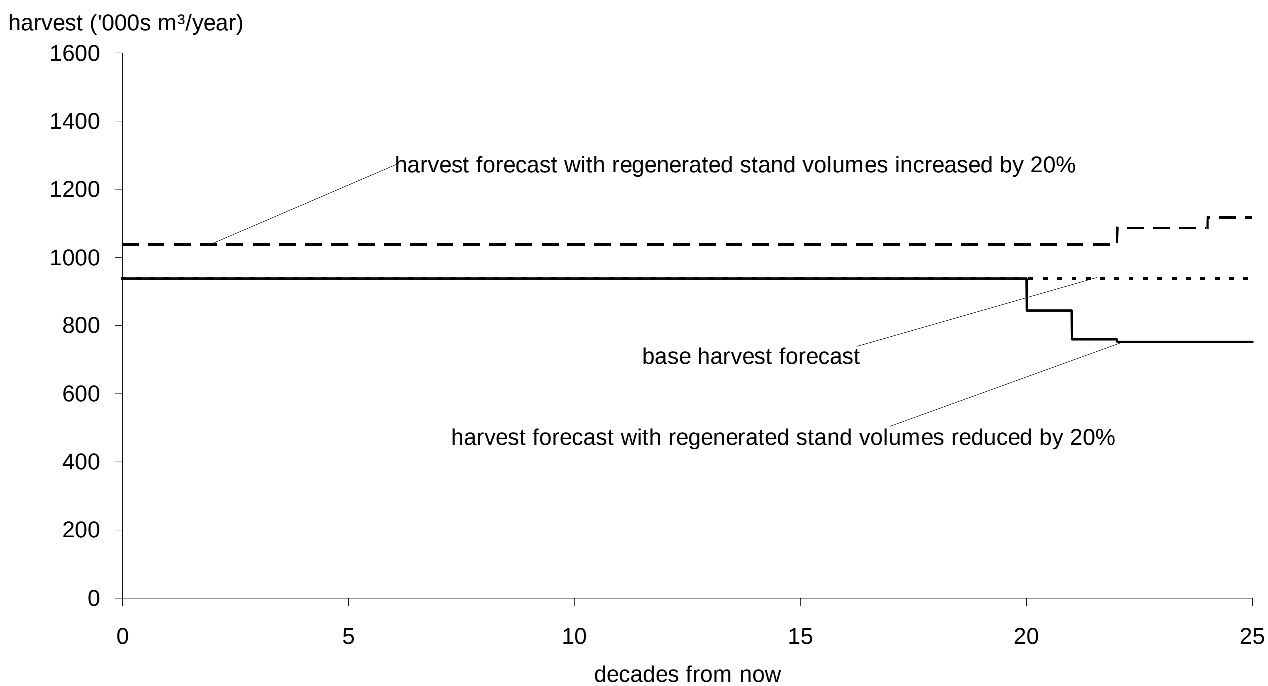

Figure 16. Coniferous harvest forecast with regenerated stands timber volume estimates increased by 20%, Dawson Creek TSA.

5.1.4 Uncertainty in minimum harvestable ages, coniferous timber supply

The minimum harvestable age for a given stand of timber is an estimate of the time needed for the stand to grow to a merchantable condition. Minimum harvestable ages define when second growth will be available for harvest, and therefore determine how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain, partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, the minimum age is estimated to be the age at which the average stand growth rate is within 5% of the maximum (or culmination of mean annual increment (MAI)*). Actual minimum harvestable ages used in the analysis range from 60 to 150 years of age, with an average of about 105 years (derived from information in Table A-8, Appendix A, "Description of Data Inputs and Assumptions.") As shown in Figure 6, the average age of stands harvested over time in the analysis declines over time to a minimum of about 130 years. This difference between the average minimum harvestable ages specified for each forest type and the actual average age at which harvesting occurs demonstrates that stands may be harvested at older ages than the minimum. If necessary to meet management objectives, forest cover guidelines may require that harvesting occurs at ages above the minimum harvestable ages. However, stands may not be harvested at ages younger than the minimum harvestable age.

Increasing the minimum harvestable ages for all coniferous stands by 20 years has no effect on the harvest forecast. The even-flow harvest level shown is decreased by less than 1% from the base harvest forecast. There are two main reasons why the harvest forecast is not significantly affected by this relatively large change in minimum harvestable ages. One reason is that the actual average age at which stands are harvested in the timber supply model (about 130 years in the long term) is already greater than the average minimum harvestable age (about 105 years). This extension of the age at which stands are harvested is caused by the forest cover requirements used to model management for visual quality of the landscape, which specify that a certain proportion of the land base available for timber harvesting be occupied by older stands. A second reason that the harvest forecast is not affected by the increased minimum harvestable ages is that at ages within 20 years of the culmination ages, the estimated average growth rate of the forest is fairly constant. Therefore, allowing stands to grow longer by extending the minimum harvestable age does not result in a significant overall increase in volume over the base harvest forecast.

Because minimum harvestable ages are not a limiting factor in the base harvest forecast, decreasing the minimum harvestable ages for all coniferous stands by 20 years does not affect the coniferous harvest forecast. As noted above, the minimum harvestable ages for each forest type are already below the age at which the maximum average growth is achieved, and in areas being managed for visual quality of the landscape, forest cover guidelines determine the age at which a stand is harvested.

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

5.1.5 Uncertainty in cutblock adjacency guidelines, coniferous timber supply

In the coniferous base harvest forecast, the forest cover requirement used to model cutblock adjacency and green-up is based on the assumption that a maximum of 33% of the timber harvesting land base may be forested with trees less than 3 metres tall at any time. However, this forest cover requirement should only be viewed as an average forest cover requirement that applies to areas with no overriding management concerns such as visual quality. Site specific forest cover requirements will vary from this average requirement. Uncertainty in the average forest cover requirement used to model cutblock adjacency and green-up in this analysis stems from these site specific variations from the average.

The results of this sensitivity analysis show that forest cover requirements used to model cutblock adjacency and green-up are not a limiting factor in the base case. The forest cover guideline has no effect on the coniferous harvest forecast until the area that may be covered with stands less than 3 metres tall is limited to 20% (as shown by the solid line in Figure 17). Because the forest cover requirement used to model cutblock adjacency and green-up is not limiting in the base harvest forecast, the harvest forecast cannot be increased by relaxing the forest cover requirement to allow more area to be covered with stands less than 3 metres tall.

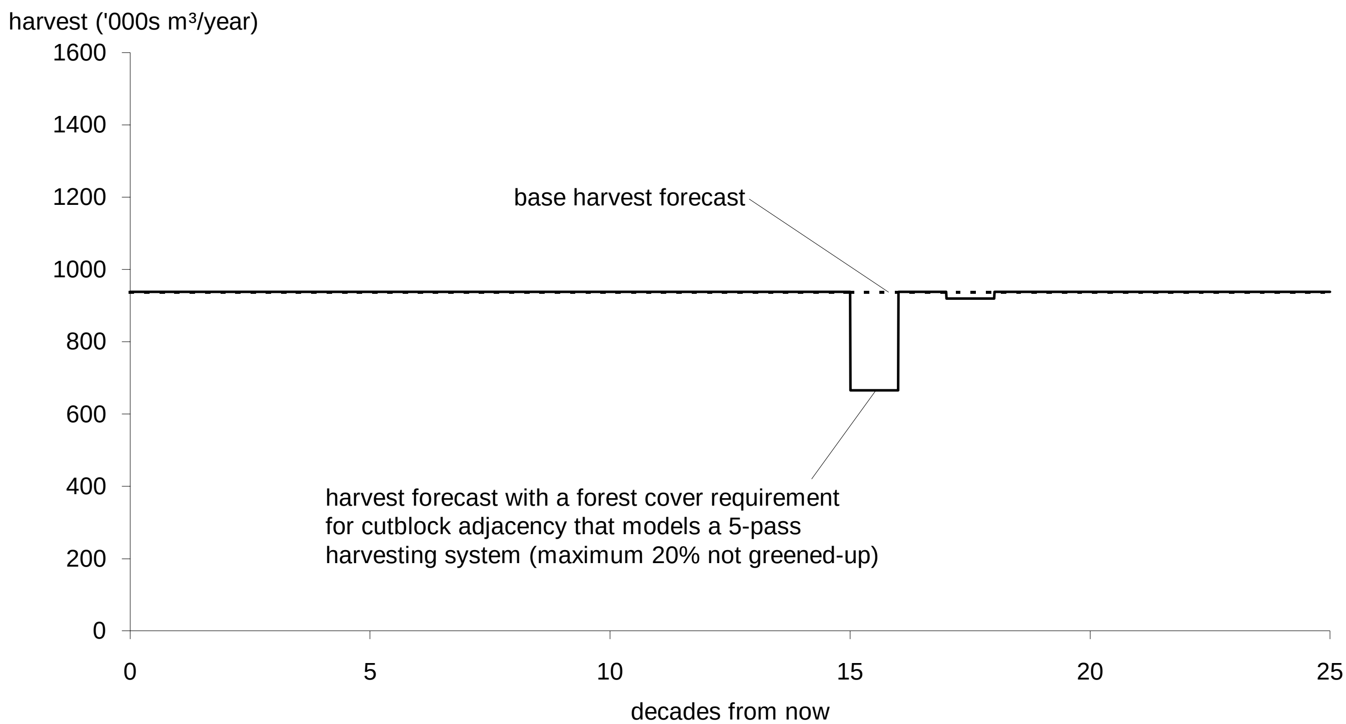

Figure 17. Coniferous harvest forecast with a more stringent cutblock adjacency requirement, Dawson Creek TSA.

5.1.6 Uncertainty in forest cover requirements for visual quality, coniferous timber supply

In the base case, forest cover requirements for visually sensitive areas define the maximum percentage of a visually sensitive forest area that is permitted to be not greened-up (in other words, recently harvested and covered with trees less than 5 metres tall) at any time. Uncertainty in these forest cover requirements stems from the subjective way in which areas are categorized as being more or less visually sensitive to harvesting activities.

The dashed line in Figure 18 shows the effect on the coniferous harvest forecast if the forest cover requirements are relaxed so that an additional 5% of each visually sensitive area may be non-greened-up at any time. The even-flow harvest level is increased to 966 000 cubic metres per year, about 8% above the base harvest forecast.

The solid line in Figure 18 shows the effect on the harvest forecast if forest cover requirements for visual quality are made more stringent so that 5% less of each visually sensitive area may be non-greened-up at any time. The even-flow harvest level is reduced by about 2% to 918 000 cubic metres per year.

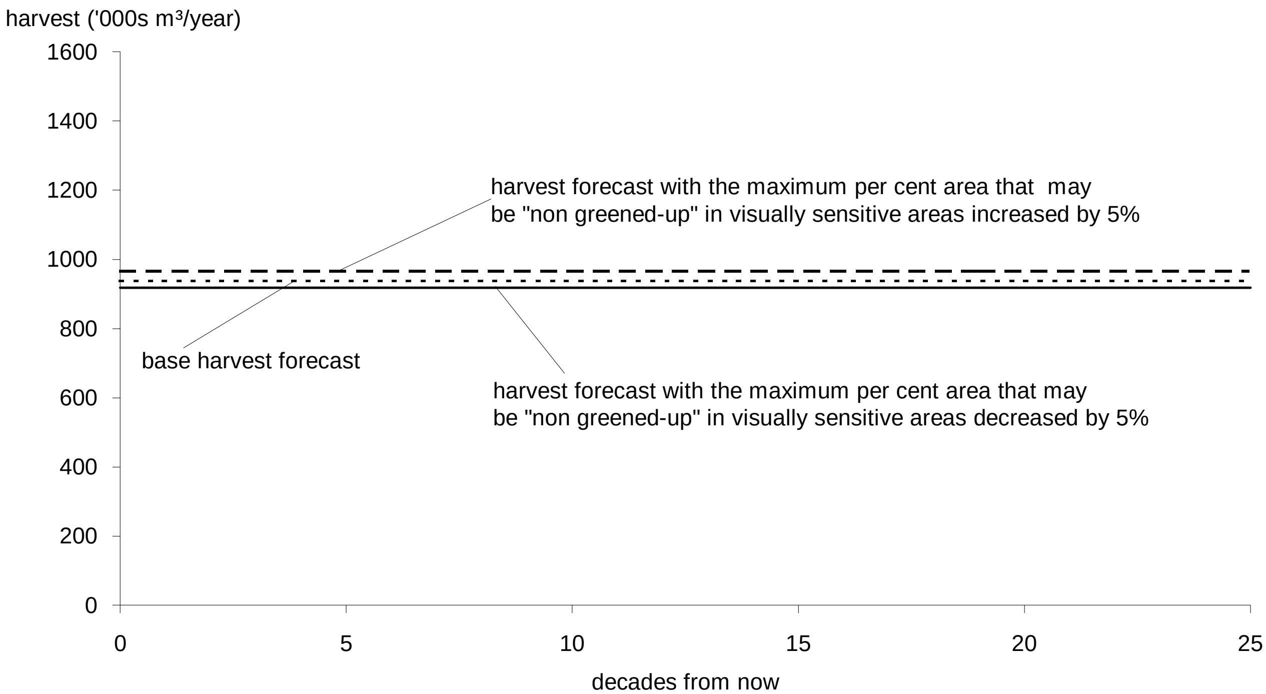

Figure 18. Coniferous harvest forecast with increased and decreased forest cover requirements for visual quality, Dawson Creek TSA.

5.1.7 Uncertainty in required green-up periods, coniferous timber supply

As discussed in Section 2.3, "Management practices", the required green-up periods used in the base harvest forecast are the estimated number of growing years required before the trees on a previously harvested area reach a required height. Uncertainty in the required green-up period stems from both the uncertainty in stand height growth rates as well as the subjectivity of the height requirement before the stand is considered "greened-up".

In assessing the results of this sensitivity analyses, note that only the forest cover requirements used to manage for visual quality limit the base harvest forecast (as shown in Sections 5.1.5, "Uncertainty in cutblock adjacency guidelines, coniferous timber supply" and 5.1.6, "Uncertainty in forest cover requirements for visual quality, coniferous timber supply"). Forest cover requirements used to model cutblock adjacency guidelines (as outlined in Section 2.3, "Management practices") have no effect on the coniferous base harvest forecast.

Extending the required green-up periods for all areas (both visually sensitive areas and non-visually sensitive areas) by 5 years has no effect on the harvest forecast. A longer green-up period does result in a reduced rate of harvest from visually sensitive areas, but the rate of harvest in areas that are not visually sensitive can be increased to compensate.

Reducing the required green-up periods for all areas by 5 years allows the even-flow rate of harvest to be increased to 981 000 cubic metres, about 5% above the base harvest forecast, as shown by the solid line in Figure 19. This change is attributable entirely to increased harvesting in visually sensitive areas that had been limited by forest cover requirements in the base harvest forecast.

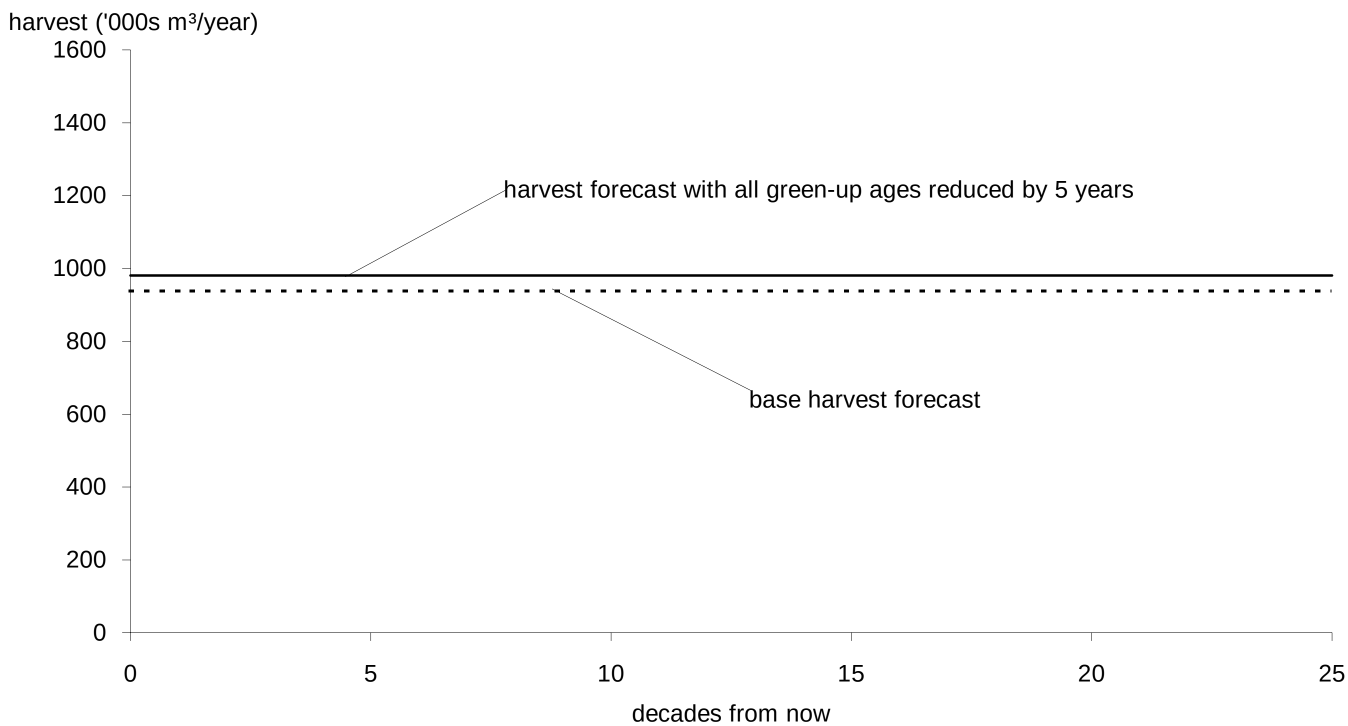

Figure 19. Coniferous harvest forecast with all green-up periods changed by 5 years, Dawson Creek TSA.

5.1.8 Uncertainty about removing all forest cover requirements, coniferous timber supply

The following sensitivity analysis examines the effect that removing all forest cover requirements for cutblock adjacency and management of visually sensitive areas has on the coniferous harvest forecast. The solid line in Figure 20 shows the harvest forecast with all forest cover requirements removed. The even-flow harvest level is increased by about 9% to just over one million cubic metres per year. This change in the harvest forecast is due entirely to the removal of the forest cover requirements for visual quality.

5.2 Sensitivity of the deciduous timber supply to uncertainty

5.2.1 Alternative initial harvest levels and harvest flows over time, deciduous timber supply

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

The dashed line in Figure 21 shows the deciduous harvest forecast if the starting harvest level is set at the current AAC (excluding designated woodlot areas) of 985 000 cubic metres per year. Despite a 35% per decade decline in the rate of harvest in subsequent years, the increased starting harvest level results in a major drop below the long-term harvest level in about 70 years. The reason for this shortfall is that an accelerated rate of harvest in the short term depletes the existing inventory before enough regenerated stands are old enough to support the harvest.

The solid line in Figure 21 shows the deciduous harvest forecast if the starting harvest level is set at about 670 000 cubic metres per year, 32% below the current AAC and about 13% below the starting harvest level in the base harvest forecast (shown by the dotted line in Figure 21). This reduced starting harvest level allows the rate of decline in later years to be reduced to 15% per decade. However, as already pointed out in Section 4.2, "Deciduous base harvest forecast," a reduced rate of harvesting of deciduous types in the short term may allow some of the older existing stands to grow too old to be harvestable due to increased decay.

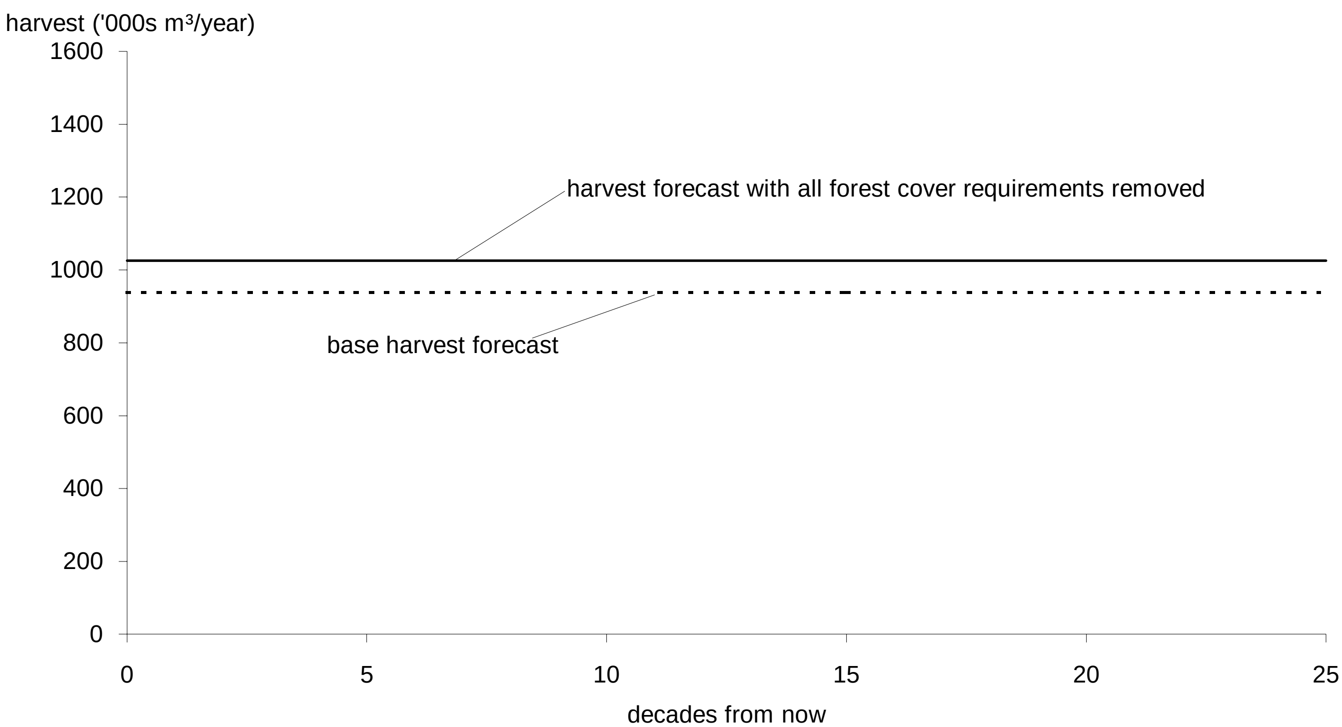

Figure 20. Coniferous harvest forecast with all forest cover requirements removed, Dawson Creek TSA.

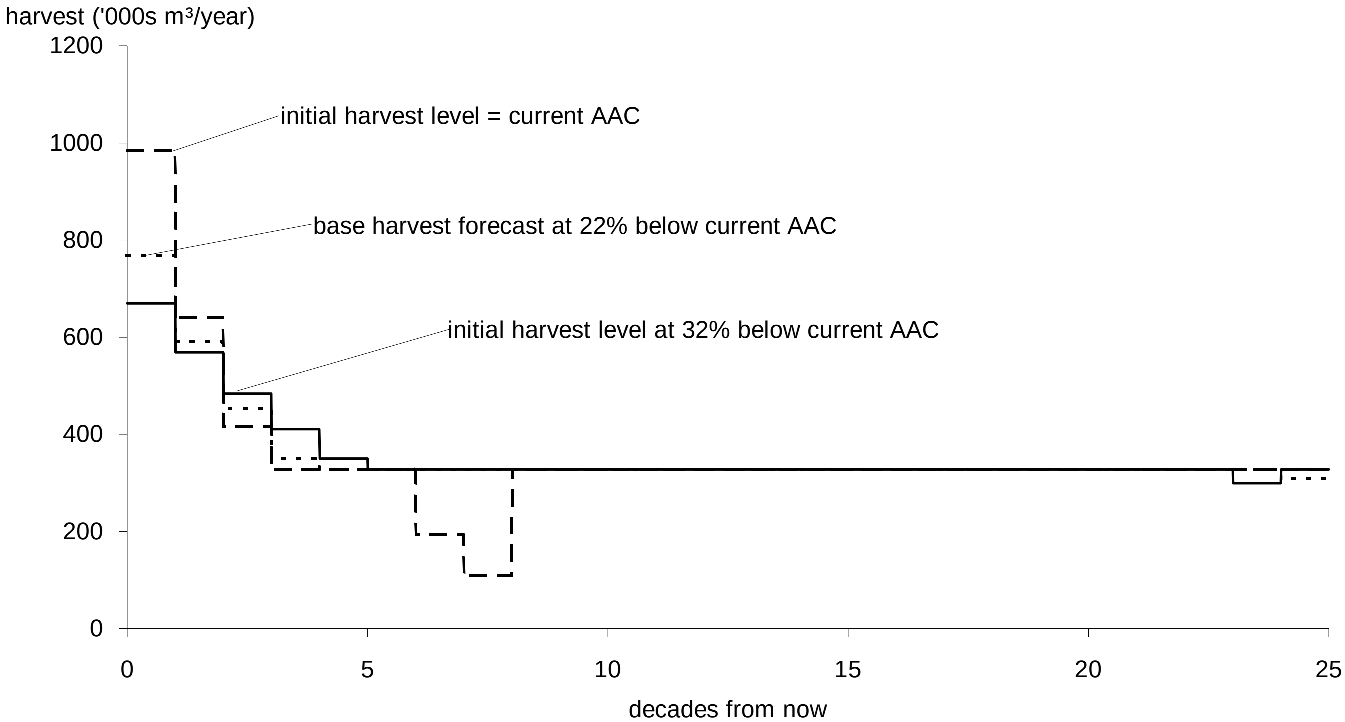

Figure 21. Alternative harvest flow patterns using deciduous base case data, Dawson Creek TSA.

5.2.2 Uncertainty in deciduous stand volume estimates

Timber yield estimates have a degree of 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 estimated timber volumes from deciduous stands used in this analysis are significantly reduced from previous estimates and are slightly below the timber yields indicated by recent scale returns, as already discussed in Section 4.2, "Deciduous base case harvest forecast" and shown in Figure 12. The following sensitivity analyses examine the effect on the harvest forecast of uncertainty in the estimated timber volumes from both existing and regenerated stands.

The dashed line in Figure 22 shows the effect on the deciduous harvest forecast of increasing the estimated timber volumes from deciduous stands by 30%. The initial rate of harvest can be increased to about 886 000 cubic metres per year, which is 15% higher than the starting level in the base case, but still 10% below the current AAC. The decline in the rate of harvest in later years is reduced to only 15% per decade, from 35% per decade in the base harvest forecast. The steady long-term harvest level is increased by about 30% to 425 000 cubic metres per year.

The solid line in Figure 22 shows the effect on the deciduous harvest forecast of decreasing the estimated timber volumes from deciduous stands by 30%. The highest initial rate of harvest that can be achieved while still maintaining a 22% per decade decline (as in the base harvest forecast) is 542 000 cubic metres per year, 45% below the current AAC. The steady long-term harvest level is reduced by 30% from the base case to 228 000 cubic metres per year.

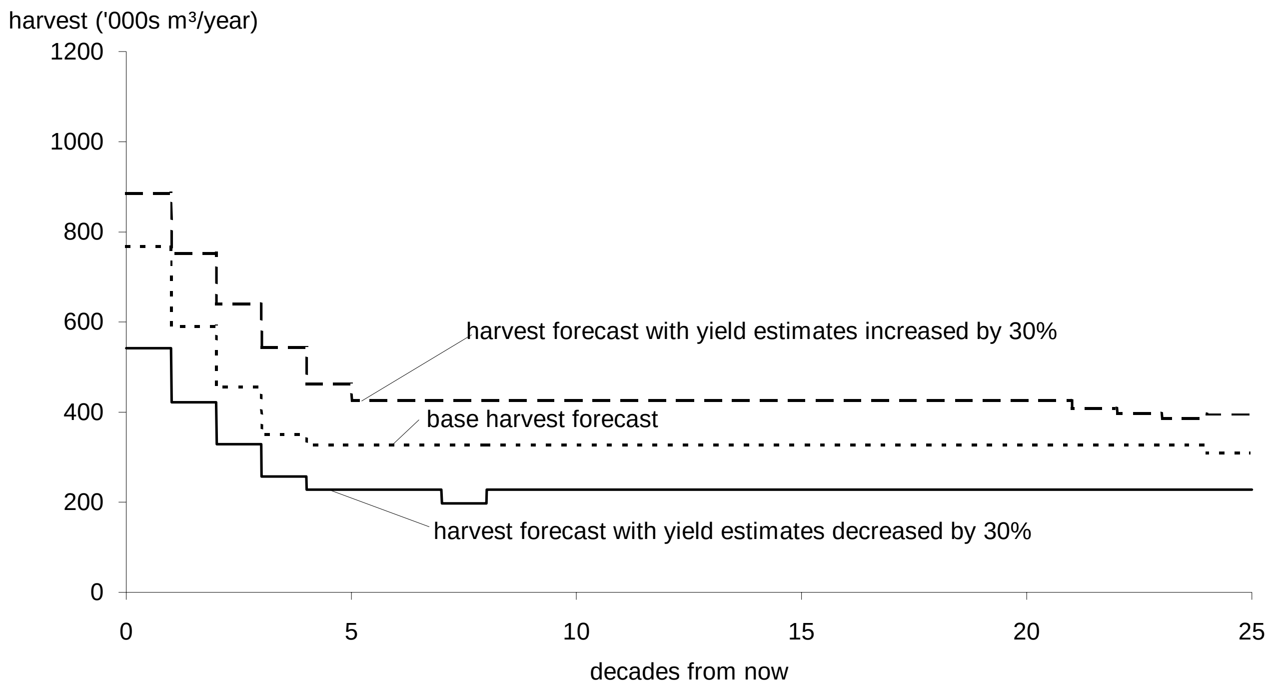

Figure 22. Harvest forecast with deciduous stand timber yield estimates changed by 30%, Dawson Creek TSA.

5.2.3 Uncertainty in the area of the deciduous 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 Dawson Creek TSA, the timber harvesting land base could be larger or smaller if any of the area reductions listed in Table 1 are different. The area of the timber harvesting land base could be increased by improved timber harvesting techniques and equipment, or as a result of increases in the value of currently unmerchantable forest types. The area of the timber harvesting land base could be reduced as a result of increases in harvesting costs, decreases in the value of currently marginal timber types, or as a result of land use decisions such as those being considered through the provincial Protected Areas Strategy.

The harvest forecast with the timber harvesting land base reduced by 30% is shown by the solid line in Figure 23. Because the area removed from the timber harvesting land base for this sensitivity analysis is representative of the entire deciduous timber harvesting land base, the effect on the harvest forecast is directly correlated to the amount of area removed. The starting harvest level is reduced to 541 750 cubic metres per year, which is 30% below the starting harvest level in the base harvest forecast, and 45% below the current AAC. The steady long-term harvest level is also reduced by 30% from the base harvest forecast.

The harvest forecast with the timber harvesting land base increased by 30% is shown by the dashed line in Figure 23. The increase in the deciduous timber supply that results from this change can be used to both increase the starting harvest level and reduce the rate of decline in the harvest level later in the harvest forecast to only 15% per decade. The starting harvest level of about 887 000 cubic metres per year shown by the dashed line in Figure 23, can be increased even further if the subsequent decline in the rate of harvest is allowed to be 23% per decade as was used in the base harvest forecast.

5.2.4 Uncertainty in minimum harvestable ages, deciduous timber supply

The minimum harvestable age for a given stand of timber is an estimate of the time needed for the stand to grow to a merchantable condition. Minimum harvestable ages define when second growth will be available for harvest, and therefore determine how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain, partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, the minimum age is estimated to be the age at which the average stand growth rate is within 5% of the maximum (or culmination of mean annual increment). Actual minimum harvestable ages for deciduous stands in the analysis range from 60 to 80 years, with an average of about 70 years (derived from information in Table A-8., Appendix A, "Description of Data Input and Assumptions.") As shown in Figure 11, the average age of deciduous stands harvested over time in the analysis declines over time to a minimum of about 90 years. This difference between the average minimum harvestable ages specified for each forest type and the actual average age at which harvesting occurs demonstrates that stands may be harvested at older ages than the minimum. If necessary to meet management objectives, forest cover guidelines require that harvesting occurs at ages above the minimum harvestable ages. However, stands may not be harvested at ages younger than the minimum harvestable ages.

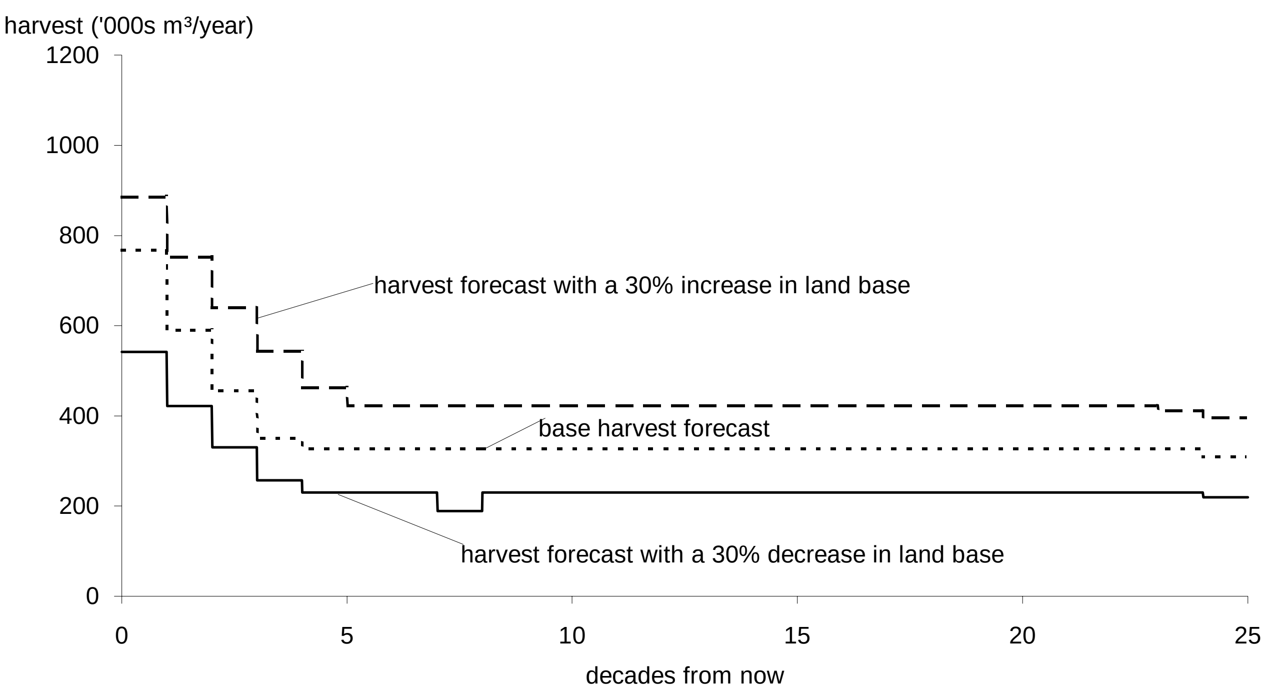

Figure 23. Harvest forecast with the area of the deciduous timber harvesting land base changed by 30%, Dawson Creek TSA.

The dashed line in Figure 24 shows the effect on the deciduous base harvest forecast of decreasing the minimum harvestable ages for all deciduous stands by 10 years. Younger minimum harvestable ages make a slightly greater volume of timber available in the short term. As a result, the starting harvest level can be increased to about 788 000 cubic metres per year, 3% higher than the starting harvest level in the base harvest forecast. The harvest level still declines by about 23% per decade after the first decade to a steady long-term harvest level that is unchanged from the base case.

The solid line in Figure 24 shows the effect on the harvest forecast of increasing the minimum harvestable ages for all deciduous stands by 10 years. Increasing all minimum harvestable ages makes less timber available for harvesting over the short term. As a result, the starting harvest level must be reduced to about 720 000 cubic metres per year, about 6% lower than in the base harvest forecast. The steady long-term harvest level is again unaffected by the change in minimum harvestable ages.

The reason that the steady long-term harvest level is not affected by either increasing or decreasing minimum harvestable ages is that in the base case minimum harvestable ages are already less than the culmination ages for all forest stands (see discussion of culmination ages in Section 4.2, "Deciduous base harvest forecast.") Therefore, no long-term timber supply benefits can be gained by reducing the minimum harvestable ages further since the maximum long-term harvest level is achieved by harvesting at an older age. Increasing the minimum harvestable ages by 10 years simply places the minimum harvestable ages closer to the culmination ages. In general, only if the minimum harvestable ages are increased to beyond the culmination age, do they affect the steady long-term harvest level.

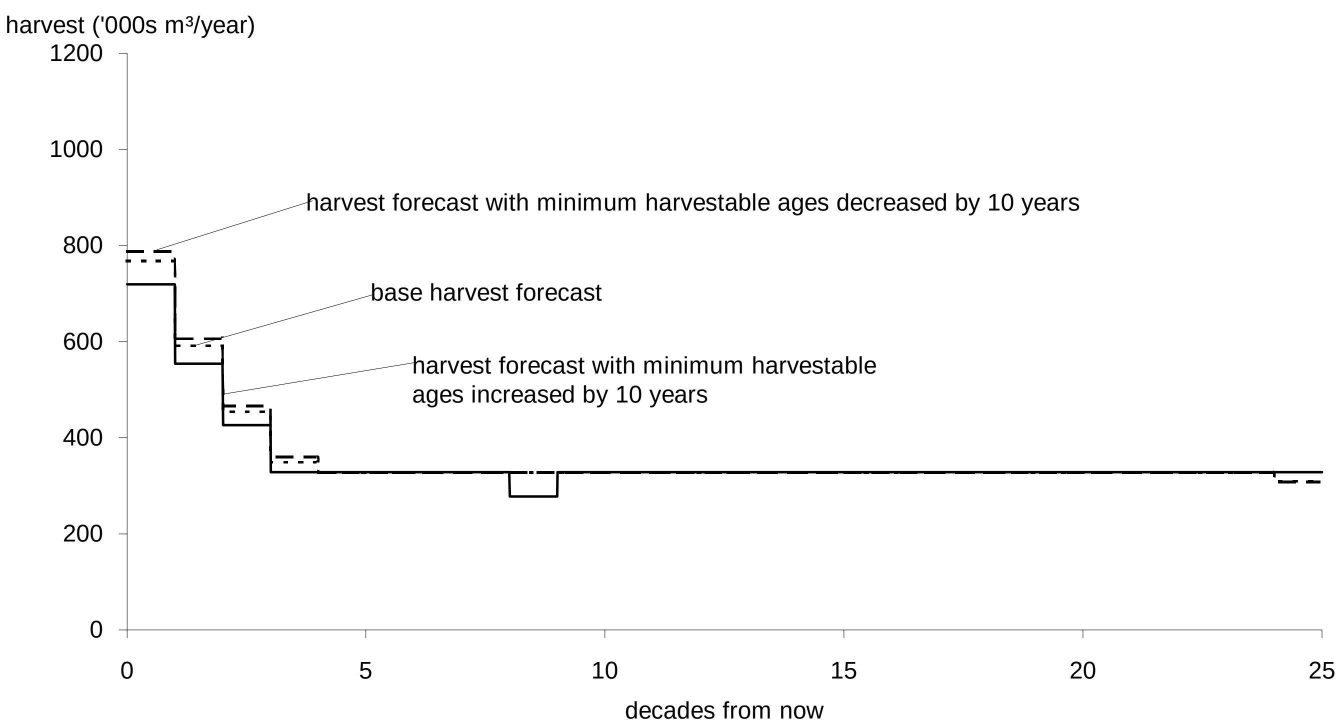

Figure 24. Harvest forecast with minimum harvestable ages for deciduous stands changed by 10 years, Dawson Creek TSA.

5.2.5 Uncertainty in cutblock adjacency guidelines, deciduous timber supply

In the deciduous base harvest forecast, the forest cover requirement used to model cutblock adjacency and green-up is based on the assumption that a maximum of 33% of the timber harvesting land base may be forested with trees less than 3 metres tall at any time. However, this forest cover requirement should only be viewed as an average forest cover requirement that applies to areas with no overriding management concerns such as visual quality. Site specific forest cover requirements will vary from this average requirement. Uncertainty in the average forest cover requirement used to model cutblock adjacency and green-up in this analysis stems from these site specific variations from the average.

The results of this sensitivity analysis show that forest cover requirements used to model cutblock adjacency and green-up are not a limiting factor in the base case. Therefore, relaxing this forest cover requirement so that more of the forest can be non-greened-up has no effect on the deciduous harvest forecast. Making this forest cover requirement more stringent so that a maximum of only 25% of the area may be non-greened-up (rather than 33% as in the base case) also has very little effect on the deciduous harvest forecast, as shown by the solid line in Figure 25. The reason that changes in cutblock adjacency requirements do not have an effect on the harvest forecast is that, in general, regenerated deciduous stands grow very quickly to the 3 metre height necessary to meet green-up requirements.

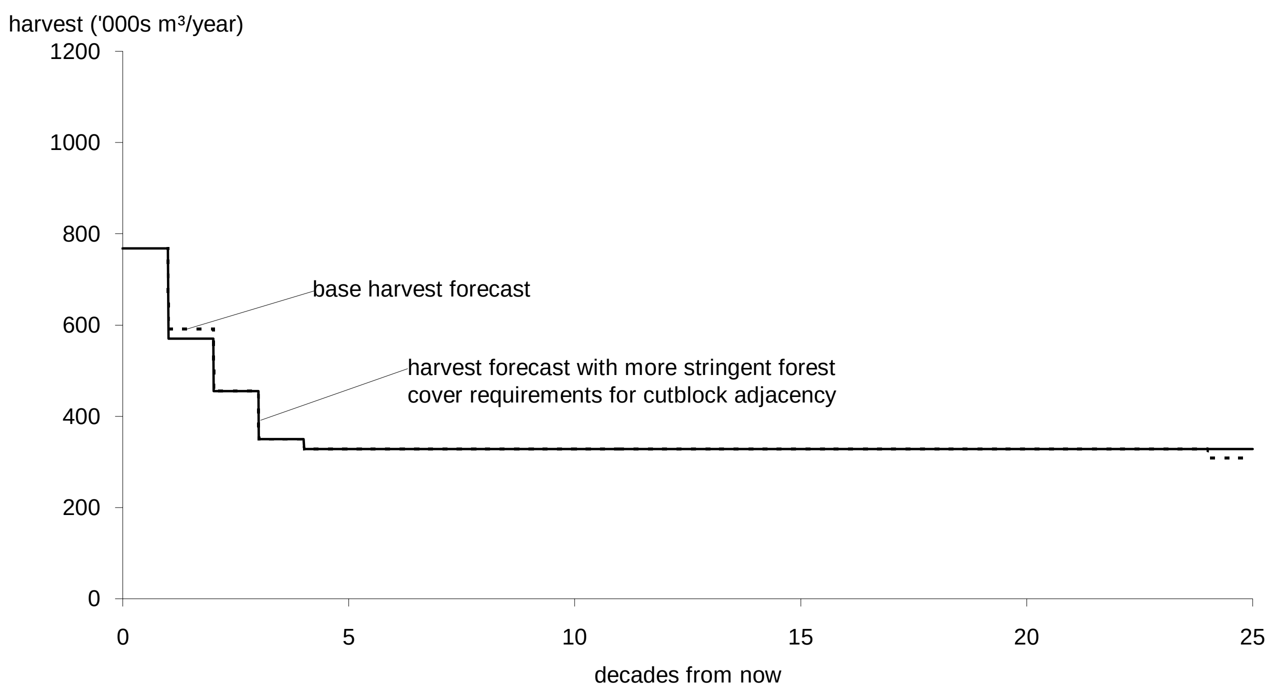

Figure 25. Deciduous harvest forecast with a more stringent cutblock adjacency requirement, Dawson Creek TSA.

5.2.6 Uncertainty in forest cover requirements for visual quality, deciduous timber supply

In the base case, forest cover requirements for visually sensitive areas define the maximum percentage of a visually sensitive forest area that is permitted to be not greened-up at any time. Uncertainty in these forest cover requirements stems from the subjective way in which areas are categorized as being more or less visually sensitive to harvesting activities.

The solid line in Figure 26 shows the effect on the deciduous harvest forecast if the forest cover requirements are relaxed so that an additional 5% of each visually sensitive area may be non-greened-up at any time. The starting harvest level is increased by about 4% to 798 000 cubic metres per year. Both the rate of decline in the harvest level after the first decade and the steady long-term harvest level are approximately the same as in the base harvest forecast.

The dashed line in Figure 26 shows the effect on the deciduous harvest forecast if forest cover requirements for visual quality are made more stringent so that 5% less of each visually sensitive area may be non-greened-up at any time. The starting harvest level is reduced to about 739 000 cubic metres per year (4% lower than in the base harvest forecast), but the rate of decline in the harvest level and the steady long-term harvest level remain approximately the same as in the base harvest forecast.

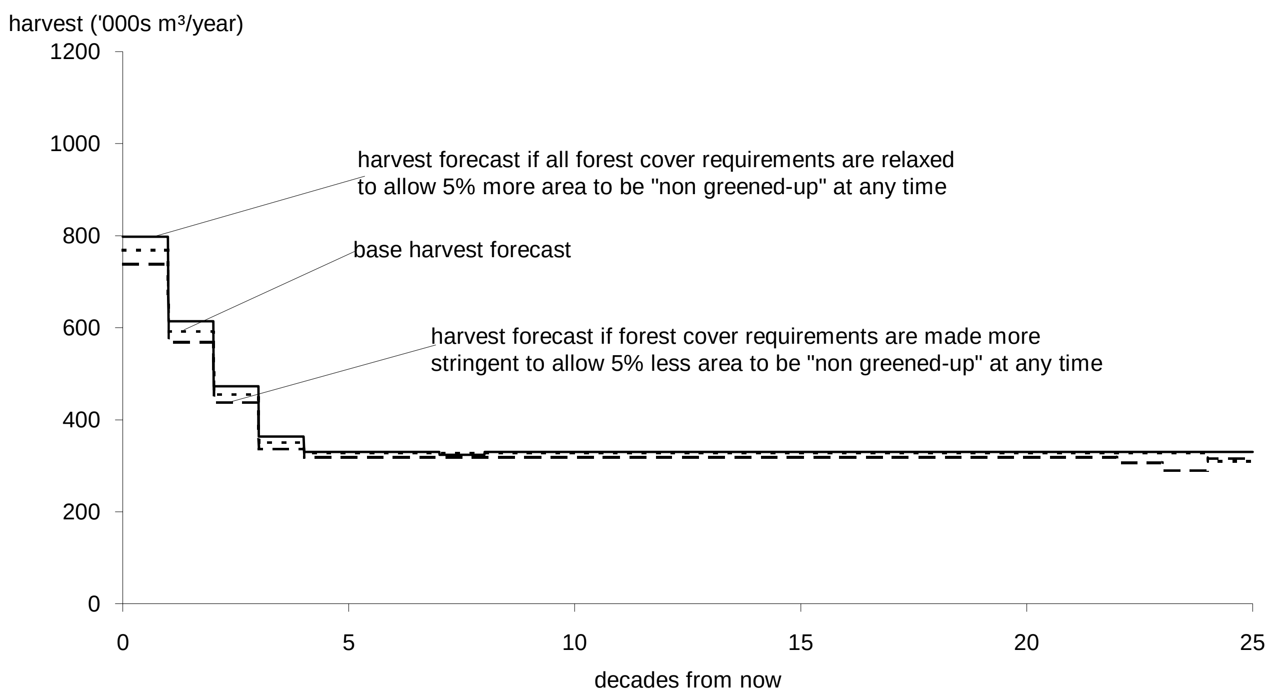

Figure 26. Deciduous harvest forecast with increased and decreased forest cover requirements for visual quality, Dawson Creek TSA.

5.2.7 Uncertainty in required green-up periods, deciduous timber supply

As discussed in Section 2.3, "Management practices", the required green-up periods used in the base harvest forecast are the estimated number of growing years required before the trees on a previously harvested area reach a required height. Uncertainty in the required green-up period stems from both the uncertainty in stand height growth rates as well as the subjectivity of the height requirement before the stand is considered greened-up.

The effect of extending the required green-up periods for all areas (both visually sensitive areas and non-visually sensitive areas) by 5 years is shown by the solid line in Figure 27. The starting harvest level is reduced by 4% from the base harvest forecast to about 739 000 cubic metres per year. The rate of harvest declines over time to a steady long-term harvest level of about 322 000 cubic metres per year, 2% lower than in the base case. This effect is due mainly to a reduced rate of harvesting from visually sensitive areas. Even with the green-up period extended by 5 years, the forest cover requirements used to model cutblock adjacency are not limiting on the harvest forecast.

As shown by the dashed line in Figure 27, reducing the required green-up periods for all areas by 5 years allows the initial harvest rate to be increased to about 4% above the starting harvest level in the base harvest forecast. The rate at which the harvest level declines after the first period is the same as in the base case. The steady long-term harvest level is increased by less than 1% from the base harvest forecast.

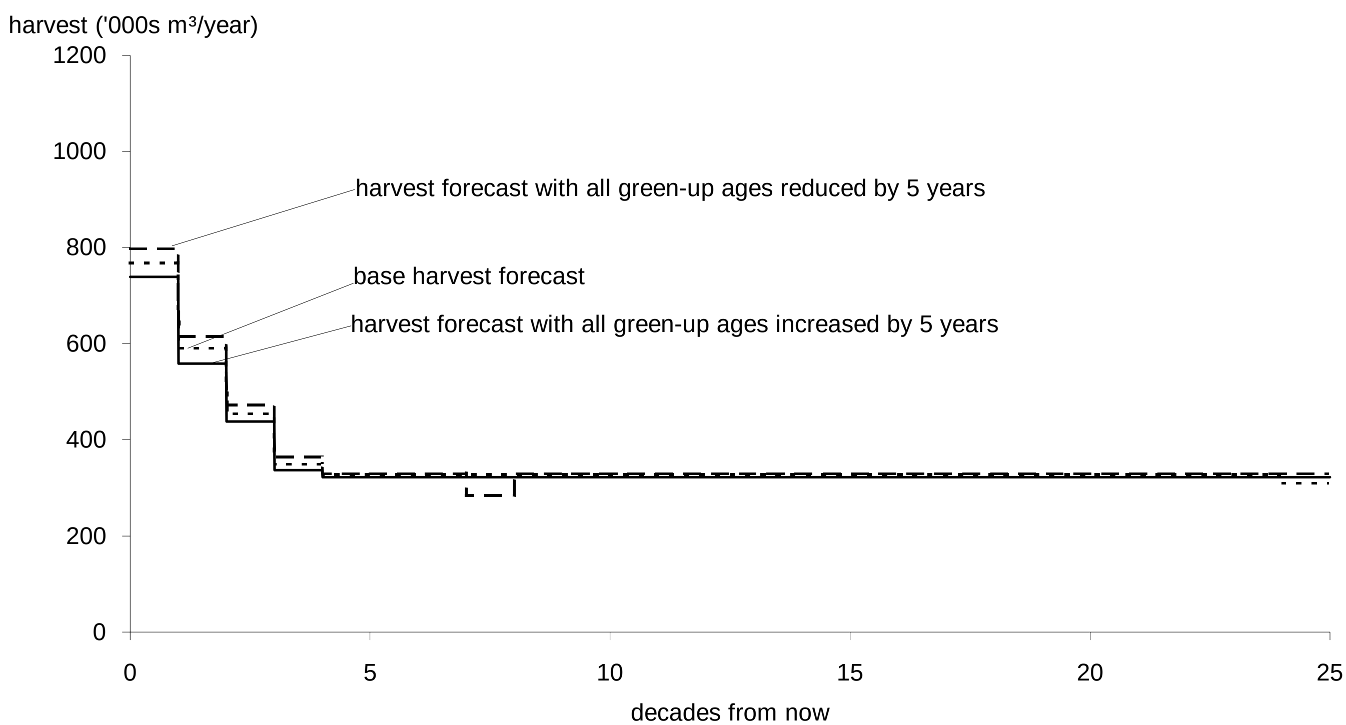

Figure 27. Deciduous harvest forecast with all green-up periods changed by 5 years, Dawson Creek TSA.

5.2.8 Uncertainty about removing all forest cover requirements, deciduous timber supply

The following sensitivity analysis examines the effect that removing all forest cover requirements for cutblock adjacency and management of visually sensitive areas has on the deciduous harvest forecast. The solid line in Figure 28 shows the harvest forecast with all forest cover requirements removed. The starting harvest level can be increased by 5% to about 808 000 cubic metres per year. After the first decade, the harvest level still declines by 22% per decade, to a steady long-term level that is virtually unchanged from the base harvest forecast. This result demonstrates that forest cover requirements are not a major factor in the deciduous harvest forecast for the Dawson Creek TSA.

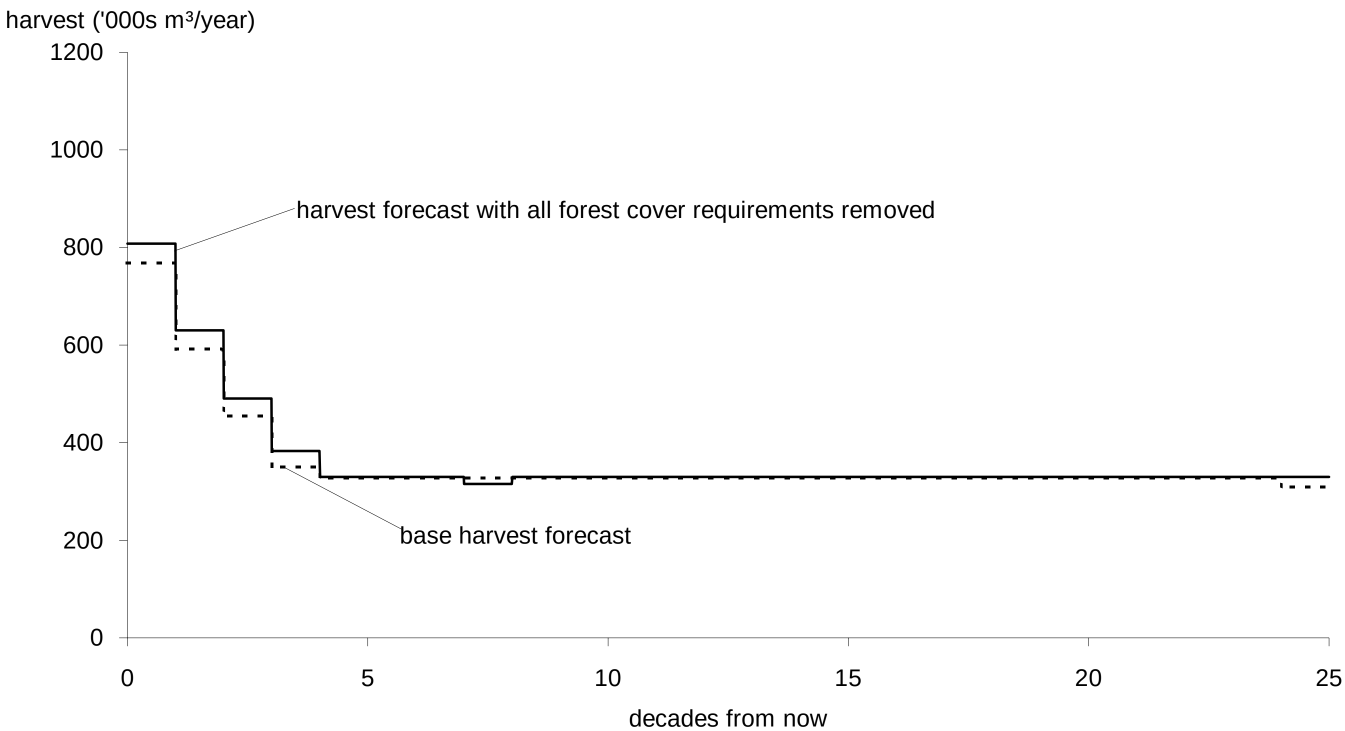

Figure 28. Deciduous harvest forecast with all forest cover requirements removed, Dawson Creek TSA.

5.2.9 Uncertainty in both deciduous stand timber yield estimates and the area of the deciduous timber harvesting land base

Sections 5.2.2, "Uncertainty in deciduous stand volume estimates" and 5.2.3, "Uncertainty in the area of the deciduous timber harvesting land base" examine the effect on the harvest forecast of changes to deciduous stand volume estimates and changes to the area of the deciduous timber harvesting land base. This section examines the effect on the deciduous harvest forecast of changing both assumptions concurrently.

The dashed line in Figure 29 shows the effect on the deciduous harvest forecast if both the area of the deciduous timber harvesting land base and the estimated deciduous stand volumes are increased by 30%. The starting harvest level can be increased to the current AAC (excluding designated woodlots) of 985 000 cubic metres per year. After 20 years at the current AAC, the harvest level declines by only 15% per decade to a steady long-term harvest level of about 560 000 cubic metres per year. This harvest level is approximately 70% higher than the steady long-term harvest level in the base harvest forecast, shown by the dotted line in Figure 29.

The effect on the deciduous harvest forecast of reducing both the area of the timber harvesting land base and the deciduous stand volume estimates by 30% is shown by the solid line in Figure 29. These changes significantly decrease the deciduous timber supply in both the short and long term. The starting harvest level is reduced by 50% from the base harvest forecast. The steady long-term harvest level is also reduced by about 50% from the base case.

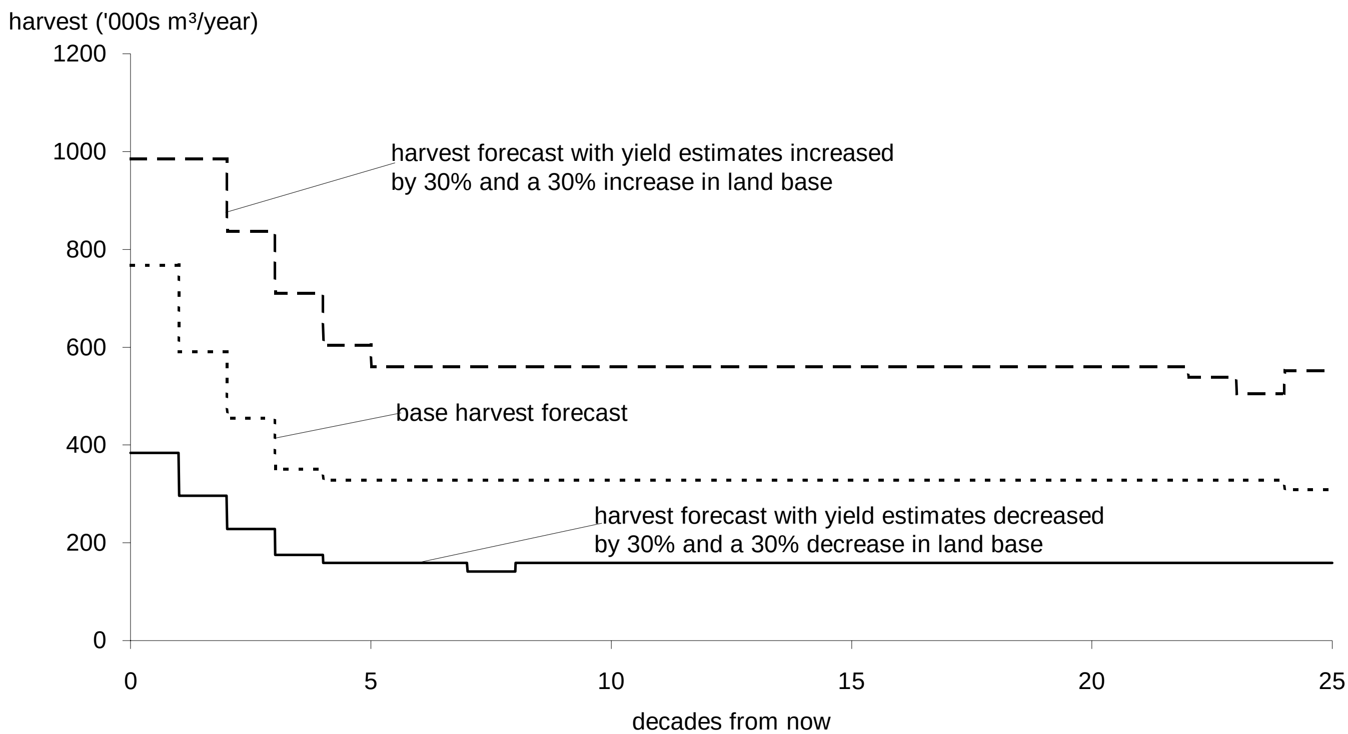

Figure 29. Deciduous harvest forecast with changes to the area of the timber harvesting land base and timber yield estimates concurrently, Dawson Creek TSA.

6 Summary and Conclusions

The results of this analysis indicate that the coniferous timber supply in the Dawson Creek TSA is capable of supporting a non-declining harvest level that is 12% higher than the current AAC (excluding designated woodlot areas) of 841 323 cubic metres per year. However, this analysis also indicates that the current AAC from deciduous stands cannot be supported, and that the rate of harvest from these stands must be reduced to avoid severe shortfalls in the deciduous timber supply in the future.

The projected increase in the coniferous timber supply is due primarily to the inclusion of small pine types that have not been previously considered harvestable. Over the long term, these pine stands contribute about 16% of the total coniferous harvest. Another important factor contributing to the increase in the coniferous timber supply is increased timber yield estimates for regenerated stands. In general, regenerated stands are assumed to be more productive in terms of timber than the existing stands that they are replacing.

The results of sensitivity analysis indicate that the coniferous base harvest forecast is not significantly affected by changes to forest management assumptions, especially in the short term. Due to the even-flow harvest level, the large inventory of older existing coniferous stands is harvested relatively slowly over the first 150 to 200 years modelled. Maintaining this large inventory over the short term provides a great deal of flexibility for dealing with changes in forest management assumptions.

The immediate and severe shortfall in the deciduous timber supply occurs in part because the deciduous timber harvesting land base is smaller than indicated in previous timber supply estimates. However, the most significant factor affecting the deciduous timber supply is that the estimated yield of timber from deciduous stands is now far less than previously estimated.

Uncertainty associated with either the area of the deciduous land base or estimated stand timber yields could have a dramatic effect in both the short and long term on the deciduous harvest forecast.

7 References

B.C. Ministry of Forests, Prince George Forest Region. 1989. Dawson Creek TSA Deciduous Timber Supply Analysis. Prince George, B.C.

B.C. Ministry of Forests, Prince George Forest Region. 1989. Dawson Creek TSA Supplemental Coniferous Timber Supply Analysis. Prince George, B.C.

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.

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., height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

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

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

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

8 Glossary

Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Modification VQO	Alterations may cominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity. (see Visual quality objective)
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked	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.
Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective)
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity. (see Visual quality objective)
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.*
Visual Quality Objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

APPENDIX A

Description of Data Inputs and Assumptions

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Dawson Creek 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 concerns. 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 (i.e. concerns about visual quality of the landscape). The zones used in the timber supply review for the Dawson Creek TSA are listed in Table A-1.

Table A-1. Definition of forest management zones

Forest management zone	Forest cover type	Special forest resource concerns
1	Coniferous leading	No special concerns
2	Coniferous leading	Retention VQO
3	Coniferous leading	Partial Retention VQO
4	Coniferous leading	Modification VQO
11	Deciduous leading	No special concerns
12	Deciduous leading	Retention VQO
13	Deciduous leading	Partial Retention VQO
14	Deciduous leading	Modification VQO

Forest resource concerns listed in Table A-1. are identified on the inventory file by the first two characters in the "recreate" variable field as follows:

02 = retention visual quality objective;

03 = partial retention visual quality objective;

04 = modification visual quality objective.

Any record that did not fall into one of the above categories is assumed to have no special forest resource concerns.

A.1.2 Analysis unit characteristics

Within each forest management zone, the forested area is divided into analysis units which are based primarily on the leading tree species and site class.

A.1 Zone and Analysis Unit Definition

Table A-2. Analysis unit characteristics

Analysis unit	Type groups	Site class	Other
1 Spruce, good site	21 - 26	G	
2 Spruce, medium site	21 - 26	M	
3 Spruce, poor site	21 - 26	P	
4 Pine, good site	28 - 31	G	
5 Pine, medium site	28 - 31	M	
6 Pine, poor site	28 - 31	P	
7 Balsam, good site	1 - 20	G	
8 Balsam, medium site	1 - 20	M	
9 Balsam, poor site	1 - 20	P	
10 Aspen, good site	37, 41, 42	G	
11 Aspen, medium site	37, 41, 42	M	
12 Aspen, poor site	37, 41, 42	P	
13 Cottonwood, good/medium site	35, 36	G,M	
14 Cottonwood, poor site	35, 36	P	
15 Coniferous minor	35 - 37, 41,42	All	Greater than 120 m^3/hectare coniferous volume
16 Height class 2 Pine	28 - 31	All	Height class 2, but taller than 17.5 metres

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.

Timber in the Dawson Creek TSA is currently used to the utilization levels shown in Table A-3.

Table A-3. Utilization levels

Species	Diameter at breast height (cm)	Top diameter (cm)	Stump height (cm)
Spruce	17.5	10	30
Balsam	17.5	10	30
Pine	12.5	10	30
Cottonwood/Aspen	12.5	10	30

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Inventory file status

Forest cover polygon information in the Dawson Creek TSA inventory file is projected to January 1994.

A.3.2 Non-contributing ownership codes

All areas that are not designated as being ownership code 62C (Crown forest management unit available for long term integrated resource management), 69C (miscellaneous reserves available for long-term integrated resource management), or 78N (community pastures) 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) and 6 (non-forest) are excluded from the timber harvesting land base.

A.3.4 Inoperable areas

Areas defined on the inventory file as inoperable for timber harvesting (operable = I) are excluded from the timber harvesting land base. An additional 2% of the forested area is removed equally from all types and sites to account for several areas that have been labeled operable on the inventory file, but are known by district staff to be inoperable (hanging valleys, etc.).

A.3.5 Not satisfactorily restocked areas

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.

A.3.6 Highly sensitive soils

Areas with highly sensitive soils that are susceptible to damage by timber harvesting are excluded from the timber harvesting land base. These areas are identified using the environmentally sensitive area information (ES1) on the inventory file.

A.3.7 Fish and wildlife habitat

Areas having high wildlife habitat value are identified on the inventory file using the environmentally sensitivity area information (EW1). Ninety per cent of these areas are assumed to be unavailable for timber harvesting and are excluded from the timber harvesting land base. An additional 1% of the forested area is excluded from all forest types and sites to account for the protection of streamside buffers and other riparian areas.

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Uneconomic forest types

Forest types that are not currently harvested and are excluded from the timber harvesting land base are identified in Table A-4. All types shown are 100% excluded.

Table A-4. Uneconomic forest types

Forest type	Species label	Type groups	Age class	Height (metres)	Volume (m^3/hectare)	Site index (BHA 50)	Other
Black spruce	Sb						
Larch		33,34					
Cottonwood					< 120 coniferous		Deciduous usage area[b] = 2 or 3
Aspen					< 120 coniferous		Deciduous usage area[b] = 3
Pine							Stocking class 4
Pine[a]		28 - 31	7,8,9	<17.5	<120		
Pine		28 - 31	3 - 6			< 11	
Spruce/Balsam[a]		1 - 27	8, 9	<17.5	<120		
Spruce		21 - 26	3 - 7			< 7.5	
Balsam		1 -20	3 - 7			< 9.5	
Cottonwood/Aspen			6 - 9		<120		
Cottonwood						< 7	
Aspen						< 14	
Non-merchantable deciduous		38, 40					

(a) If either the height or the timber volume per hectare criteria are not met, the area is excluded

(b) Deciduous usage areas are geographically defined by planning cell in Section A.4.10 and are used to model the usage of cottonwood, balsam poplar and aspen which varies by area. Deciduous usage areas are explained further in Section A.4.7 Yield Assumptions

A.3.9 Recreation areas

Areas designated as feature significance A, B, and C and management class 0 in the recreate field on the inventory file, or that have a preservation visual quality objective (the first two characters in the recreate field are 01) are excluded from the timber harvesting land base. Areas that are designated as feature significance B and management class 1 are 20% excluded.

A.3.10 Roads, trails and landings

The area currently under existing roads, trails and landings was determined by digitally reviewing each mapsheet in the Dawson Creek TSA. The operable forest area currently under roads, trails and landings is estimated to total 19 442 hectares. Future roads, trails and landings are modeled by excluding a percentage of all stands older than 30 years after the first harvest (to simulate the harvest of right-of-way timber). The total forest area that will eventually be lost to roads, trails and landings (sum of both existing and future) is assumed to equal 5% of the timber harvesting land base.

A.4 Forest Management Assumptions

A.4.1 Forest cover requirements

Table A-5. specifies the forest cover requirements used to model current forest management objectives for each zone.

Table A-5. Forest cover requirements for each forest management zone

Forest management zone		Age 1	Maximum per cent area younger than age 1
1	Coniferous leading, general	23	33
2	Coniferous leading, retention VQO	27	6
3	Coniferous leading, partial retention VQO	30	13
4	Coniferous leading, modification VQO	28	24
11	Deciduous leading, general	10	33
12	Deciduous leading, retention VQO	15	8
13	Deciduous leading, partial retention VQO	15	14
14	Deciduous leading, modification VQO	15	29

In forest management zones 1 and 11, forest cover requirements are intended to model cutblock adjacency requirements. Given current cutblock adjacency requirements in the Dawson Creek TSA, roughly one-third of any area in which harvesting is occurring is harvested with each subsequent harvest, and forested areas adjacent to any previously harvested area may not be harvested until the previously harvested area has reached at least 3 metres in height. The forest cover requirement shown for zones 1 and 11 reflects the effect of cutblock adjacency requirements by specifying that a maximum of one-third (33%) of the area in each zone may be less than age 1 (the average time required for regenerated stands to achieve a height of 3 metres).

In all other forest management zones, the forest cover requirements are based on provincial guidelines for managing forest cover in visually sensitive areas. These guidelines define the maximum per cent of the landscape that may be visually non-greened-up (previously harvested, covered with trees less than 5 metres tall).

Age 1 for all zones with visual quality objectives represents the average time required for regenerated stands to achieve a 5 metre height. The maximum percentage of each zone that may be less than age 1 is based on the following assumptions:

Retention VQO — 5% of the gross forested area may be less than 5 metres tall;

Partial retention VQO — 10% of the gross forested area may be less than 5 metres tall;

Modification VQO — 20% of the gross forested area may be less than 5 metres tall.

The above per cents are then adjusted using the methods outlined in *Recreation Branch Technical Report 1993:1, Procedures for Factoring Recreation Resources into Timber Supply Analyses*. The gross green/operable ratio used in the calculation is determined separately for each zone, and default values for dispersion identified in the technical report are used.

A.4.2 Not satisfactorily restocked (NSR) areas

The forested area that has been harvested or destroyed by natural causes such as fire, but is currently not satisfactorily restocked with trees (NSR), is assumed to be restocked with trees according to the schedule shown in Table A-6.

A.4 Forest Management Assumptions

Table A-6. NSR restocking

Zone	Analysis unit	Age (years)	Area (hectares)
1	1	5	390.6
1	2	5	6334.3
1	3	5	1996.4
1	4	5	156.7
1	5	5	3887.8
1	6	5	4984.0
1	9	5	172.2
2	1	5	9.0
2	2	5	145.9
2	3	5	46.0
2	4	5	3.6
2	5	5	89.5
2	6	5	114.8
2	9	5	4.0
3	1	5	42.2
3	2	5	683.5
3	3	5	215.4
3	4	5	16.9
3	5	5	419.5
3	6	5	537.8
3	9	5	18.6
4	1	5	64.2
4	2	5	1041.3
4	3	5	328.2
4	4	5	25.8
4	5	5	639.1
4	6	5	819.4
4	9	5	28.3
11	10	5	62.3
11	11	5	3246.6
11	12	5	1499.8
11	13	5	219.0
11	14	5	71.9
12	10	5	4.5
12	11	5	232.5
12	12	5	107.4
12	13	5	15.7
12	14	5	5.1
13	10	5	2.5
13	11	5	128.9
13	12	5	59.5
13	13	5	8.7
13	14	5	2.9
14	10	5	21.8
14	11	5	1135.0
14	12	5	524.3
14	13	5	76.6
14	14	5	25.1

continued

Table A-6. NSR restocking (concluded)

Zone	Analysis unit	Age (years)	Area (hectares)
1	2	-5	532.7
1	3	-5	1032.9
1	5	-5	1014.4
1	6	-5	788.2
2	2	-5	12.3
2	3	-5	23.8
2	5	-5	23.4
2	6	-5	18.2
3	2	-5	57.5
3	3	-5	111.5
3	5	-5	109.5
3	6	-5	85.1
4	2	-5	87.6
4	3	-5	169.8
4	5	-5	166.8
4	6	-5	129.6

A.4 Forest Management Assumptions

A.4.3 Unsalvaged losses

Unsalvaged losses are timber volumes destroyed by natural causes. 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-7. shows the estimated average annual unsalvaged losses in the Dawson Creek TSA.

Table A-7. Unsalvaged losses

Cause of loss	Gross losses (m^3/year)	Salvaged volume (m^3/year)	Unsalvaged losses (m^3/year)
Insects	30 000	6 000	24 000
Fire	20 000	15 000	5 000
Wind	30 000	15 000	15 000
Total	80 000	36 000	44 000

Fire losses are determined from the forest inventory reporting system and from the protection database for the period from 1987 to 1993. The remaining information is taken from Dawson Creek Forest District surveys.

A.4.4 Minimum harvestable age for each leading species and site class

Table A-8. lists the minimum harvestable age for each leading species/site class combination. Minimum harvestable ages are based on the age at which the average annual volume growth of a stand is within 5% of its maximum.

Table A-8. Minimum harvestable age by leading species and site class

Species/site	Minimum harvestable age (years)	Volume (m^3/hectare) at minimum harvestable age	Estimated DBH (cm) of 250 largest stems at minimum harvestable age
Spruce, good	80	357	33.1
Spruce, medium	100	301	31.4
Spruce, poor	150	212	28.7
Pine, good	60	257	27.8
Pine, medium	70	188	25.4
Pine, poor	90	154	24.0
Balsam, good	70	248	29.6
Balsam, medium	80	190	27.7
Balsam, poor	130	189	27.8
Aspen, good	60	193	24.6
Aspen, medium	70	131	22.4
Aspen, poor	80	82	18.2
Cottonwood, good/medium	70	133	23.6
Cottonwood, poor	80	98	20.7
Coniferous minor	70	-	-
Pine, height class 2	80	141	23.5

A.4 Forest Management Assumptions

A.4.5 Basic silviculture and regeneration assumptions

Basic silviculture is assumed to be continued indefinitely into the future. The expected average regeneration delay (time before an area is restocked with trees) for all species and growing site types is 4 years. All areas harvested are assumed to be restocked with the same tree species that were harvested from the area with the exception of areas in which balsam is the leading species. Balsam leading stands are assumed to be regenerated with spruce after harvesting.

A.4.6 Existing immature plantations

To reflect the expected productivity of managed stands resulting from past harvesting, all existing coniferous stands less than 5 years old and all deciduous stands less than 8 years old are assigned immediately to regenerated stand yield tables in the timber supply model.

A.4.7 Yield assumptions

Yield tables for all existing coniferous stands and all deciduous stands were developed using a batch processing version of the Variable Density Yield Prediction (VDYP) growth and yield model provided by B.C. Forest Service, Inventory Branch. All yield tables assume the utilization levels identified in Section A.2, "Utilization Levels."

The data requirements for the VDYP model are obtained from existing stand information on the 1994 inventory file provided by Inventory Branch.

Regenerated stand yield tables for all coniferous types were produced using the Table Interpolation Program for Stand Yields (TIPSY) growth and yield model (Version 2.1.3) developed by B.C. Forest Service, Research Branch. These regenerated stand yield tables are based on the following assumptions:

- a pure species composition;
- the mean area weighted site index for each analysis unit;
- waste and breakage in regenerated stands is assumed to be accounted for in operational adjustment factors used in the TIPSY model inputs. The specific operational adjustment factors used were:
  - Operational adjustment factor 1 - 15%;
  - Operational adjustment factor 2 - 5%.

A.4.8 Reductions for waste and breakage

Aggregated waste and breakage factors applied to existing stands 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 and each Public Sustained Yield Unit (PSYU), species and utilization level.

A.4.9 Existing immature plantations

To reflect the expected higher productivity of regenerated stands, all coniferous stands less than 5 years old are assigned immediately to a regenerated stand yield table in the timber supply model.

A.4.10 Deciduous Usage Areas Defined By Planning Cell

Deciduous Usage Area 1, in which both aspen and cottonwood timber volumes are included, is composed of the following planninbg cells:

B045 B036 B035 B034 D067 D619 D618 D057 D696
D040 D027 D025 B017 B013 B012 B015 B010 B008
B007 B006 B003 B004 B014 B009 B016 B604 D084
D607 D606 D085 D605 D684 D603 D074 D075 D640
D641 D085 D656 D086 D675 D674 D655 D654 D072
D653 D652 D651 D649 D648 D650 D072 D644 D673
D672 D071 D634 D633 D669 D083 D070 D601 D624
D070 D626 D627 D602 D069 D628 D629 D630 D631
D622 D642 D645 D071 D646 D632 D635 D636 D637
D718 D071 D713 D708 D707 D709 D710 D711 D667
D666 D664 D663 D665 D620 D621 D622 D714 D069
D623 D625 D069 D661 D659 D662 D660 D676 D677
D678 D679 D682 D668 D643 D044 D045 D698 D684
D683 D682 D680 D681 D042 D028 D029 D750 D704
D040 D026 D041 D705 D694 D695 D696 D658 D644
D601 D604 D608 D618 D619 D647 D731 D732 B017
D024 A300 D025 D026 D027 D042 D057 D064 D067
D670 D671 D083 D723 D731 D091 D232 D023

Deciduous Usage Area 2, in which cottonwood timber volumes are excluded, is composed of the following planning cells:

D087 D082 B002 D081 D080 D088 B021 D078 D079
B002 B021 D088 D062 D061 D056 D610 D611 D609
D638 D055 D068 D612 D617 D613 D614 D616 D689
D691 D692 D058 D656 D615 D639 D059 D693 D697
D039 D090 D054 D036 D035 D687 D054 D053 D686
D034 D052 D033 D688 D037 D089 D720 D721 D722
D719 D016 D701 D703 D702 D018 D089 D685 D019
D726 D022 D021 D020 D726 D012 D011 D727 D733
D734 D013 D017 D015 D016 D014 D038 D690 D010
D002 D003 D004 D005 D006 D009 D700 D728 D729
D730 D712

All planning cells not in Deciduous Usage Area 1 or 2 are by default in Deciduous Usage Area 3 (aspen and cottonwood volumes not used)

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. shows the existing and regenerated volume over age tables for each species and site type included in the analysis. The appropriate regeneration delay, as discussed in Section A.4.5 is applied to regenerated stands in the timber supply model.

Table A-9.   Volume (cubic metres) over age (years) for each species/site type combination

	Existing Spruce			Existing Pine		
Age	Good site DUA 1	Medium site DUA 1 Volume	Poor site DUA 1	Good site DUA 1	Medium site DUA 1 Volume	Poor site DUA 1
10	0	0	0	0	0	0
20	0	0	0	0.09	0.02	0.01
30	0.02	0	0	22.9	1.26	0.07
40	9.07	0.36	0.01	74.8	31.39	5.32
50	57.91	6.9	0.24	124.42	71.65	28.27
60	116.91	41.83	1.35	167.41	108.96	57.33
70	169.86	87.21	7.75	205.24	142.4	84.63
80	215.9	129.12	21.74	238.29	172.31	109.63
90	255.47	166.36	40.19	268.01	199.63	132.81
100	289.37	199.57	59.99	294.76	224.57	154.31
110	318.3	229.06	80.22	318.98	247.44	174.34
120	343.16	255.21	100.17	341.06	268.53	193.07
130	365.26	279.14	120.11	361.51	288.19	211.18
140	383.44	299.49	139.04	375.29	301.72	224.18
150	398.98	317.14	157.29	386.05	312.39	234.68
160	410.61	330.99	173.97	393.14	319.8	242.5
170	420.4	342.94	189.41	397.35	324.47	247.88
180	428.56	353.19	203.66	398.69	326.42	250.84
190	435.21	361.88	216.8	397.19	325.67	251.38
200	441.65	370.22	229.28	399.25	328.02	254.32
210	447.38	377.79	240.99	401.64	330.6	257.35
220	452.48	384.65	251.97	404.12	333.2	260.32
230	457.02	390.84	262.27	406.61	335.73	263.16
240	461.05	396.42	271.93	409.01	338.16	265.81
250	464.61	401.45	280.99	411.33	340.44	268.29
260	467.57	405.74	288.3	413.48	342.54	270.53
270	470.2	409.6	295.12	415.49	344.49	272.58
280	472.51	413.05	301.49	417.36	346.28	274.44
290	474.52	416.12	307.43	419.11	347.9	276.09
300	476.29	418.84	312.97	420.72	349.37	277.58
310	477.82	421.28	318.13	422.18	350.67	278.89
320	479.14	423.43	322.94	423.52	351.83	280.04
330	480.28	425.34	327.39	424.72	352.84	281.02
340	481.24	427.03	331.52	425.79	353.7	281.83
350	482.05	428.51	335.33	426.73	354.42	282.48

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Balsam			Existing Aspen		
	Good site DUA 1	Medium site DUA 1	Poor site DUA 1	Good site DUA 1	Medium site DUA 1	Poor site DUA 1
Age	Volume			Volume		
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	15.29	1.42	0.01	36.06	2.01	0
40	57.31	19.24	0.68	92.56	29.17	3.2
50	102.74	51.48	4.87	145.03	65.31	21.23
60	145.21	85.18	14.3	192.79	99.2	43.53
70	186.5	119.87	30.94	235.78	130.85	64.59
80	221.72	148.49	47.43	268.26	155.82	82
90	251.16	173.08	62.57	296.39	177.57	97.26
100	276.89	195.04	76.78	318.99	195.44	110.07
110	299.59	214.75	90.09	336.19	209.39	120.4
120	319.58	232.46	102.24	348.15	219.52	128.33
130	342.47	251.95	115.06	355.02	225.93	133.92
140	364.52	270.47	127.38	363.88	233.11	139.51
150	385.32	287.86	139.07	371.96	239.51	144.59
160	404.46	304.07	150.23	372.58	240.27	145.47
170	422.18	319.37	160.92	373.07	240.85	146.15
180	438.69	333.85	171.13	373.45	241.26	146.64
190	454.43	347.54	180.9	373.73	241.51	146.96
200	469.37	360.77	190.35	374.03	241.86	147.4
210	483.68	373.26	199.46	374.28	242.2	147.81
220	497.22	385.22	208.25	374.51	242.52	148.21
230	510.24	396.65	216.73	374.73	242.81	148.57
240	522.65	407.61	224.94	374.91	243.08	148.91
250	534.6	418.08	232.87	375.05	243.32	149.22
260	535.87	420.04	234.55	375.2	243.54	149.5
270	537	421.88	236.14	375.31	243.74	149.77
280	538.09	423.56	237.62	375.41	243.91	150
290	539.09	425.12	239.02	375.49	244.08	150.22
300	539.95	426.6	240.33	375.56	244.22	150.42
310	540.75	427.96	241.58	375.62	244.35	150.59
320	541.5	429.22	242.75	375.67	244.46	150.75
330	542.15	430.4	243.86	375.7	244.56	150.89
340	542.75	431.47	244.9	375.73	244.65	151.02
350	543.33	432.45	245.89	375.74	244.73	151.13

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Cottonwood		Existing Coniferous Minor	Existing Small Pine
	Good/medium site DUA 1	Poor site DUA 1	All sites DUA 1	All sites DUA 1
Age	Volume		Volume	Volume
10	0	0	0	0
20	0.01	0	0.2	0
30	2.08	0.01	8.98	0.04
40	27.44	0.96	43.77	4.28
50	68.59	20.67	85.34	31.29
60	103.61	49.1	124.2	62.55
70	133.01	75.26	157.87	91.73
80	156.94	97.68	185.75	118.52
90	177.23	117.23	209.7	143.41
100	194.34	134.27	230.02	166.55
110	208.75	149.16	247.11	188.13
120	220.85	162.17	261.31	208.34
130	231	173.59	273.21	227.43
140	240.22	183.87	283.52	240.91
150	248.47	193.18	292.42	251.71
160	248.96	193.88	296.18	259.7
170	249.33	194.41	299.11	265.06
180	249.62	194.81	301.3	267.83
190	249.8	195.06	302.73	268.02
200	250.04	195.4	304.58	270.89
210	250.25	195.72	306.3	273.86
220	250.45	196.02	307.89	276.78
230	250.63	196.29	309.34	279.58
240	250.79	196.55	310.66	282.21
250	250.94	196.77	311.86	284.66
260	251.07	196.97	312.89	286.9
270	251.18	197.16	313.82	288.94
280	251.29	197.33	314.66	290.79
290	251.38	197.48	315.4	292.45
300	251.46	197.61	316.06	293.93
310	251.53	197.73	316.64	295.22
320	251.59	197.82	317.16	296.35
330	251.64	197.92	317.6	297.3
340	251.68	197.99	317.98	298.09
350	251.72	198.06	318.3	298.73

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Spruce			Existing Pine		
	Good site DUA 2	Medium site DUA 2	Poor site DUA 2	Good site DUA 2	Medium site DUA 2	Poor site DUA 2
Age	Volume			Volume		
10	0	0	0	0	0	0
20	0	0	0	0.09	0.02	0.01
30	0.02	0	0	22.92	1.26	0.07
40	8.97	0.36	0.01	74	31.41	5.32
50	56.04	6.88	0.24	121.48	71	28.25
60	108.6	41.27	1.34	163.12	107.5	57.13
70	156.05	83.03	7.72	199.83	140.41	84.21
80	197.81	121.6	21.38	231.96	169.86	109.04
90	233.86	156.3	39.19	260.87	196.79	132.09
100	264.81	187.37	58.5	286.92	221.37	153.47
110	291.3	215.02	78.33	310.53	243.93	173.38
120	314.07	239.57	97.92	332.06	264.73	192
130	334.38	262.1	117.52	352.01	284.14	210.01
140	351.02	281.24	136.14	365.4	297.46	222.93
150	365.24	297.82	153.99	375.83	307.95	233.36
160	376.38	311.23	170.51	382.84	315.31	241.16
170	385.76	322.81	185.82	386.99	319.95	246.53
180	393.56	332.73	199.95	388.31	321.89	249.48
190	399.92	341.15	212.98	386.83	321.14	250.01
200	406.07	349.22	225.35	388.86	323.48	252.95
210	411.56	356.56	236.96	391.22	326.03	255.97
220	416.44	363.2	247.86	393.68	328.62	258.93
230	420.79	369.21	258.07	396.13	331.13	261.76
240	424.65	374.62	267.65	398.5	333.54	264.4
250	428.05	379.5	276.64	400.79	335.81	266.87
260	430.88	383.65	283.89	402.91	337.89	269.11
270	433.38	387.38	290.65	404.9	339.83	271.15
280	435.58	390.71	296.96	406.75	341.6	273
290	437.5	393.68	302.85	408.47	343.21	274.66
300	439.19	396.32	308.34	410.06	344.67	276.14
310	440.66	398.67	313.46	411.51	345.96	277.44
320	441.92	400.75	318.22	412.83	347.11	278.59
330	443.01	402.6	322.63	414.01	348.11	279.56
340	443.93	404.23	326.72	415.07	348.96	280.37
350	444.71	405.67	330.5	416	349.67	281.02

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Balsam			Existing Aspen		
Age	Good site DUA 2	Medium site DUA 2 Volume	Poor site DUA 2	Good site DUA 2	Medium site DUA 2 Volume	Poor site DUA 2
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	15.29	1.42	0.01	23.1	1.85	0
40	57.34	19.24	0.68	62.6	22.76	2.88
50	102.23	51.45	4.87	100.75	50.2	16.49
60	143.79	84.81	14.3	136.49	76.87	33.31
70	184.34	119.21	30.89	169.46	102.23	49.84
80	218.95	147.62	47.25	194.32	122.19	63.49
90	247.87	172.03	62.3	216.07	139.67	75.46
100	273.14	193.83	76.44	233.52	153.96	85.44
110	295.44	213.4	89.7	246.63	164.99	93.4
120	315.07	230.98	101.79	255.46	172.79	99.34
130	337.61	250.36	114.55	260.12	177.41	103.33
140	359.35	268.77	126.79	266.7	182.8	107.37
150	379.86	286.06	138.43	272.73	187.59	111.04
160	398.88	302.22	149.56	273.32	188.28	111.83
170	416.49	317.49	160.23	273.78	188.81	112.45
180	432.9	331.92	170.41	274.13	189.17	112.89
190	448.55	345.58	180.15	274.39	189.39	113.17
200	463.4	358.76	189.58	274.67	189.72	113.57
210	477.62	371.23	198.67	274.91	190.02	113.94
220	491.08	383.16	207.44	275.13	190.31	114.3
230	504.02	394.56	215.9	275.32	190.57	114.63
240	516.35	405.48	224.09	275.51	190.81	114.93
250	528.23	415.93	232.01	275.64	191.03	115.21
260	529.48	417.89	233.69	275.77	191.23	115.46
270	530.59	419.71	235.26	275.89	191.41	115.7
280	531.66	421.39	236.74	275.98	191.57	115.91
290	532.64	422.95	238.14	276.06	191.72	116.11
300	533.48	424.42	239.44	276.13	191.85	116.28
310	534.27	425.78	240.68	276.18	191.96	116.44
320	535	427.04	241.85	276.23	192.07	116.59
330	535.63	428.21	242.95	276.26	192.16	116.72
340	536.22	429.28	243.99	276.3	192.24	116.83
350	536.78	430.25	244.97	276.31	192.31	116.93

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Cottonwood		Existing Coniferous minor	Existing Small pine
	Good/medium site DUA 2	Poor site DUA 2	All sites DUA 2	All sites DUA 2
Age	Volume		Volume	Volume
10	0	0	0	0
20	0.01	0	0.01	0
30	2.08	0.01	1.74	0.04
40	27.44	0.96	16.27	4.28
50	68.59	20.67	41.13	31.3
60	103.61	49.1	65.86	62.21
70	133.01	75.26	88.69	91.12
80	156.94	97.68	107.94	117.7
90	177.23	117.23	124.74	142.41
100	194.34	134.27	139.09	165.39
110	208.75	149.16	151.15	186.82
120	220.85	162.17	161.1	206.88
130	231	173.59	169.28	225.85
140	240.22	183.87	176.41	239.22
150	248.47	193.18	182.51	249.92
160	248.96	193.88	186	257.88
170	249.33	194.41	188.78	263.23
180	249.62	194.81	190.89	265.99
190	249.8	195.06	192.36	266.18
200	250.04	195.4	194.14	269.03
210	250.25	195.72	195.78	271.99
220	250.45	196.02	197.29	274.9
230	250.63	196.29	198.68	277.69
240	250.79	196.55	199.92	280.31
250	250.94	196.77	201.06	282.76
260	251.07	196.97	202.04	284.98
270	251.18	197.16	202.92	287.02
280	251.29	197.33	203.73	288.86
290	251.38	197.48	204.43	290.51
300	251.46	197.61	205.07	291.98
310	251.53	197.73	205.63	293.27
320	251.59	197.82	206.13	294.39
330	251.64	197.92	206.56	295.34
340	251.68	197.99	206.93	296.13
350	251.72	198.06	207.25	296.76

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Spruce			Existing Pine		
	Good site DUA 3	Medium site DUA 3	Poor site DUA 3	Good site DUA 3	Medium site DUA 3	Poor site DUA 3
Age		Volume			Volume	
10	0	0	0	0	0	0
20	0	0	0	0.09	0.02	0.01
30	0.02	0	0	22.53	1.25	0.07
40	8.65	0.35	0.01	69.74	30.63	5.24
50	52.29	6.61	0.22	111.16	66.91	27.62
60	97.96	38.31	1.25	147.31	99.6	55.37
70	138.31	75.12	7.39	179.01	129	81.04
80	173.51	108.8	20.53	207.06	155.54	104.65
90	203.82	139.07	37.81	232.39	179.88	126.62
100	230	166.17	56.6	255.4	202.26	147.06
110	252.69	190.39	75.92	276.5	222.96	166.16
120	272.34	211.99	95.02	296.04	242.26	184.1
130	290.09	231.96	114.15	314.49	260.5	201.55
140	304.43	248.88	132.39	326.61	272.86	214.03
150	316.62	263.48	149.89	335.99	282.56	224.09
160	326.99	276.11	166.26	342.65	289.64	231.75
170	335.72	287.03	181.43	346.6	294.11	237.03
180	342.96	296.39	195.44	347.86	295.98	239.93
190	348.85	304.33	208.37	346.47	295.26	240.47
200	354.57	311.96	220.65	348.41	297.52	243.36
210	359.66	318.89	232.18	350.65	299.98	246.33
220	364.19	325.16	242.99	352.99	302.46	249.24
230	368.21	330.82	253.13	355.32	304.88	252.02
240	371.78	335.92	262.65	357.58	307.2	254.62
250	374.93	340.52	271.58	359.75	309.37	257.05
260	377.55	344.42	278.77	361.76	311.38	259.24
270	379.86	347.92	285.48	363.65	313.24	261.24
280	381.88	351.04	291.74	365.41	314.94	263.07
290	383.66	353.82	297.58	367.04	316.48	264.69
300	385.22	356.29	303.03	368.54	317.88	266.15
310	386.58	358.49	308.11	369.92	319.12	267.43
320	387.76	360.44	312.84	371.17	320.22	268.55
330	388.77	362.17	317.22	372.29	321.18	269.51
340	389.63	363.7	321.28	373.28	321.99	270.3
350	390.35	365.04	325.03	374.16	322.67	270.93

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Balsam			Existing Aspen		
	Good site DUA 3	Medium site DUA 3	Poor site DUA 3	Good site DUA 3	Medium site DUA 3	Poor site DUA 3
Age	Volume			Volume		
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	15.22	1.42	0.01	23.1	1.85	0
40	56.3	19.16	0.68	62.6	22.76	2.88
50	98.94	50.94	4.86	100.75	50.2	16.49
60	138.14	83.61	14.27	136.49	76.87	33.31
70	176.24	117.25	30.83	169.46	102.23	49.84
80	208.72	144.99	47.17	194.32	122.19	63.49
90	235.72	168.81	62.2	216.07	139.67	75.46
100	259.42	190.1	76.32	233.52	153.96	85.44
110	280.48	209.26	89.55	246.63	164.99	93.4
120	299.06	226.5	101.63	255.46	172.79	99.34
130	320.65	245.55	114.38	260.12	177.41	103.33
140	341.44	263.64	126.6	266.7	182.8	107.37
150	361.05	280.63	138.23	272.73	187.59	111.04
160	379.66	296.65	149.35	273.32	188.28	111.83
170	396.89	311.79	160.01	273.78	188.81	112.45
180	412.95	326.11	170.19	274.13	189.17	112.89
190	428.27	339.65	179.93	274.39	189.39	113.17
200	442.81	352.72	189.35	274.67	189.72	113.57
210	456.73	365.08	198.44	274.91	190.02	113.94
220	469.92	376.92	207.2	275.13	190.31	114.3
230	482.59	388.22	215.66	275.32	190.57	114.63
240	494.66	399.05	223.85	275.51	190.81	114.93
250	506.31	409.42	231.76	275.64	191.03	115.21
260	507.5	411.36	233.43	275.77	191.23	115.46
270	508.56	413.17	235.01	275.89	191.41	115.7
280	509.58	414.84	236.49	275.98	191.57	115.91
290	510.53	416.37	237.88	276.06	191.72	116.11
300	511.33	417.84	239.19	276.13	191.85	116.28
310	512.09	419.18	240.42	276.18	191.96	116.44
320	512.79	420.43	241.59	276.23	192.07	116.59
330	513.4	421.6	242.69	276.26	192.16	116.72
340	513.95	422.65	243.73	276.3	192.24	116.83
350	514.5	423.62	244.71	276.31	192.31	116.93

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Existing Cottonwood		Existing/Regenerated Coniferous minor	Existing Small Pine
	Good/Medium site DUA 3	Poor site DUA 3	All sites DUA 3	All sites DUA 3
Age	Volume		Volume	Volume
10	0	0	0	0
20	0.01	0	0	0
30	2.03	0.02	1.21	0.04
40	23.54	1.07	7.35	4.28
50	54.63	18.35	17.09	31
60	78.97	41.18	26.81	60.98
70	98.62	61.16	35.49	88.8
80	114.75	78.1	43.12	114.45
90	128.36	92.87	49.88	138.34
100	139.97	105.84	55.87	160.59
110	149.99	117.38	61.16	181.41
120	158.76	127.75	65.87	200.97
130	166.57	137.18	70.23	219.52
140	173.46	145.64	73.65	232.56
150	179.65	153.37	76.52	243
160	180.08	154	78.88	250.85
170	180.41	154.48	80.78	256.13
180	180.65	154.82	82.21	258.86
190	180.81	155.04	83.21	259.05
200	181.02	155.34	84.44	261.86
210	181.21	155.63	85.58	264.79
220	181.38	155.9	86.63	267.66
230	181.53	156.14	87.6	270.42
240	181.67	156.37	88.46	273
250	181.8	156.57	89.27	275.41
260	181.91	156.75	89.98	277.61
270	182.01	156.92	90.62	279.62
280	182.1	157.07	91.2	281.43
290	182.17	157.21	91.73	283.06
300	182.24	157.32	92.21	284.52
310	182.31	157.43	92.63	285.79
320	182.35	157.52	93.01	286.89
330	182.4	157.6	93.35	287.83
340	182.43	157.67	93.64	288.6
350	182.46	157.73	93.9	289.22

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination

	Regenerated Spruce			Regenerated Pine		
	Good site	Medium site	Poor site	Good site	Medium site	Poor site
Age	Volume			Volume		
10	0	0	0	0	0	0
20	0	0	0	2	0	0
30	0	0	0	53	12	0
40	28	0	0	132.8	56.39	12.32
50	112.91	15.9	0	191.42	113.65	41.27
60	202.91	66.83	0	257.41	152.96	71.33
70	282.86	132.21	0	302.24	188.4	107.63
80	357.9	192.12	7	338.29	227.31	132.63
90	406.47	245.36	23.19	365.01	259.63	153.81
100	437.37	301.57	50.99	385.76	282.57	173.31
110	459.3	347.06	84.22	401.98	302.44	190.34
120	477.16	382.21	119.17	414.06	319.53	211.07
130	489.26	405.14	154.11	425.51	333.19	228.18
140	497.44	423.49	183.04	434	344.72	243.18
150	500.98	437.14	211.29	441.05	352.39	254.68
160	501.61	448.99	238.97	448.14	360.8	263.5
170	501.4	458.94	266.41			
180	500.56	466.19	294.66			
190	498.21	470.88	318.8			
200	497.65	474.22	337.28			
210	495.38	477.79	355.99			
220	494.48	479.65	367.97			
230	492.02	478.84	378.27			
240	491.05	477.42	388.93			
250	489.61	476.45	395.99			

continued

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Table A-9. Volume (cubic metres) over age (years) for each species/site type combination (concluded)

	Regenerated Spruce (ex-Balsam)			Regenerated Small Pine
	Good site	Medium site	Poor site	All sites
Age	Volume			Volume
10	0	0	0	0
20	0	0	0	0
30	0	0	0	1
40	15.31	0	0	16.28
50	86.74	15.48	0	46.29
60	173.21	64.18	0	81.55
70	247.5	129.87	1	116.73
80	325.72	190.49	16.43	141.52
90	381.16	243.08	44.57	163.41
100	417.89	298.04	80.78	182.55
110	441.59	345.75	118.09	204.13
120	460.58	380.46	156.24	224.34
130	476.47	404.95	188.06	241.43
140	485.52	422.47	219.38	254.91
150	493.32	435.86	247.07	265.71
160	496.46	447.07	279.23	274.7
170	497.18	456.37	309.92	283.06
180	497.69	465.85	332.13	290.83
190	496.43	470.54	352.9	296.02
200	494.37	473.77	368.35	302.89
210	493.68	477.26	380.46	306.86
220	491.22	478.22	390.25	310.78
230	489.24	478.65	399.73	314.58
240	488.65	477.61	405.94	317.21
250	486.6	476.08	411.87	319.66

A.5 Volume Over Age Tables for Existing and Regenerated Stands

Dawson Creek TSA
Timber Supply Analysis
Addendum

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

June 1996

Dawson Creek TSA Timber Supply Analysis Addendum

Background

The British Columbia Forest Service released the Dawson Creek TSA Timber Supply Analysis in September 1994. Since the publication of the analysis report, a significant difference in the deciduous forest timber harvesting land base was discovered. This change means that the timber harvesting land base in the original analysis understates the area currently available for timber harvesting. As well a forest inventory audit indicates that the timber volumes used in the analysis may underestimate the actual volumes. The Forest Service felt that discussions about alternative timber harvest levels in the Dawson Creek TSA would be best facilitated if the effects of the change in the timber harvesting land base and the results of the inventory audit were assessed.

It is stressed that neither the results of this addendum, nor those of the original analysis should be construed as recommendations on the allowable annual cut (AAC). These reports have been produced to facilitate the discussion of alternative timber harvest levels.

This report is intended as an addition to, not a replacement of, the original Dawson Creek TSA Timber Supply Analysis Report. It is assumed that the reader is familiar with the original analysis report which contains definitions of terms, describes the Dawson Creek TSA, and outlines analysis methods.

The first part of this report describes the timber harvesting land base adjustment and its effect on the timber supply. The second part of the report describes the forest inventory audit trends and their potential effect on the timber supply.

The explanations contained in the original report of the major factors affecting timber supply over time are still relevant. The reader is advised to check the original report for this information. The changes in the harvest forecasts are discussed in this document, however it should be noted that Figures 5 through 8 and 10 through 29 in the original report would also change slightly. The entire series of corrected sensitivity analysis graphs are attached.

Description of the timber harvesting land base adjustment

The management assumptions used for the deciduous timber harvesting land base in the Dawson Creek TSA Timber Supply Analysis Report (1994) do not accurately reflect current management in the area. In addition, the 1994 analysis report described the deciduous land base in terms of "deciduous usage areas" reflecting two pulpwood use agreements rather than the entire TSA. The original analysis assumptions excluded deciduous harvesting in the furthest reaches of the pulpwood agreement areas and from the portions of the Dawson Creek TSA not covered by the pulpwood agreements.

Therefore, the original analysis does not provide the appropriate information for setting a deciduous harvest level for the entire TSA. The effect of including all deciduous areas was to significantly increase the deciduous timber harvesting land base (23%) and slightly decrease the coniferous timber harvesting land base (0.5%) for a net increase in the total timber harvesting land base of 7%.

The coniferous land base analysis is also affected because the excluded deciduous stands were assumed to contribute to the coniferous timber harvesting land base, if the coniferous component provided at least 120 cubic metres per hectare.

Table 1 summarizes the areas excluded from the total area of the Dawson Creek TSA, and shows the area of the timber harvesting land base.

Table 1. Corrected timber harvesting land base, Dawson Creek TSA Addendum, 1996.

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	2 277 753	100.0	
Not managed by B.C. Forest Service	- 408 776	17.9	
Non-forest	- 390 137	17.1	
Total productive forest managed by Forest Service (Crown forest)	1 478 839	64.9	100
Reductions to Crown forest:			
Non-commercial cover (brush)	- 63 240	2.8	4.3
Inoperable	- 213 736	9.4	14.5
Inoperable areas not identified on inventory file	- 24 037	1.1	1.6
Not satisfactorily restocked[a]	- 54 999	2.4	3.7
Sensitive soils	- 16 763	0.7	1.1
Important wildlife values	- 8 428	0.4	0.6
Wildlife/riparian areas not identified on inventory file	- 10 976	0.5	0.7
Non-merchantable forest types	- 262 872	11.5	17.8
Mature overstocked pine stands	- 15 587	0.7	1.1
High recreation value	- 10 138	0.5	0.7
Preservation visual quality objective	- 1 987	0.1	0.1
Existing roads, trails, landings and rights-of-way	- 19 442	0.9	1.3
Total current reductions	- 702 205	30.8	47.5
Initial timber harvesting land base	776 634	34.1	52.5
coniferous	(512 195)		
deciduous	(264 439)		
Additions:			
Not satisfactorily restocked	+ 35 028	1.5	2.4
coniferous	(27 577.9)		
deciduous	(7 450.1)		
Total current timber harvesting land base	811 662	35.6	54.9
coniferous	(539 772.9)		
deciduous	(271 889.1)		
Future reductions:			
Future roads	- 19 987	0.9	1.4
coniferous	(13 291.7)		
deciduous	(6695.3)		
Long-term timber harvesting land base	791 675	34.7	53.5
coniferous	(526 481.2)		
deciduous	(265 193.8)		

(a) NSR includes: current NSR; backlog NSR; NSR due to natural disturbances.

Figure 1 shows the corrected coniferous base case harvest forecast, which is approximately 16% above the current AAC, at 972 000 cubic metres per year.

Although the coniferous timber harvesting land base decreased slightly, the revised harvest forecast slightly increases. The mixed deciduous and coniferous stands, that were removed from the coniferous land base in this new analysis, produced very low coniferous volumes. Also this change results in a different age class distribution for the existing stands. This change in distribution results in the stands being harvested at slightly older ages than in the 1994 analysis. These two things combined result in a higher average volume per hectare harvested in the new coniferous timber base case. This leads to a higher overall harvest level.

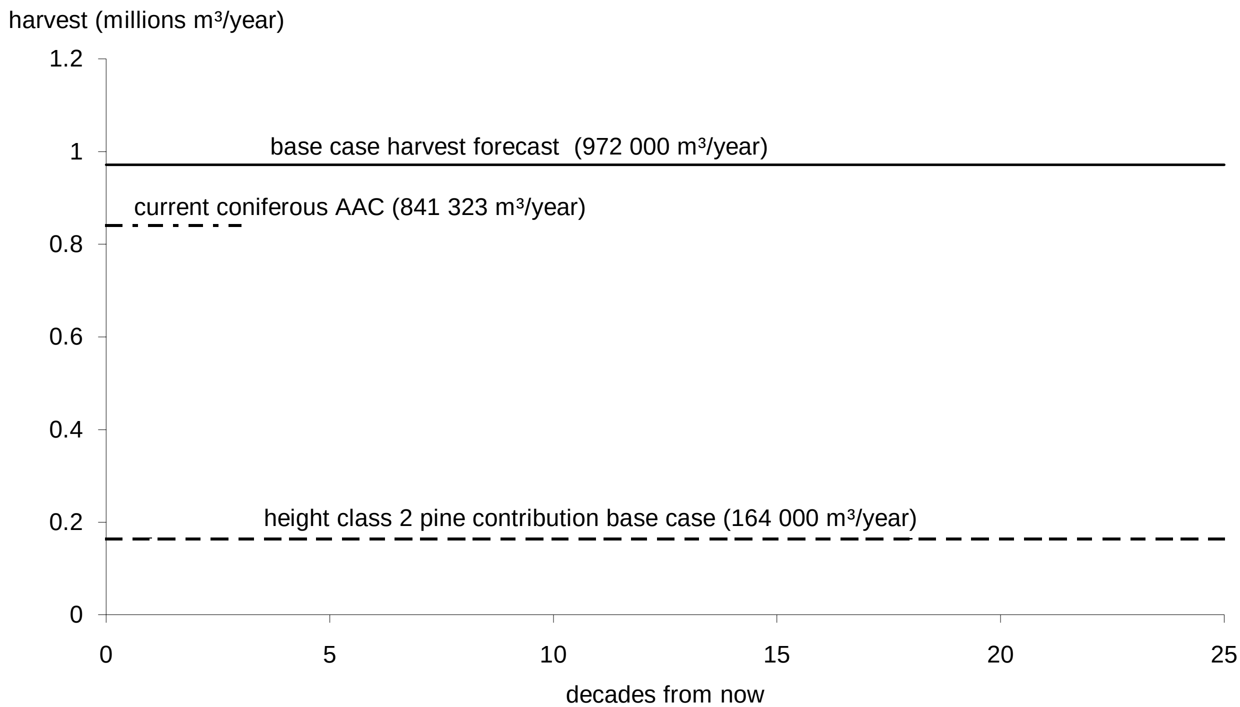

Figure 1. Coniferous base harvest forecast, Dawson Creek TSA Addendum, 1996.

Figure 2 shows the corrected deciduous base case harvest forecast which starts at 886 500 cubic metres per year (10% below the current AAC of 985 000 cubic metres per year) then declines at 22% per decade for two decades. The long-term sustainable level of 480 000 cubic metres per year is reached in decade 4.

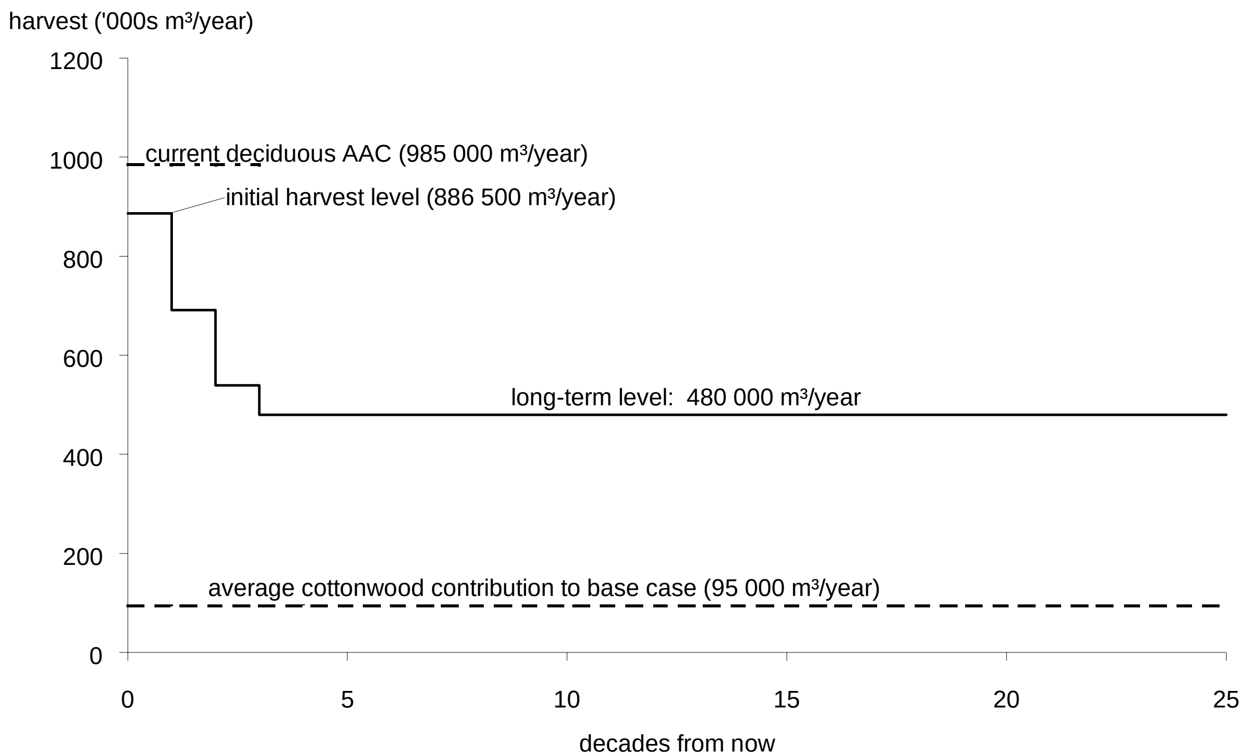

Figure 2. Deciduous base harvest forecast, Dawson Creek TSA Addendum, 1996.

Description of the forest inventory audit results

The Resource Inventory Branch of the B.C. Forest Service is currently undertaking forest inventory audits of timber supply areas and tree farm licences. These audits are designed to give an indication of the quality of the inventory by comparing stand volumes predicted from inventory information to actual ground volumes.

For the Dawson Creek TSA, the inventory audit show that there is a significant difference in the volume estimates for existing mature stands. Overall for the entire TSA (deciduous and coniferous) the audit indicates the volumes may be 27% higher than those predicted from the inventory file. However, the inventory audit does not produce results that are statistically reliable for specific areas or tree species. Therefore, the results cannot justifiably be used to make specific adjustments to growth and yield and other information used in timber supply analysis. The audits provide a general assessment of the uncertainty associated with mature timber volumes. The results displayed here are meant to illustrate the possible impacts of this uncertainty.

Although when separated there are not enough samples in either deciduous or coniferous stands to measure if there is a statistical difference in volume estimates it is possible to see general trends. The coniferous samples suggest that the volumes predicted using inventory information may underestimate actual volumes by about 33% in the mature coniferous stands and about 9% in the mature deciduous stands.

Sensitivity of timber supply to existing stand volume estimates

The heavy, solid line in Figure 3 shows the harvest forecast on the corrected land base with a 35% increase in existing stand yields for conifers. The harvest level is increased by 25% to 1.211 million cubic metres per year. The dotted line in Figure 3 shows the base case harvest forecast with the corrected land base.

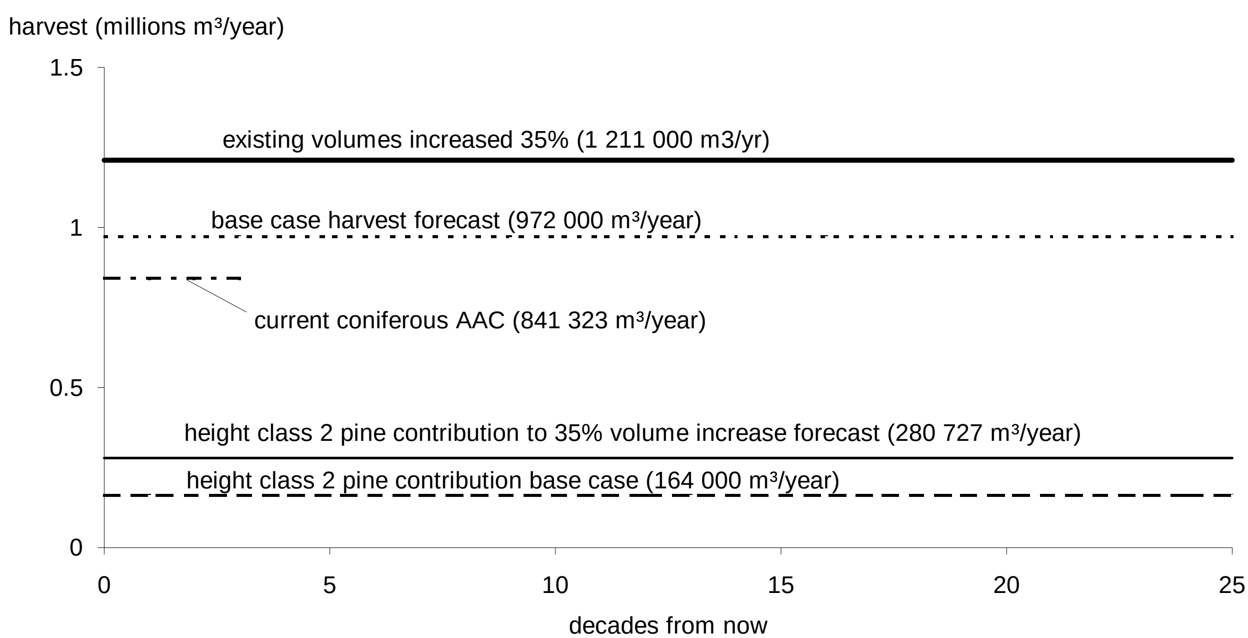

Figure 3. Sensitivity of increasing existing stand yields by 35% on the corrected coniferous land base, Dawson Creek TSA Addendum, 1996.

The heavy, solid line in Figure 4 shows the harvest forecast on the corrected deciduous timber harvesting land base with a 10% increase in volume estimates. The current AAC of 985 000 cubic metres per year can be achieved for 10 years followed by declines at 22% per decade to the long-term harvest level of 525 000 million cubic metres per year. The dotted line in Figure 4 shows the base case harvest forecast on the corrected land base.

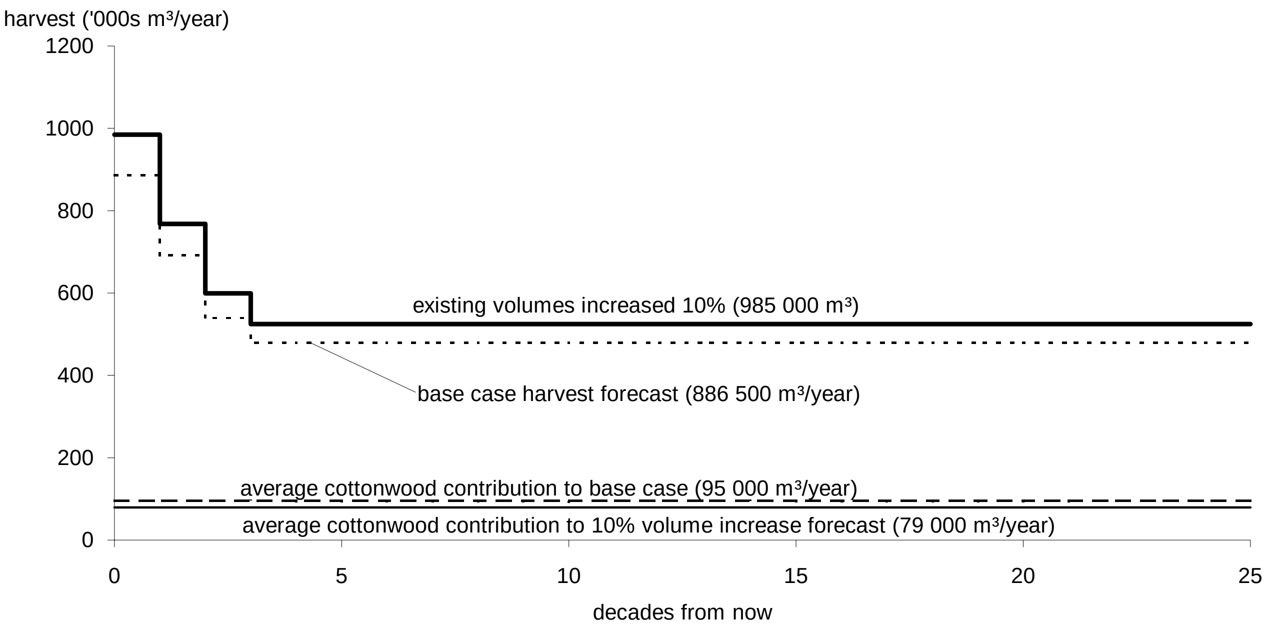

Figure 4. Sensitivity of increasing deciduous yields by 10% on the corrected deciduous land base, Dawson Creek TSA Addendum, 1996.

Summary and conclusions

The results in this addendum indicate that the land base adjustments result in more timber supply over all time frames than shown in the original analysis. The coniferous timber supply increased by 3.8% and deciduous timber supply increased by 12%, in the first decade.

The inventory audit also suggests there may be additional timber supply than the original analysis indicated. As noted previously the audit provides a general indication of the uncertainty associated with mature timber volumes. The sensitivity analysis in this addendum is only meant to illustrate the possible impact of this uncertainty.

If the coniferous volumes in the analysis are underestimated by 35% there is an increase of 25% in the initial harvest level. If the deciduous volumes are underestimated by 10%, there is an increase, of 11% to harvest levels in the first decade and 9% to the long-term sustainable harvest level.

The entire series of sensitivity graphs are attached. The explanations in the timber supply analysis report about the major factors affecting timber supply are still appropriate for the base case and the sensitivity analysis. The reader is advised to check the original report for this information.

Dawson Creek TSA
Timber Supply Analysis
Addendum

Sensitivity Analyses

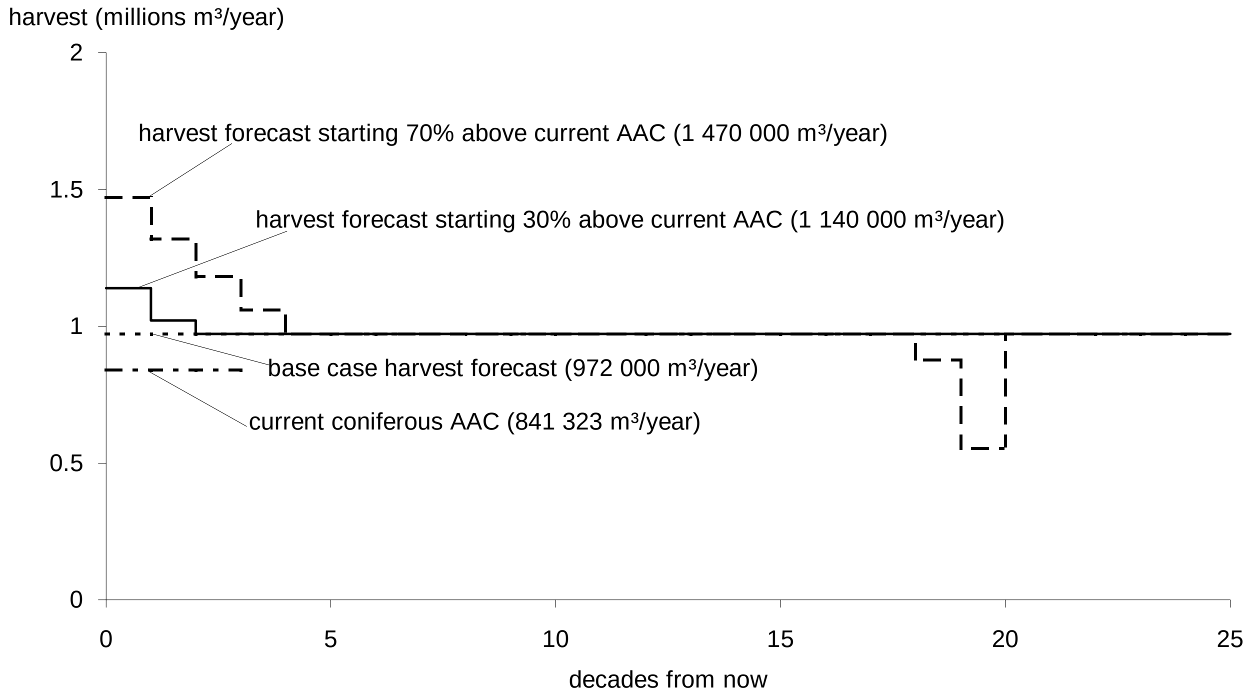

Figure 14. Alternative harvest flow patterns using coniferous base case data, Dawson Creek TSA Addendum, 1996.

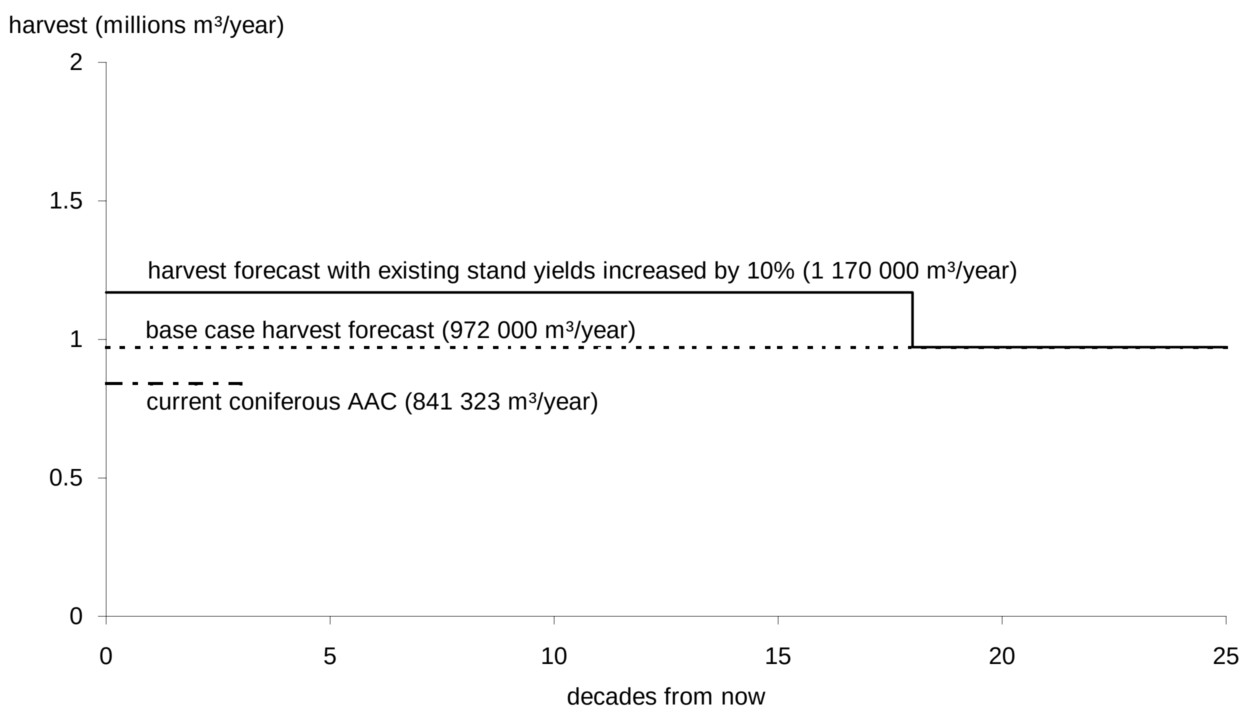

Figure 15. Harvest forecast with existing coniferous stand timber volume estimates changed by 10%, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

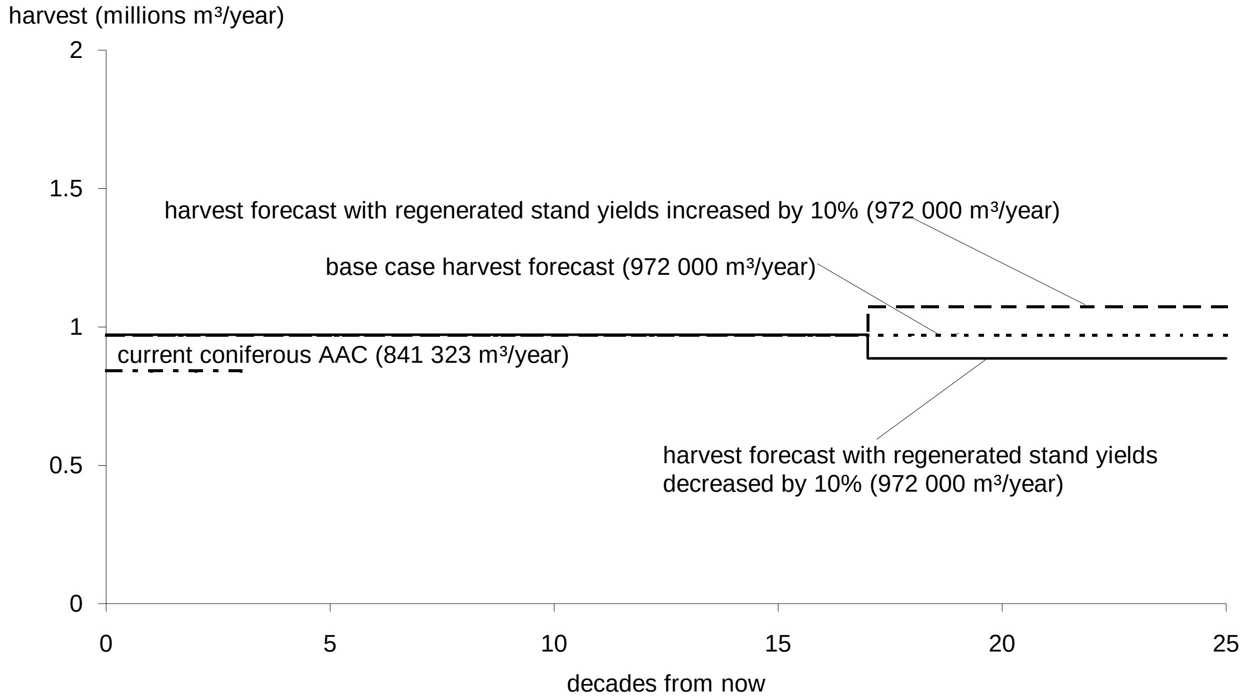

Figure 16. Coniferous harvest forecast with regenerated stands timber volume estimates changed by 10%, Dawson Creek TSA Addendum, 1996.

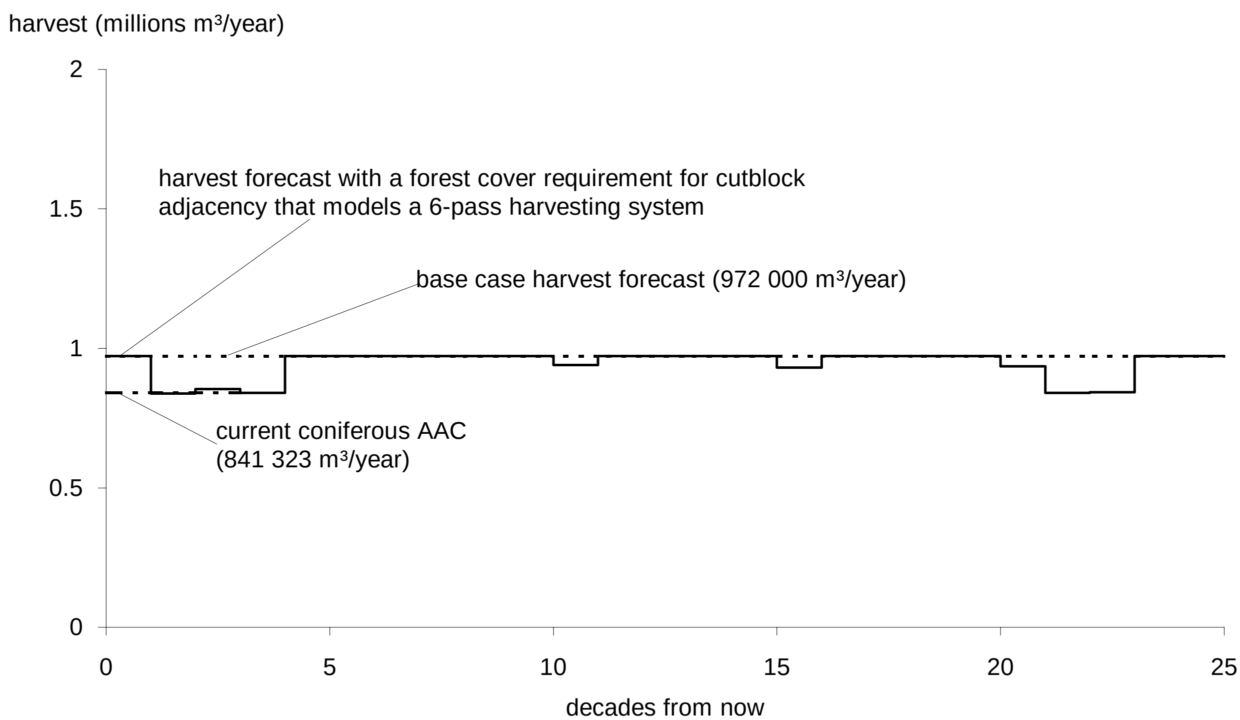

Figure 17. Coniferous harvest forecast with a more stringent cutblock adjacency requirement, Dawson Creek TSA Addendum, 1996.

Note: A five-pass harvesting system does not change the base harvest forecast.
Figure numbers correspond to those in the original timber supply analysis report.

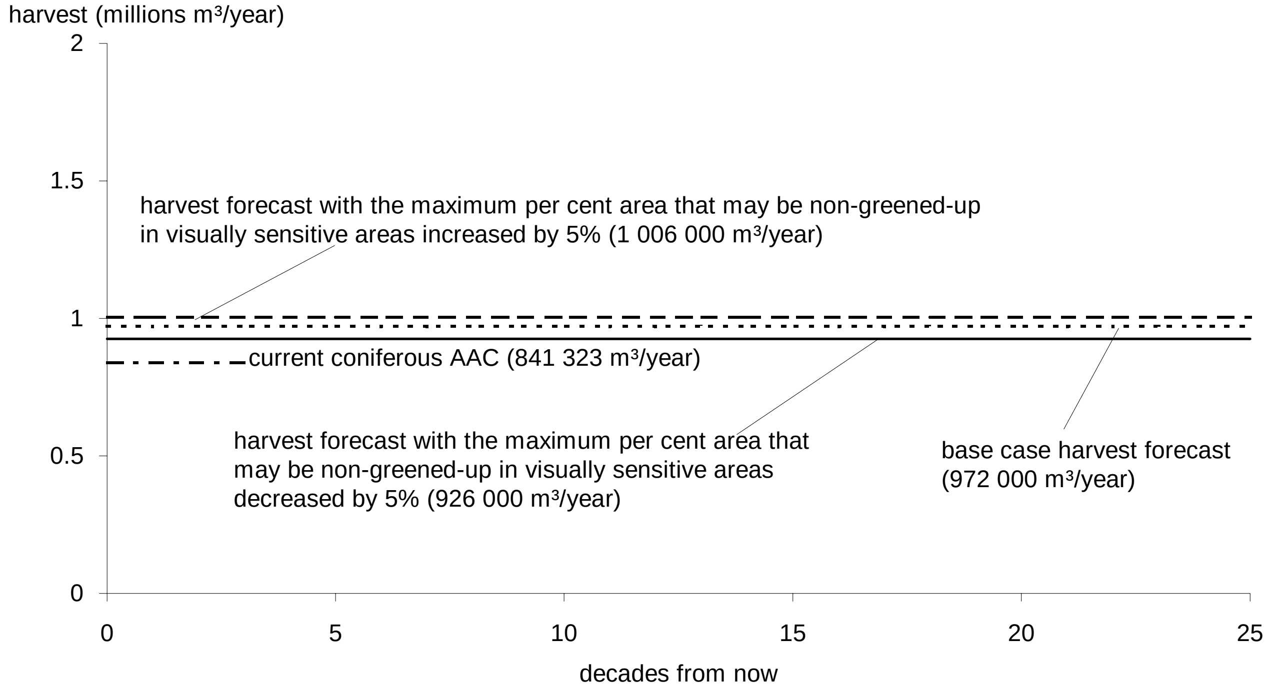

Figure 18. Coniferous harvest forecast with increased and decreased forest cover requirements for visual quality, Dawson Creek TSA Addendum, 1996.

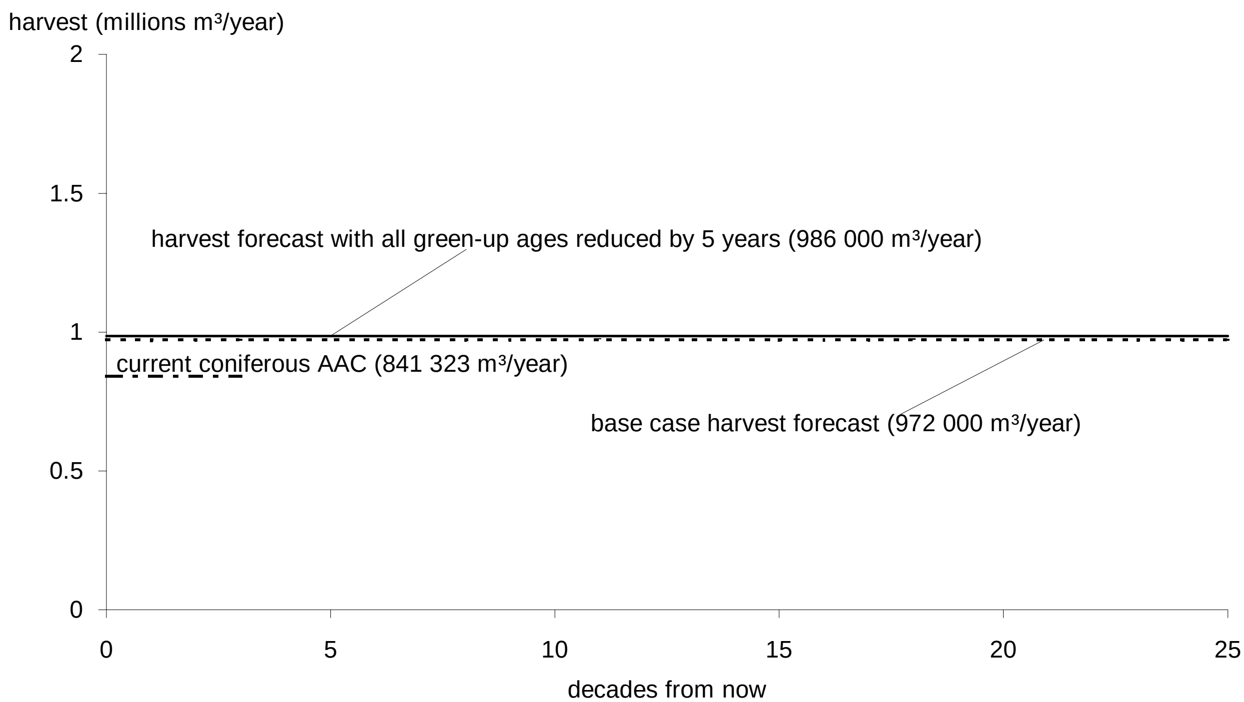

Figure 19. Coniferous harvest forecast with all green-up periods reduced by 5 years, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

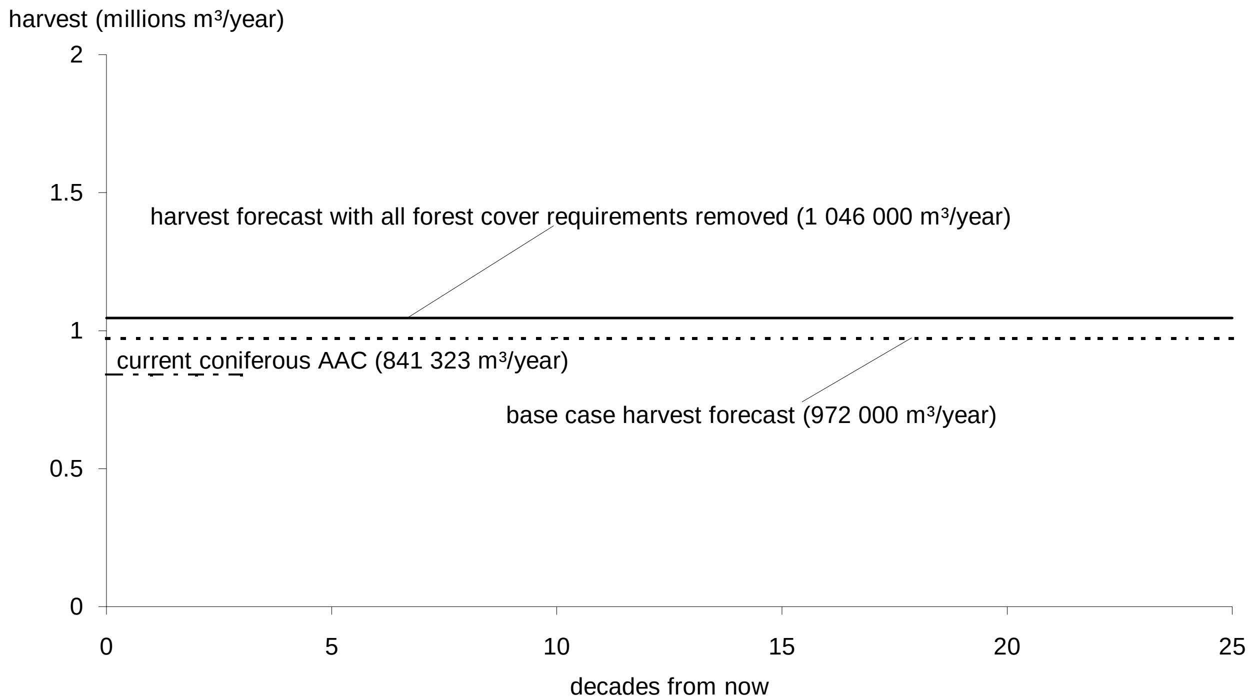

Figure 20. Coniferous harvest forecast with all forest cover requirements removed, Dawson Creek TSA Addendum, 1996.

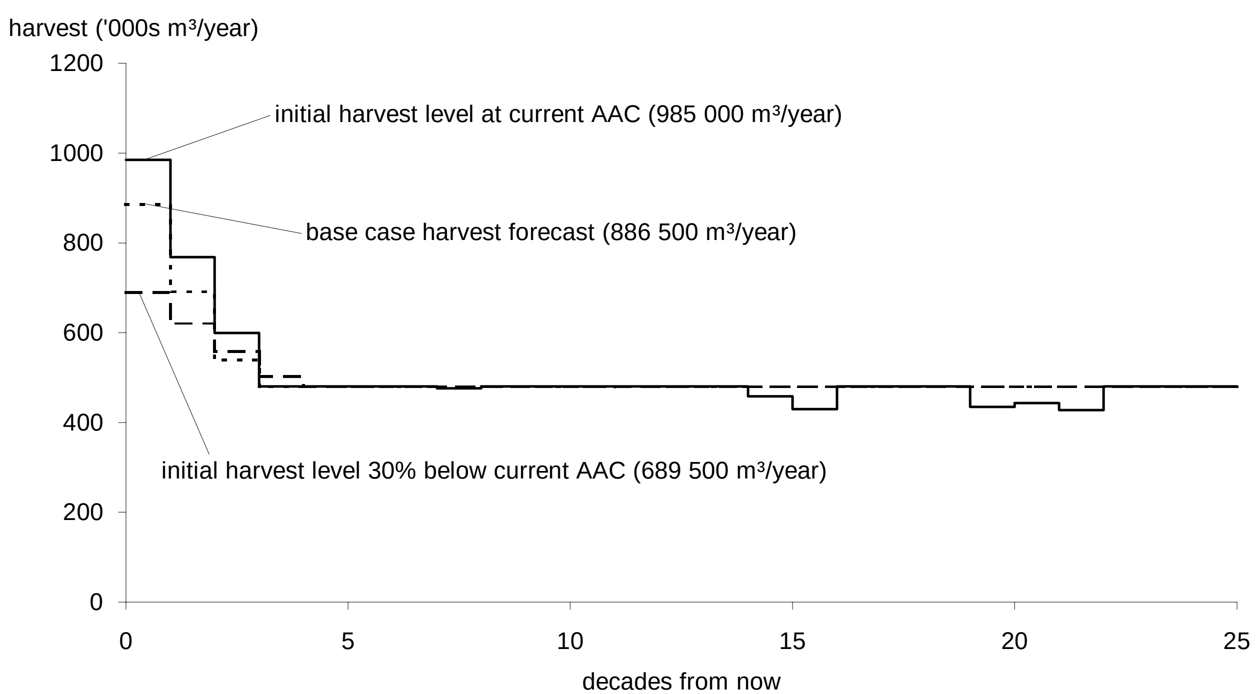

Figure 21. Alternative harvest flow patterns using deciduous base case data, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

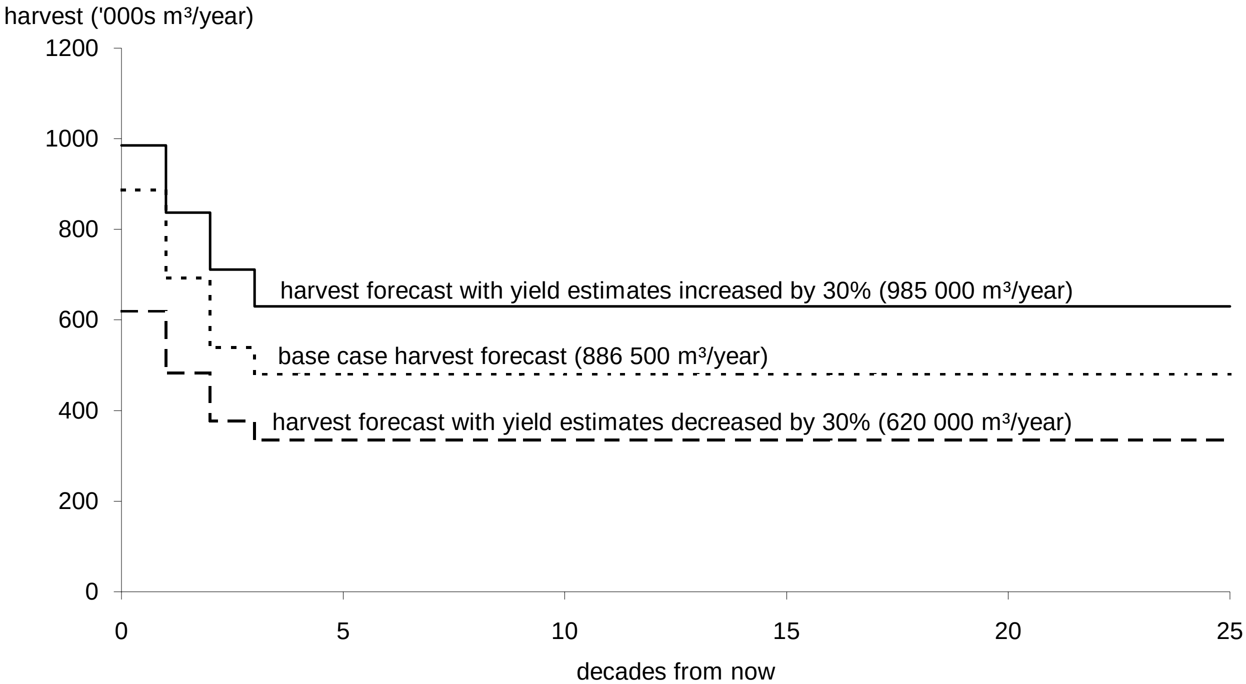

Figure 22. Harvest forecast with deciduous stand timber yield estimates changed by 30%, Dawson Creek TSA Addendum, 1996.

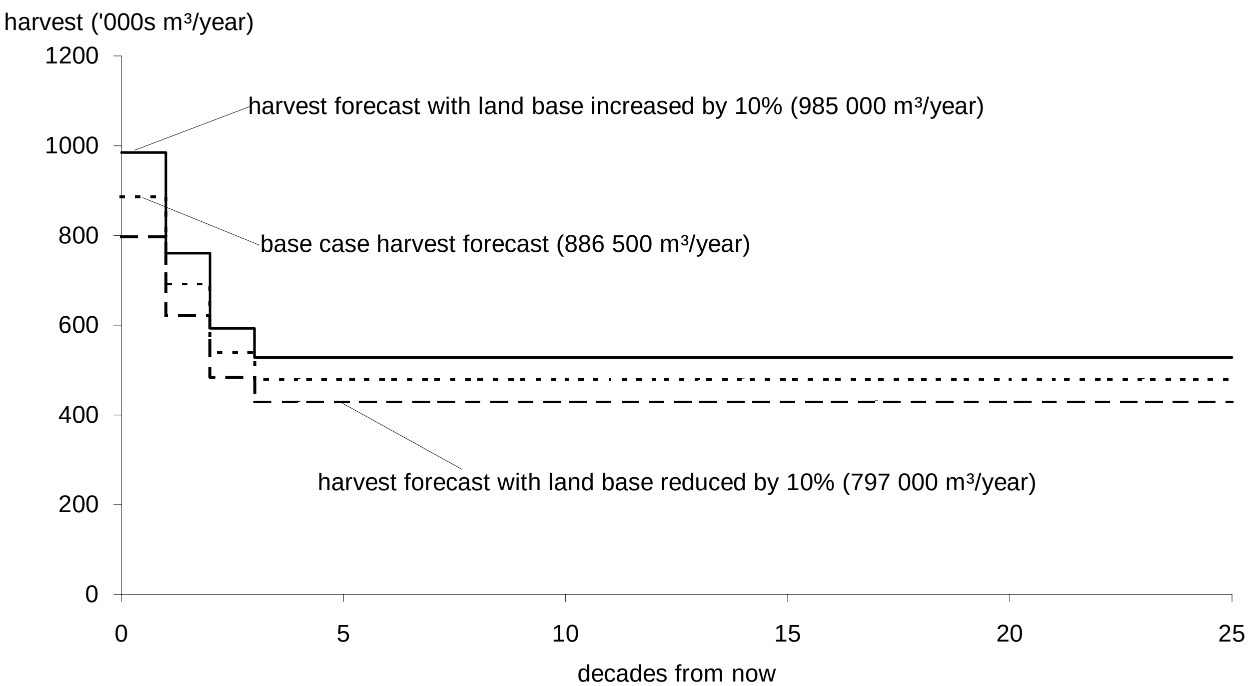

Figure 23. Harvest forecast with the area of the deciduous timber harvesting land base changed by 10%, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

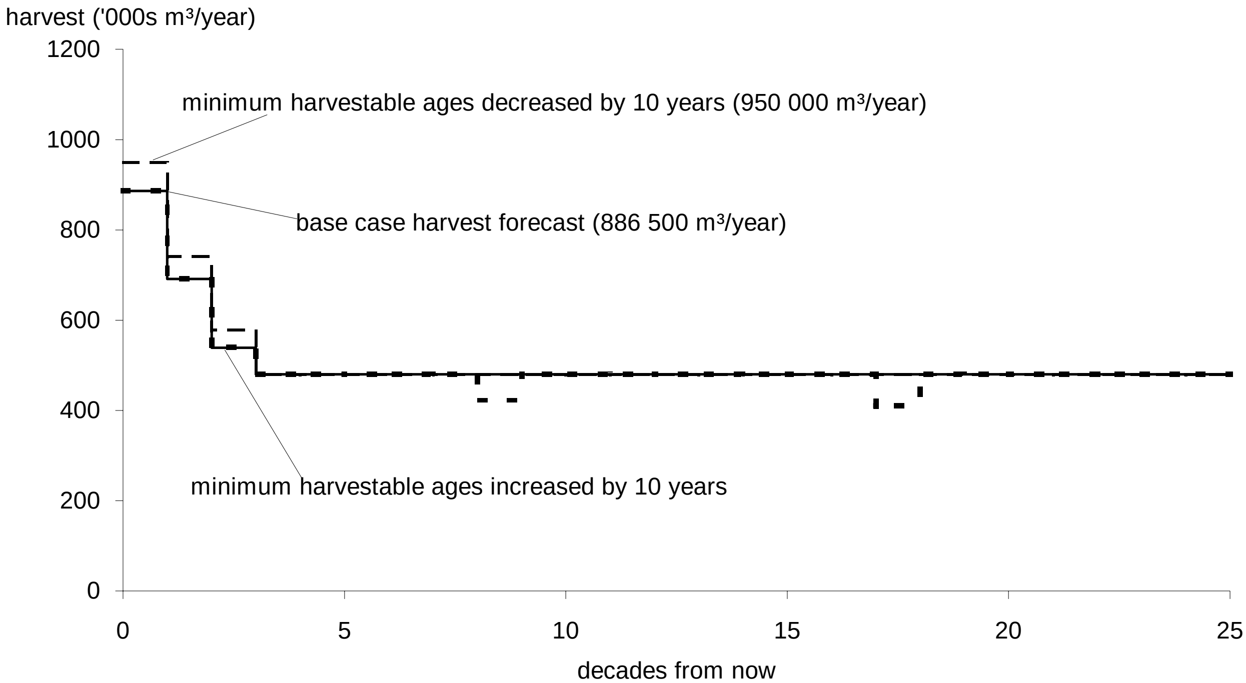

Figure 24. Harvest forecast with minimum harvestable ages for deciduous stands changed by 10 years, Dawson Creek TSA Addendum, 1996.

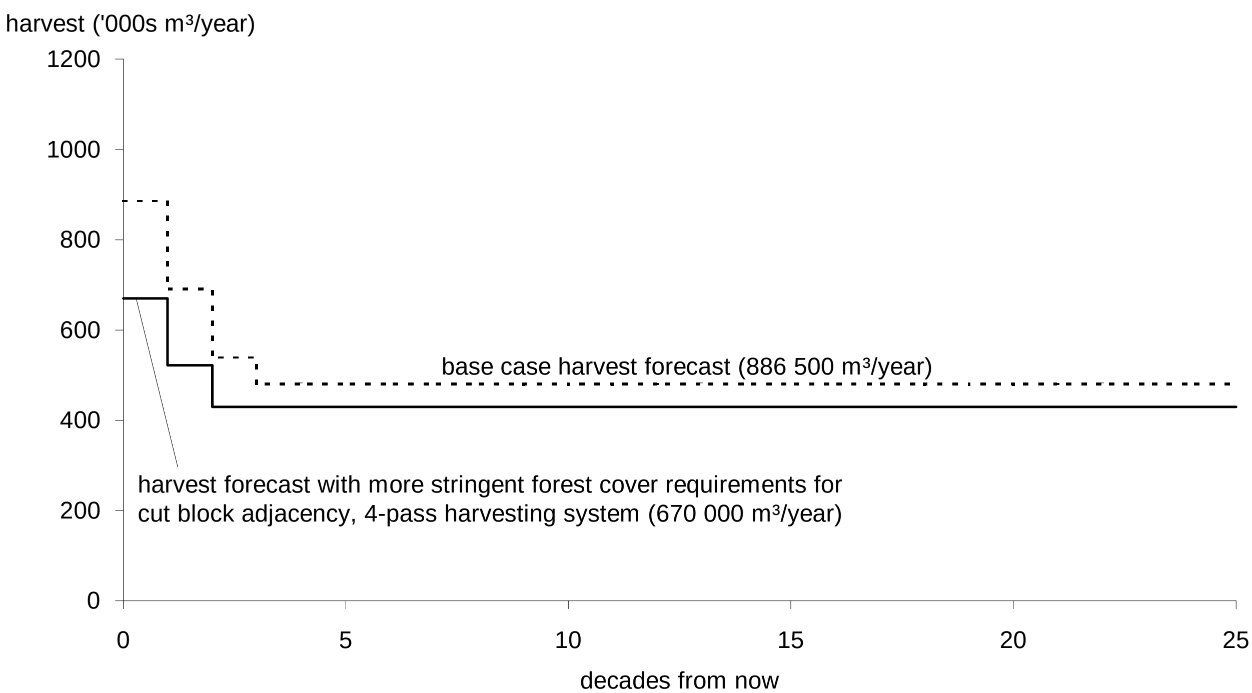

Figure 25. Deciduous harvest forecast with a more stringent cutblock adjacency requirement, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

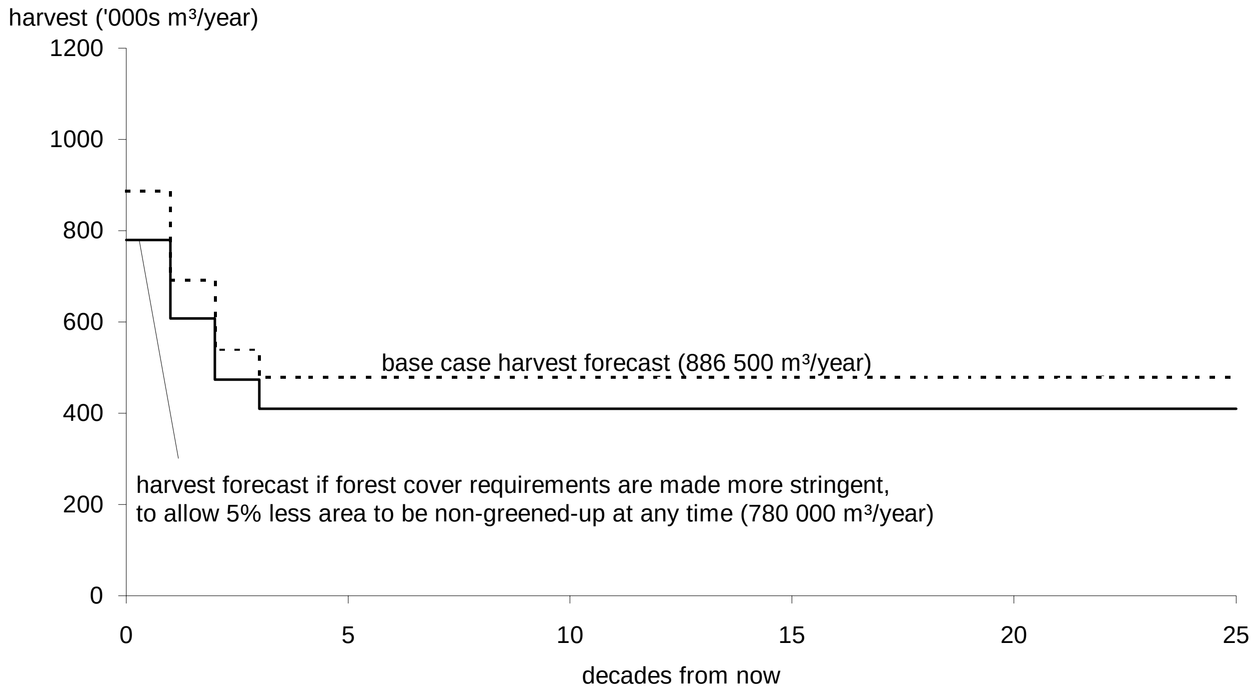

Figure 26. Deciduous harvest forecast with decreased forest cover requirements for visual quality, Dawson Creek TSA Addendum, 1996.

Note: Relaxing the forest cover requirements to allow 5% more area to be non-greened-up at any time does not change the base case harvest levels.

Figure numbers correspond to those in the original timber supply analysis report.

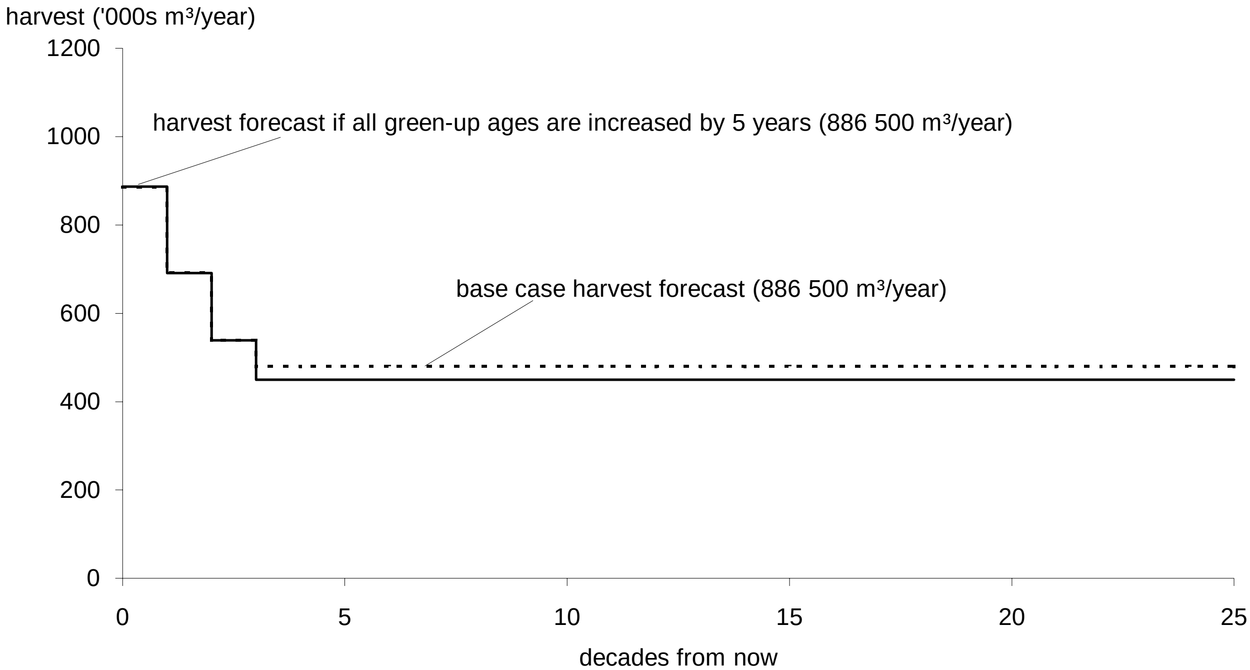

Figure 27. Deciduous harvest forecast with all green-up periods increased by 5 years, Dawson Creek TSA Addendum, 1996.

Note: Reducing all green-up ages by 5 years does not change the base case harvest levels.

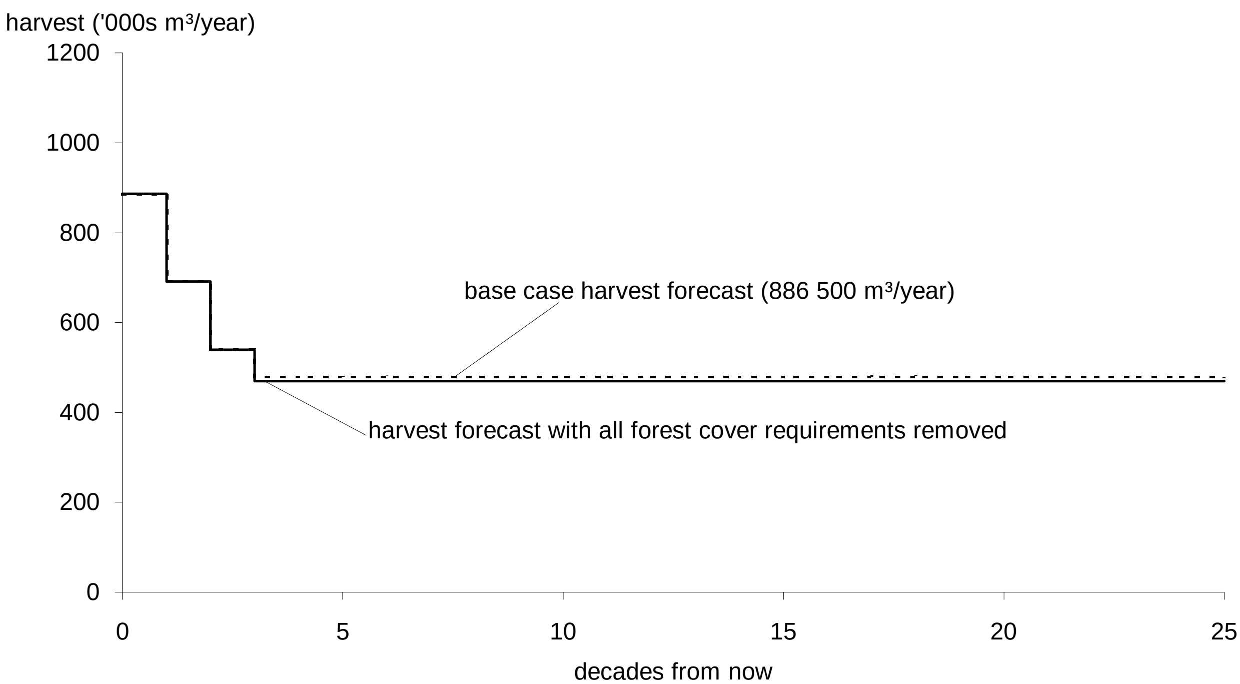

Figure 28. Deciduous harvest forecast with all forest cover requirements removed, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.

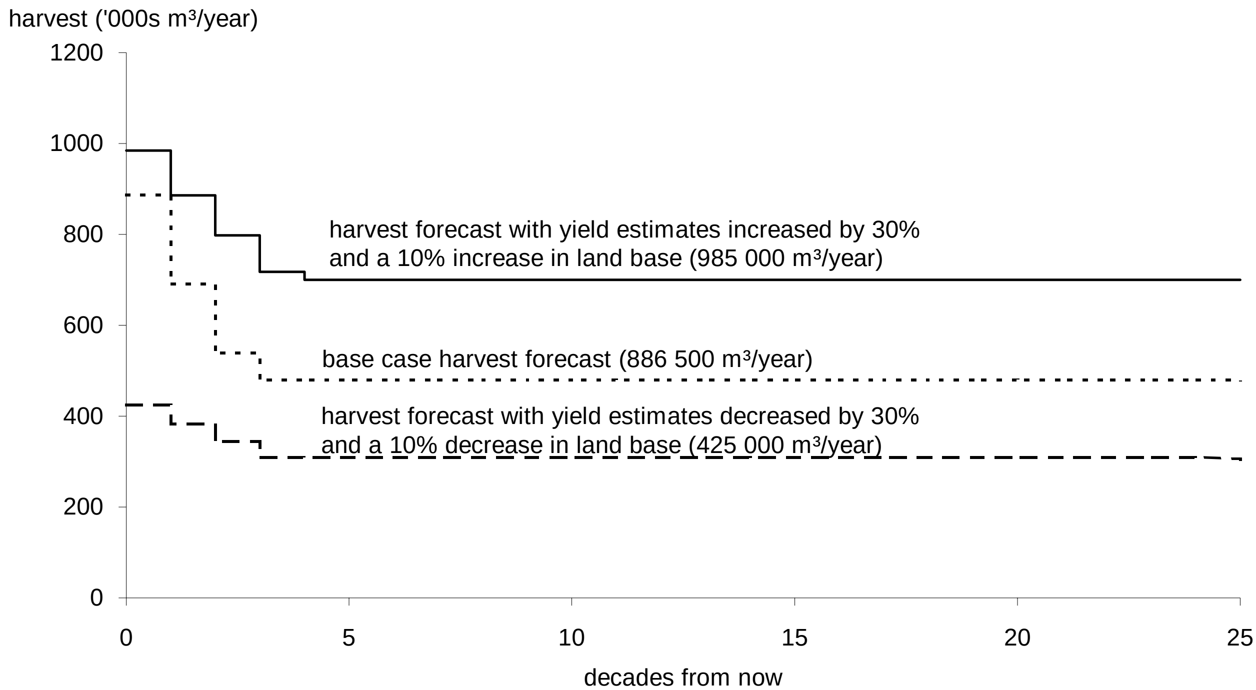

Figure 29. Deciduous harvest forecast with changes to the area of the timber harvesting land base and timber yield estimates concurrently, Dawson Creek TSA Addendum, 1996.

Figure numbers correspond to those in the original timber supply analysis report.