Cassiar
Timber Supply Area
Analysis Report

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Preface

This report contains a timber supply analysis and a social-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is to be completed every five years.

To determine allowable timber harvesting levels accurately and rationally, the chief forester must have an up-to-date assessment of the 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.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code* (FPC) and official land-use decisions made by Cabinet.

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 every five years. An important part of these analyses 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 the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information regarding possible timber harvest levels and will provide a focus for public discussion. The fifth will outline the chief forester's harvest level 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 Cassiar Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short- (next 20 years) and long- (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

As part of the last AAC determination for the Cassiar TSA, the chief forester gave direction to examine uncertainties with respect to several land base, growth and yield, and management factors including:

- timber harvesting land base;
- site productivity;
- northern growing conditions;
- forest cover requirements for wildlife habitat;
- time to green-up for cutblock adjacency;
- riparian habitat; and
- unsalvaged losses due to fire, insects and disease.

Several studies were done to improve information corresponding to these factors for this analysis. Some uncertainty remains with respect to some of these issues, given the very limited amount of current harvesting activity in the Cassiar Timber Supply Area (TSA), lack of local data on site productivity and the inability to predict fire occurrence and behaviour. This analysis focussed on these uncertainties.

The Cassiar Timber Supply Area (TSA) is situated in the northwest corner of the province in the Prince Rupert Forest Region. The timber supply area is the largest in British Columbia at over 14.8 million hectares, and covers approximately one-sixth of the province[1]. About 25% of the Cassiar TSA (approximately 3 708 000 hectares) is considered productive forest area managed by the Crown. Currently, about 5.4% of the productive Crown forest, or 1.3% of the total TSA, is considered available for timber harvesting.

The results of this timber supply analysis suggest that the current AAC for the Cassiar TSA (400 000 cubic metres per year) can be maintained over the short-, medium- and long-term. An assessment of alternative timber supply levels showed that a maximum even-flow harvest level of 441 000 cubic metres per year could also be sustained over all time frames.

The base case timber supply forecast in this analysis is lower than the forecast in the previous (1994) analysis, which projected a harvest level of 842 400 cubic metres per year. Due to several downward pressures on the timber supply projected in the 1994 analysis, the chief forester set the allowable annual cut at 400 000 cubic metres per year in his October 1995 determination.

The change from the 1994 forecast has resulted primarily from a timber harvesting feasibility project and a re-assessment of operability. These studies resulted in a significant decrease in the estimate of area that is available for timber supply. Other factors leading to the decrease in the projected timber supply include the transfer of 1.6 million hectares to the Fort Nelson TSA (including 27 452 hectares, or 12% of the timber harvesting land base), a change in the definition of merchantability, and an increase in the estimate of volume losses due to fire and insects. Together, these factors led to lower short- and long-term harvest levels relative to the 1994 analysis.

These results reflect current knowledge and information on forest inventory, growth, and management. However, it is important to recognize that uncertainty exists in several factors that define timber supply.

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(1) The total figure of 14.8 million hectares includes the 1.6 million hectares that were transferred to the Fort Nelson TSA while this analysis was in progress. The area transferred was excluded from the timber harvesting land base.

Executive Summary

A series of sensitivity analyses showed that uncertainties affect timber supply to varying degrees. The uncertainty with the largest potential effect on projected harvests over the short and long terms involves estimates of the size of the timber harvesting land base. Additionally, projected volumes for existing stands of timber also have a large potential effect on projected harvest levels.

The size of the timber harvesting land base is subject to uncertainties about economic operability. At this time there is no indication that the timber harvesting land base is either larger or smaller than that defined in the analysis, mainly because minimal harvesting is occurring. Until more timber harvesting occurs, which will help improve the definition of operability limits, the current estimate of the area suitable for timber harvesting constitutes the best available estimate.

The results from a TSA-wide timber inventory audit (*Cassiar TSA Inventory Audit*, Resources Inventory Branch, Ministry of Forests, December 1997) were re-compiled to match the current timber harvesting land base, and re-stratified from southern and northern supply units into coastal/transitional and interior units, based on ecological classification. The re-compiled results show that inventory-derived volumes over-estimate ground measured volumes in stands greater than 60 years old, by 14% in coastal/transitional units and 49% in interior units. If volumes are adjusted to account for these differences, the base case harvest level of 400 000 cubic metres per year can be maintained for only one decade before decreasing by 8% in decade 2 to 353 000 cubic metres per year. In decade 18, the harvest can be increased to the maximum even-flow harvest level of 441 000 cubic metres per year.

Inventory-based estimates of site productivity for old-growth stands have been shown to underestimate productivity of future regenerated stands in some areas of the province. If these differences are confirmed for the Cassiar TSA, the impact in the short- and long-term could be as large as 4%.

Minimal timber harvesting has occurred in the Cassiar TSA for the last five years. Therefore, the socio-economic analysis examines the potential employment and revenue if the AAC was fully harvested.

The socio-economic analysis for the Cassiar TSA indicates that the current AAC of 400 000 cubic metres could support a provincial total of approximately 428 person-years of direct forestry employment if it was fully harvested. Residents of the Cassiar TSA could account for approximately 20% of this direct employment. Forestry activities in the TSA could support a further 523 person-years of indirect and induced employment across the province. Additionally, the current AAC could provide the provincial government with average revenues of about $20.7 million per year.

In conclusion, the timber supply analysis indicates that based on current inventory, growth and yield information and current management assumptions, timber harvests in the Cassiar TSA could be maintained at 400 000 cubic metres per year over the long term. However, some uncertainties could affect the timber supply. See Section 6, "Timber Supply Sensitivity Analyses" for detailed information.

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Introduction

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

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

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

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

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

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

Timber supply projections made for TSAs look far into the future — 250 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* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

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

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

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

Sections 1 through 7 outline the timber supply analysis for the Cassiar TSA. Following a brief description of the area in Section 1, critical issues noted in the previous AAC determination are examined in Section 2. Data preparation and formulation of assumptions are discussed in Section 3. Analysis methodology and results are presented in Sections 4 and 5. Section 6 examines the sensitivity of the results to uncertainties in the data and assumptions used. A summary and conclusion follow this.

Appendix A contains further details about the data and assumptions used in this analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis, described in Section 8, provides information for the chief forester and the local community to better understand the potential magnitude of employment and government revenue impacts associated with any harvest level changes.

Forest inventory
An 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 other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

1 Description of the Cassiar Timber Supply Area

The Cassiar Timber Supply Area (TSA) is situated in the northwest corner of the province in the Prince Rupert Forest Region. This TSA is the largest in British Columbia at over 14.8 million hectares[2], covering approximately one-sixth of the province. The boundary for the TSA was amended in January 2000 to transfer 1.6 million hectares of the Muskwa-Kechika area to the Fort Nelson TSA. The Cassiar TSA is part of the Bulkley/Cassiar Forest District, which also includes the Bulkley TSA. The Cassiar TSA is administered from the Bulkley/Cassiar forest district office in Smithers, with a field office in Dease Lake.

The Cassiar TSA is bordered to the west by Alaska, to the north by the Yukon Territory, to the east by the Fort Nelson and Mackenzie TSAs, and to the south by the Nass and Prince George TSAs. In the west, the Cassiar TSA consists of rugged, ice-capped mountains, dissected by several major river valleys. East of this, the majority of the TSA is characterized by mountains and plateaus separated by wide valleys and lowlands. Approximately 75% of the TSA is tundra, rock and alpine, while 25% is forested Crown land.

Forests in the Cassiar TSA range from areas of coastal forest in the west, to extensive areas of boreal forest in the majority of the TSA. Lodgepole pine and white and black spruce are the predominate tree species in the Cassiar TSA forests. Lodgepole pine dominates 49% of forest stands within the timber harvesting land base*, mainly in the northern part of the TSA. Spruce dominates 47% of the timber harvesting land base, mainly in the southern portion of the TSA. In a small portion of the area, subalpine fir is predominant.

The current allowable annual cut (AAC) for the Cassiar TSA is 400 000 cubic metres, which is partitioned* and assigned to three geographic blocks. This level was set in 1996 and was an increase from the previous level of 140 000 cubic metres per year. For the 2000 timber supply analysis, about 25% of the TSA (about 3.7 million hectares) is considered productive Crown forest land. Approximately 5.4% of that productive forest (about 200 000 hectares, or 1.3% of the total TSA land base) is available for harvesting under current management considerations and objectives.

Significant changes in forest management information in the Cassiar TSA have occurred since the last timber supply review was completed. These changes include:

- implementation of the *Forest Practices Code* of B.C. Act*;
- completion of a timber harvesting feasibility project;
- re-assessment of the operable corridor; and
- re-definition of the timber harvesting land base.

The Cassiar TSA is the least populated TSA in the province. From 1991 to 1996 the population decreased by about one-third to approximately 2000 people, largely due to the closure of the Cassiar asbestos mine. The communities in this TSA include Dease Lake, Atlin, Iskut, Telegraph Creek, Good Hope Lake and Lower Post.

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.

Partition
A portion of the AAC that is attributable to certain types of timber and/or terrain.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

(2) This figure includes the Muskwa-Kechika area.

1 Description of the Cassiar Timber Supply Area

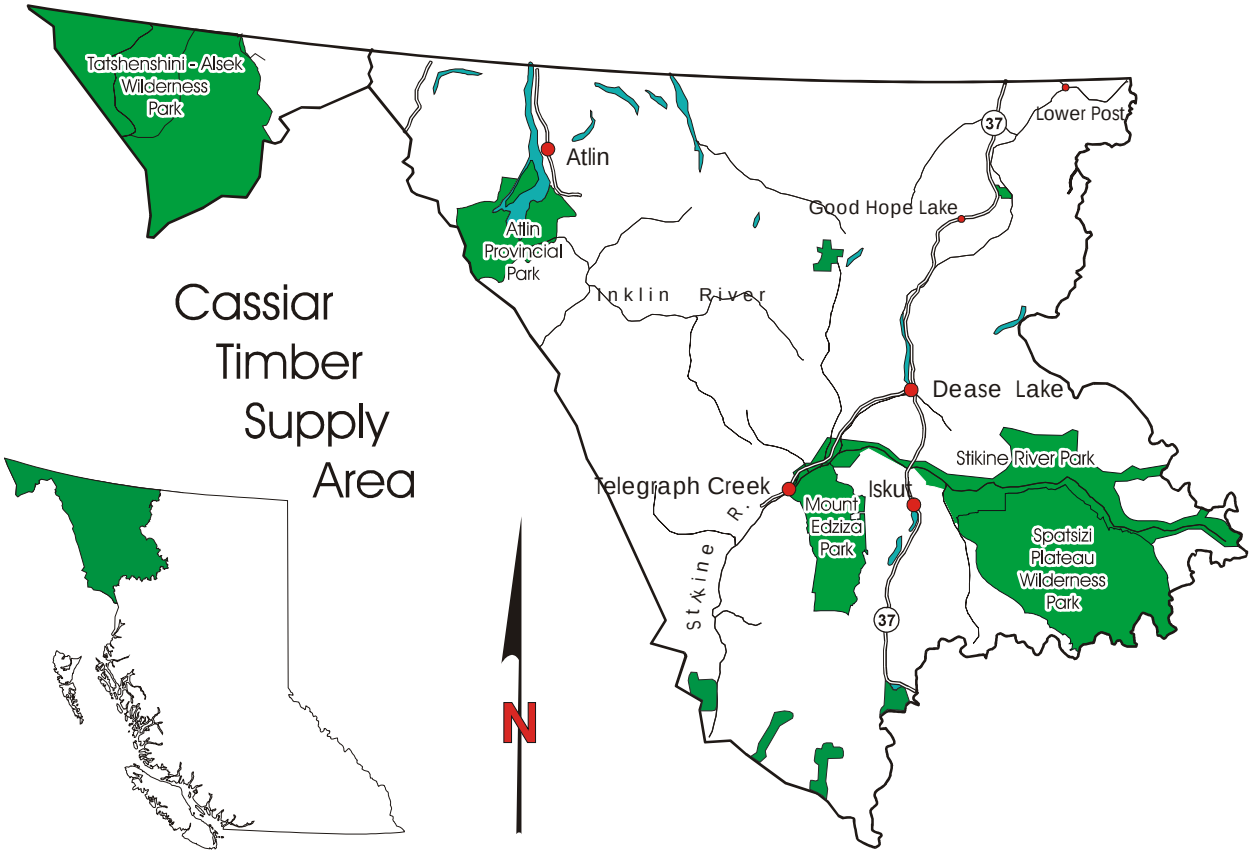

Figure 1. Map of the Cassiar Timber Supply Area, Prince Rupert Forest Region.

1 Description of the Cassiar Timber Supply Area

Numerous natural resources are associated with the forest land base, many of which are undeveloped and located in inaccessible areas of the TSA. These resources include forest products, minerals, recreation and tourism amenities, and wildlife habitat. The Cassiar TSA is one of the finest big-game trophy hunting areas in North America. Recreational activities include hiking, canoeing, rafting, kayaking, fishing and nature viewing. Several provincial parks — Atlin Lake, Stikine Recreation Area, Spatsizi Plateau, Mount Edziza and Tatshenshini-Alsek — offer outstanding backcountry wilderness experiences and draw international recognition to the area's wilderness values.

1.1 The environment

Eight biogeoclimatic zones* are found in the Cassiar TSA. The vast pristine wilderness and diverse range of ecosystems contribute to high biodiversity* values.

The Alpine Tundra (AT) zone is the most extensive zone, occupying about 38% of the Cassiar TSA at elevations above 1000 metres. By definition, this zone is treeless although stunted (or krummholz) trees occur at the lower elevations of the zone. Overall rock, ice and snow dominate this zone.

The Boreal White and Black Spruce (BWBS) zone occupies about 20% of the TSA, from valley bottoms to about 1100 metres elevation, along the main valleys of the TSA at a distance from the coastal mountains. The northern continental climate features long, very cold winters and short growing seasons. White spruce, trembling aspen, lodgepole pine, black spruce, balsam poplar, subalpine fir and paper birch are the dominant tree species.

The Spruce-Willow-Birch (SWB) zone occupies about 31% of the TSA, at elevations above the BWBS zone. Winters are long and cold and summers brief and cool in this zone. In valley bottoms and on lower slopes, closed forests of white spruce, with varying amounts of lodgepole pine and aspen, are common. Higher on the slopes, subalpine fir dominates, and black spruce, lodgepole pine and trembling aspen are relatively minor species.

The Interior Cedar-Hemlock (ICH) zone occupies less than 1% of the TSA at lower and middle elevations in the central portions of the Iskut and Stikine Rivers. The ICH zone is characterized by cool, wet winters and warm, dry summers, and has the highest diversity of tree species of any zone in the province. Western hemlock is the dominant species, but subalpine fir, Roche spruce and occasionally western redcedar also occur.

The Sub-Boreal Spruce (SBS) zone occupies about 2% of the TSA, at lower and middle elevations in the Stikine and Taku river valleys and further inland than the ICH, thus giving it a more continental climate. The SBS zone's climate is characterized by severe, snowy winters and relatively warm, moist, and short summers. Roche spruce and subalpine fir are the dominant trees, but black cottonwood and paper birch also occur.

The Engelmann Spruce-Subalpine Fir (ESSF) zone occupies about 5% of the Cassiar TSA, at elevations above the ICH and SBS in the southern portion of the TSA. The ESSF has a relatively cold, moist and snowy continental climate, characterized by cool, short growing seasons and long, cold winters. Subalpine fir is the dominant species, but Engelmann spruce, Roche spruce and mountain hemlock also occur.

The Coastal Western Hemlock (CWH) zone breaks through the Coast Mountains to occupy about 1% of the TSA at low elevations along the lower reaches of the Unuk, Iskut, Stikine, Whiting and Taku Rivers. This is the rainiest zone in British Columbia, with cool summers and mild winters. Western hemlock is the most common species, but sitka spruce and some lodgepole pine also occur.

The Mountain Hemlock (MH) zone occupies about 2% of the TSA, at elevations above the CWH zone. This coastal subalpine climate is characterized by short, cool summers and long, cool, and wet winters with heavy snow cover for several months. Mountain hemlock is the dominant tree species, but sitka spruce, Roche spruce (a white spruce/sitka spruce hybrid), western hemlock and subalpine fir also occur in this zone.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

1 Description of the Cassiar Timber Supply Area

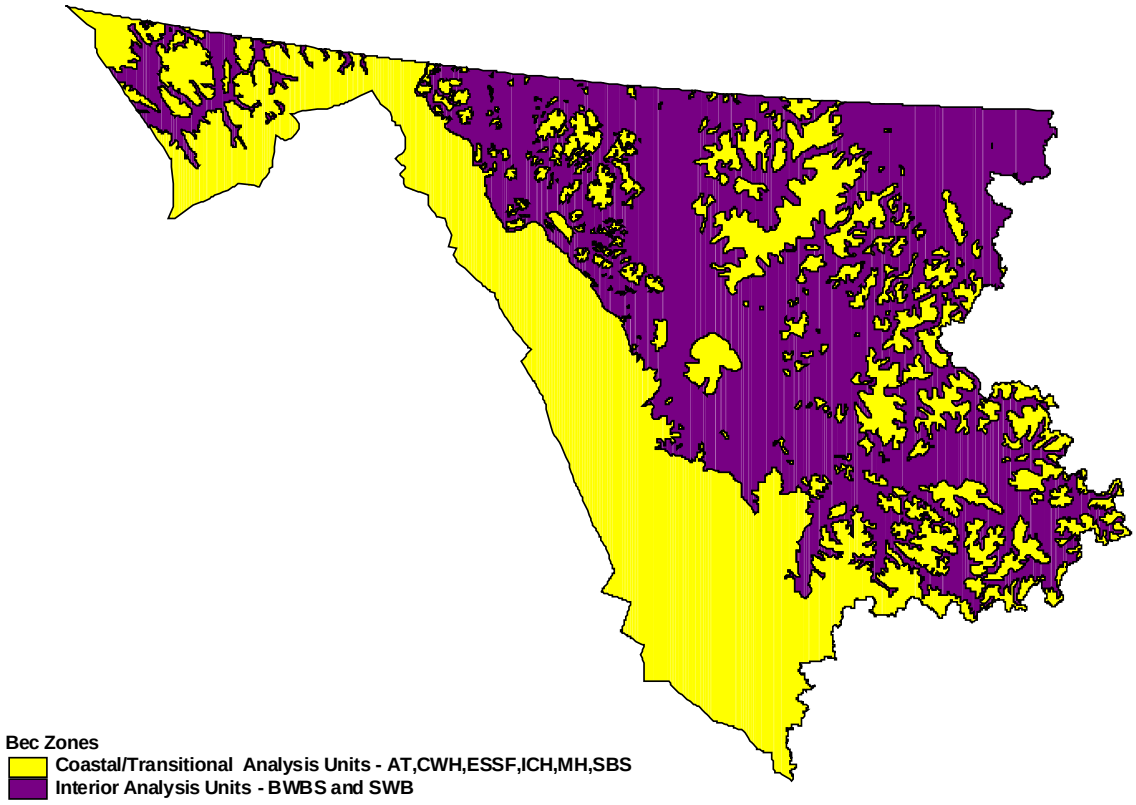

Figure 2. Map of the biogeoclimatic ecosystem classification zones — Cassiar Timber Supply Area, 2001.

1 Description of the Cassiar Timber Supply Area

The forests of the Cassiar TSA host a range of wildlife species, some of which are considered to be potentially threatened by human activities or natural events. Moose are the most numerous ungulate*, but thinhorn sheep, caribou and mountain goats also occur in large numbers. Grizzly bears, black bears, wolverines, lynx and wolves are common throughout the valleys of the TSA. Many bird species also occur, and several breed nowhere else in British Columbia.

The lakes and rivers of the Cassiar TSA support a wide variety of fish species. All five species of salmon are found in the Taku and Tatshenshini watersheds*, and the lower portion of the Stikine watershed. Freshwater fish including rainbow trout, Arctic grayling, Dolly Varden char, lake char, white sucker, whitefish and northern pike are found throughout the TSA.

The majority of species that are considered at risk or regionally significant and that occur or potentially may be found in the Cassiar TSA are presented in Table 1.

Table 1. Vulnerable, endangered and threatened species found in the Cassiar TSA

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	
Broad whitefish	bull trout	red-necked phalarope
least cisco	trumpeter swan	short-eared owl
peregrine falcon *anatum*	oldsquaw	Smith's longspur
upland sandpiper	peregrine falcon *pealei*	meadow jumping mouse *alascensis*
Hudsonian godwit	gyrfalcon	glacier bear
tundra shrew	American golden-plover	grizzly bear
	wandering tattler	fisher
	short-billed dowitcher	wolverine *luscus*
		Dall's sheep

Source: B.C. Conservation Data Centre, June 2000.

Ungulate
A hoofed herbivore, such as deer.

Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

1 Description of the Cassiar Timber Supply Area

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the application of the *Code*. In addition, in October 2000, government approved the *Cassiar Iskut-Stikine Land and Resource Management Plan* (LRMP)* planning table's recommendations on new protected areas* and resource management practices for public forest lands. The LRMP, initiated in 1997, covers approximately five million hectares in the Cassiar TSA, roughly corresponding to the watershed of the Stikine River and the Canadian portion of the Unuk River.

1.2 First Nations

First Nations people comprise approximately 55 to 65% of the TSA population. First Nations that have traditional territory within the Cassiar TSA are the Tahltan First Nation, the Dease River First Nation, Kwadacha First Nation (formerly Fort Ware Indian Band), Lower Post First Nation, Taku River Tlingit First Nation, and Champagne-Aishihik First Nations. Most bands are participating in provincial treaty negotiations.

Some Archeological Overview Assessments (AOA) and Traditional Use Studies (TUS) have been completed in the Cassiar TSA, and these are expected to guide future forestry activities.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

2 Critical Issues

The combination of land-use decisions and forest management practices that constitute "current management" cannot always be defined with certainty or precision. Because there is currently little harvesting activity in the Cassiar TSA, this timber supply analysis focussed on addressing key issues, or factors, identified by the chief forester as not being fully accounted for in the 1994 base case projection of timber supply. These factors include:

- size of the timber harvesting land base as determined by conventional (ground-based) harvesting methods (see Figure 3);
- site productivity;
- northern growing conditions;
- forest cover requirements* for wildlife habitat;
- green-up* for cutblock adjacency*;
- riparian habitat*; and
- unsalvaged losses* due to fire, insects and disease.

All of these issues were examined when preparing information for this analysis.

A study of economic and physical operability helped to improve the estimate of the area suitable for timber harvesting. Significant uncertainty still remains about the size of the timber harvesting land base. The potential impacts of this uncertainty are evaluated in Section 6.2, "Uncertainty in the size of the timber harvesting land base."

An approach has been developed to enable application of improved site productivity information to future regenerated stands (see Section 6.4.2, "Uncertainty in estimates of managed stand yields").

Forest Service staff evaluated the implications of northern growing conditions, and concluded that they would be reflected in forest characteristics such as site productivity (site index) in the inventory. While harsh winters limit growth, long growing days in the summer improve productivity. No adjustments were believed necessary on this account.

Wildlife habitat mapping and related forest cover requirements for grizzly bear, goat, moose and caribou not available at the time of the previous analysis, were used in this analysis.

At the time of the previous analysis, field observations suggested that green-up ages were being underestimated. Further assessment indicated that the observed stands were suppressed. Appropriate silviculture practices should address this issue, and no adjustments were made for this analysis.

Information use in the last analysis was believed to underestimate the area of riparian buffers needed to protect streams, lakes and wetlands. For this analysis, a geographic information system (GIS) was used to estimate the area of riparian buffers that would be needed to achieve *Forest Practices Code* requirements in the Cassiar Iskut-Stikine (CIS) LRMP area. This information is incorporated into this analysis, and extrapolated to the whole TSA.

Finally, to improve estimates of unsalvaged losses, information representing current fire suppression policies was used. This information was incorporated into this analysis. Also, analysis was done to assess the potential impacts of uncertainties about unsalvaged losses (Section 6.3, "Uncertainty in the estimate of catastrophic losses due to fire").

A more detailed discussion on these factors is included in Appendix A (Section A.1, "Critical Issues").

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

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Riparian habitat
The stream bank and flood plain area adjacent to streams or water bodies.

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

3 Information Preparation for the Timber Supply Analysis

Information required for timber supply analysis falls into three general categories: land base inventory; timber growth and yield; and management practices. In preparation for this analysis, a number of changes since the 1994 Cassiar TSA timber supply analysis were identified.

3.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1999 by the B.C. Forest Service from its geographic database. This file contains information on the forest land in the Cassiar TSA. It includes general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other notable characteristics such as environmental sensitivity and physical accessibility (operability*). Inventory estimates for forest stand attributes such as tree height, stocking* and age have been projected to 1999. The inventory file has also been updated to account for forest harvesting, silviculture activities or major wildfires up to 1993. Since there has been little harvesting and no large disturbances in the timber harvesting land base since 1993, the vintage of the update does not affect the results of this analysis.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks; areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development areas. A description of these areas specific to the Cassiar TSA is provided below. These types of areas do not contribute to the timber harvesting land base of the Cassiar TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base. When deriving this data file, care is taken to make only a single reduction for areas that overlap (for example, where an inoperable area is also wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is removed from the Cassiar TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein 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 the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

For the Cassiar TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — non-Crown areas and parks are removed from the productive forest. Parks and reserves (e.g., ecological) still contribute towards biodiversity values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- environmentally sensitive areas (ESAs)* — areas considered sensitive (e.g., soil, avalanche, regeneration).

Operability
Classification of an area considered available 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.

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

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

- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons.
- sites with low productivity — areas occupied by forests with low timber-growing potential or marginal merchantability.
- problem forest types (PFT) — forest types* which are currently not utilized. They are predominantly whitebark pine, yellow pine, tamarack, or deciduous*.
- visually sensitive corridor — a one kilometre-wide corridor along Highway 37 was removed to model visual concerns in the TSA.
- existing roads, trails and landings (RTLs) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- future roads, trails, and landings — areas of forest land that will be removed from timber production in the future. These areas are initially included in the timber harvesting land base, and are subsequently removed as part of the first harvest.
- riparian areas* — areas otherwise available for timber production, a portion of which is assumed to be unavailable for harvesting to provide protection for riparian and stream ecosystems.
- wildlife tree* patch (WTP) areas — areas reserved within and along the edges of cutblocks* for the maintenance of stand-level biodiversity* (stand structure), primarily for conservation or enhancement of wildlife.
- low volume pine — areas occupied by pine stands with volumes less than what would normally be harvested.
- marginally inoperable — areas that have access constraints which may be overcome during periods of higher market value.
- pulpwood stands — areas that are occupied by predominantly pulp-quality stands in which no harvesting has occurred, but which could potentially be harvested economically given high market prices for pulp.
- Muskwa-Kechika — area of the Cassiar TSA transferred by Order-in-Council to the Fort Nelson TSA after initiation of the Cassiar timber supply analysis.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Cutblock
A specific area, with defined boundaries, authorized for harvest.
Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

3 Information Preparation for the Timber Supply Analysis

A more detailed description of these categories, including specific criteria for removal, is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Productive forest area by classification" provides the total productive forest area managed by the B.C. Forest Service within the given category. For example, while there is a total of 387 427 hectares of land classified as problem forest types, only 49 025 hectares were removed specifically due to problem forest types criteria. The difference arises because one area can be in more than one classification (e.g., inoperable and problem forest types), and the actual area deducted depends on the point at which the reduction occurs in the sequence. Further, partial reductions are sometimes employed to represent situations where parts of areas are retained to protect a particular value, or do not contribute to harvests due to low timber quality volume or productivity.

The current timber harvesting land base in the Cassiar TSA represents about 1.3% of the total TSA area and about 5.4% of the productive forest. The two categories that most reduce the availability of the productive forest for timber supply are inoperability (53%) and low-growth potential (32%). The percentages provided depend on the order in which each class is considered. For instance, riparian areas would constitute a larger proportion of the reduction if they were considered prior to inoperable areas.

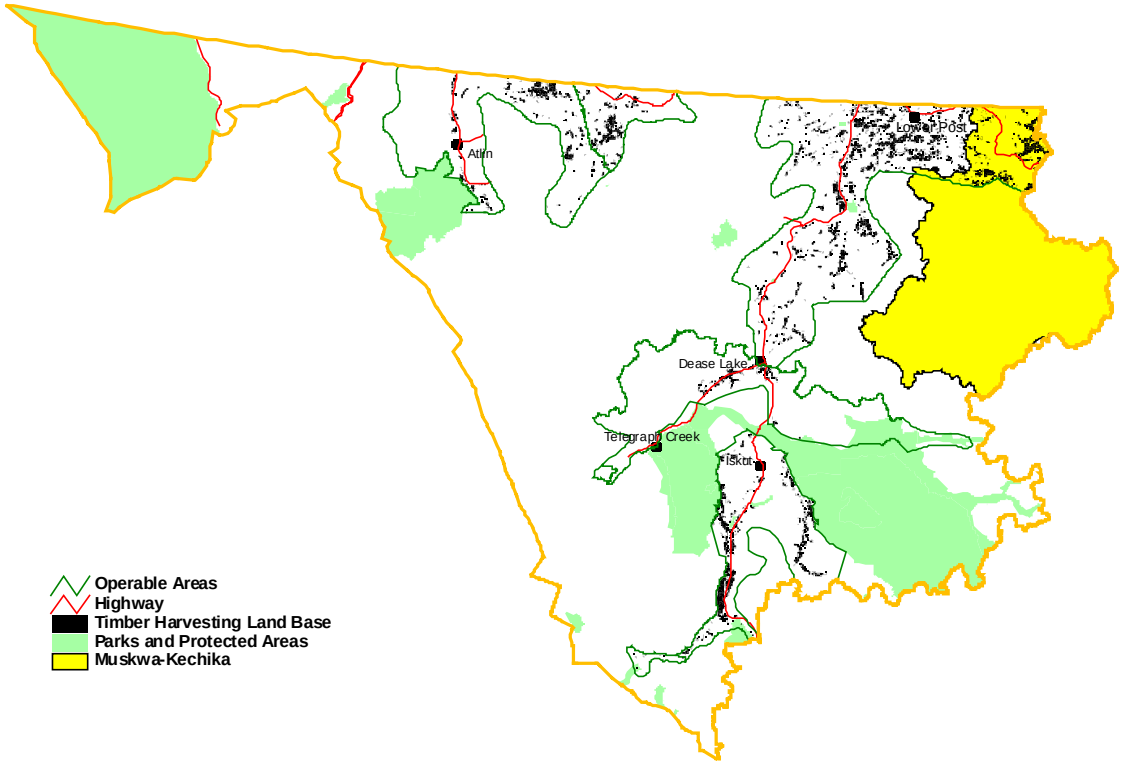

Figure 3. Map of the timber harvesting land base — Cassiar Timber Supply Area, 2001.

3 Information Preparation for the Timber Supply Analysis

Table 2. Determination of the timber harvesting land base for the Cassiar TSA

Classification	Productive forest area by classification (hectares)	Area (hectares)	Per cent (%) of total TSA area	Per cent (%) of Crown forest
Total TSA area		14 800 323	100.0	
Not managed by the B.C. Forest Service		2 590 893	17.5	
Non-forest		8 500 936	57.4	
Total productive forest managed by the Forest Service (Crown forest)		**3 708 494**	**25.1**	**100.0**
Reductions to Crown forest:				
Non-commercial cover (brush)	116 825	116 825	0.8	3.2
Environmentally sensitive areas (ESAs)	41 062	41 062	0.3	1.1
Inoperable areas	2 052 173	1 954 577	13.2	52.7
Sites with low-growth potential	2 654 981	1 184 062	8.0	31.9
Problem forest types	387 427	49 025	0.3	1.3
Visually sensitive corridor	44 260	12 190	0.1	0.3
Current roads, trails and landings[a]		723	0	0
Riparian areas[a]		33 193	0.2	0.9
Wildlife tree patch (WTP) area[a]		12 673	0.1	0.3
Low-volume pine	720 996	7 310	0	0.2
Marginally operable	448 868	43 788	0.3	1.2
Pulpwood stands	1 310 719	26 846	0.2	0.7
Muskwa-Kechika	805 665	27 452	0.2	0.7
Total current reductions		**3 509 726**	**23.7**	**94.7**
Current timber harvesting land base (includes 7 874 hectares not satisfactorily restocked (NSR)* land)		**198 768**	**1.3**	**5.4**
Future reductions				
Future roads, trails and landings		13 131	0.09	0.35
Long-term timber harvesting land base		**185 637**	**1.25**	**5.0**

(a) For these categories, the area exclusions were derived using percentages of the timber harvesting land base. They are not mapped features, and therefore total productive forest area covered is not available.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

3 Information Preparation for the Timber Supply Analysis

Figure 4 represents both the total Cassiar TSA area, and the productive forest land base. The total area chart shows that about 75% of the total land base is classified as not managed by the B.C. Forest Service, non-forest or non-productive forest (i.e., having very few trees). The productive forest chart details the categories of forest land and shows that about 95% of the forest land in the Cassiar TSA is considered to be unavailable for harvesting. The predominant reasons for forest unavailability are physical or economic inoperability and low site productivity. Slightly more than 5% of the productive forest is considered available for timber harvesting (including NSR).

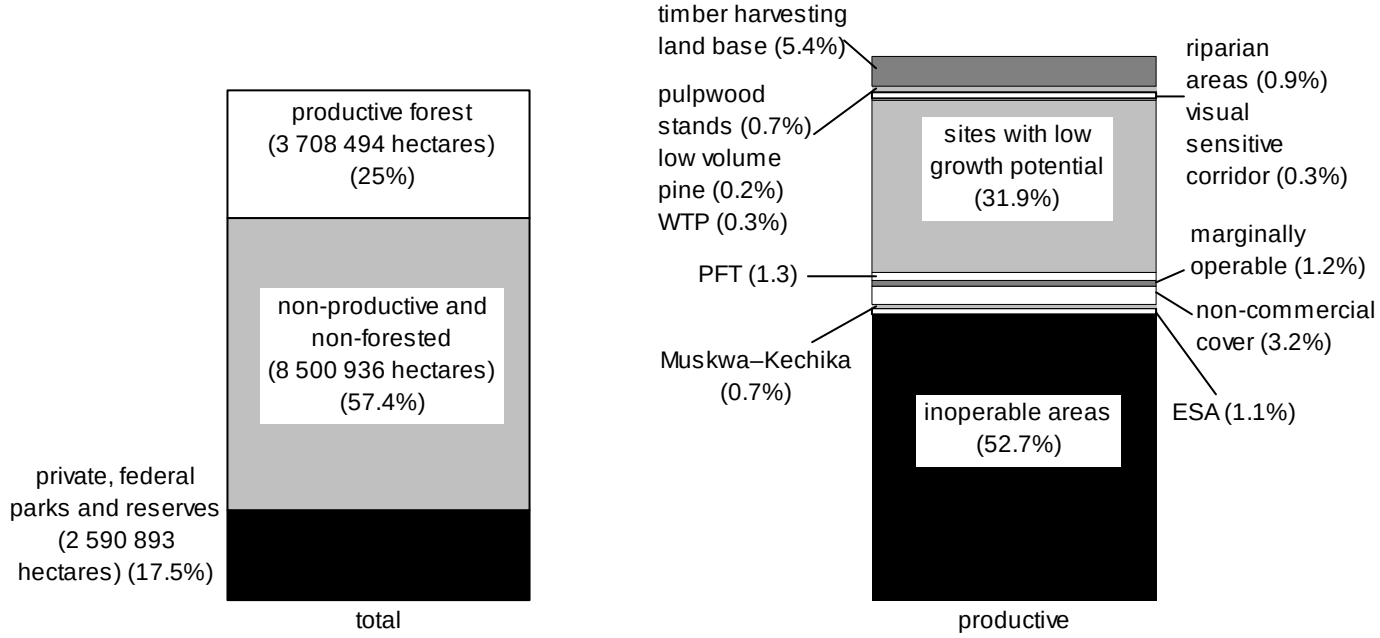

Figure 4. Composition of the total and productive forest land bases — Cassiar TSA, 2001.

3 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current composition of the timber harvesting land base by dominant tree species. Lodgepole pine dominates about 49% of stands within the timber harvesting land base, with spruce dominating 47% and subalpine fir about 4%. Although western hemlock grows in the Cassiar TSA, there are no western hemlock-leading stands in the timber harvesting land base. Where mixed stands include western hemlock, the hemlock will be harvested along with the other species. After being harvested, most stands are expected to regenerate to a mixture of spruce and pine.

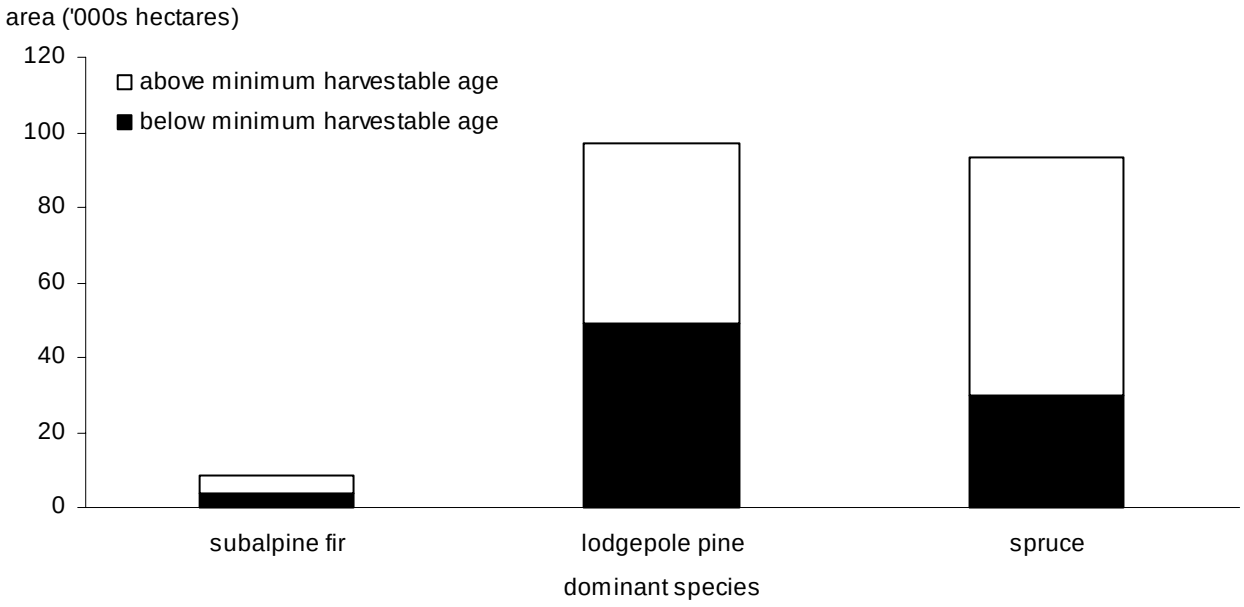

Figure 5. Area by dominant species — Cassiar TSA timber harvesting land base, 2001.

Figure 5 also shows the proportion of area of each species that is either younger or older than the minimum harvestable age (MHA) (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 58% of the stands in the timber harvesting land base are at or above the minimum harvestable age. However, there is variation among leading species: 49% of the pine stands, 68% of the spruce stands, and 56% of the subalpine fir stands are currently above minimum harvestable age. The area below minimum harvestable age is largely due to the extensive fires rather than harvesting history. The pine stands appear to have been the most impacted by fire, since 51% are below minimum harvestable age, the highest among all the species types. The limited incidence of western balsam bark beetle (*Dryocoetes confusus*) has led to some tree mortality (primarily in subalpine fir).

3 Information Preparation for the Timber Supply Analysis

Figure 6 provides an overview of the distribution of site productivity of the dominant stand types within the timber harvesting land base. Site productivity was measured in terms of site index (SI)*, which was categorized into good, medium and poor. See Appendix A, Section A.3.2, "Analysis unit characteristics" for definitions. Only 6% of the stands are classified as good, 26% as medium and 69% as poor.

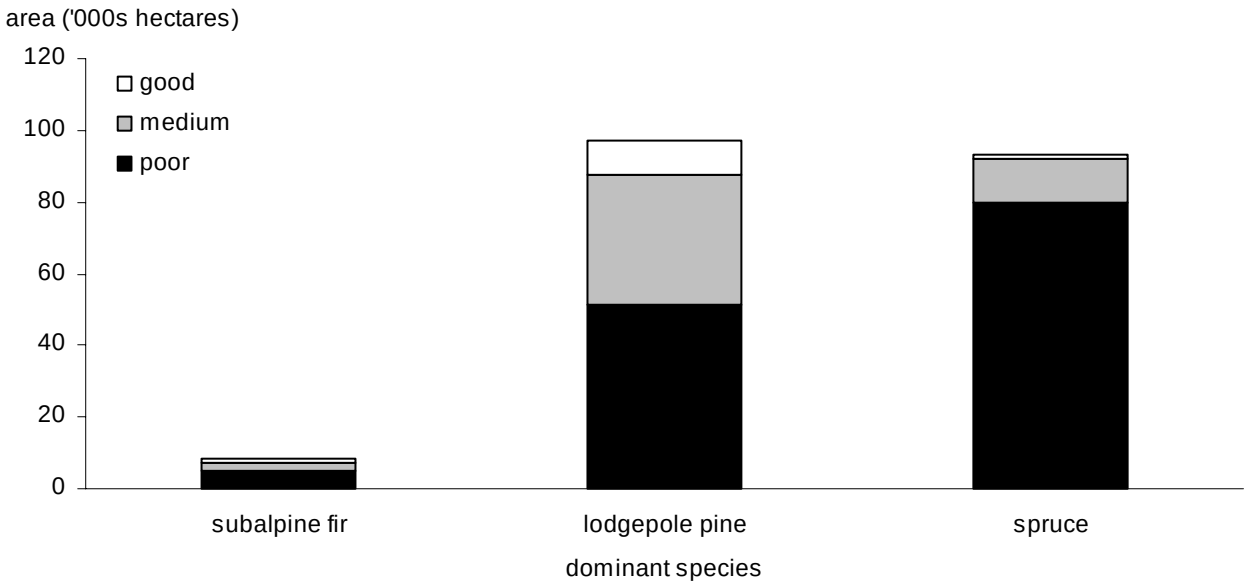

Figure 6. Area by dominant tree species and site productivity — Cassiar TSA timber harvesting land base, 2001.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

3 Information Preparation for the Timber Supply Analysis

Figure 7 shows the distribution of timber harvesting land base by leading species and age groups relevant for defining timber yield projections, and for testing growth and yield assumptions. Stands that are 15 years old or less and have a logging history have managed characteristics, and are modelled with managed stand yield curves. These stands represent about 0.5% of the timber harvesting land base. Forty per cent of the stands are over 140 years of age.

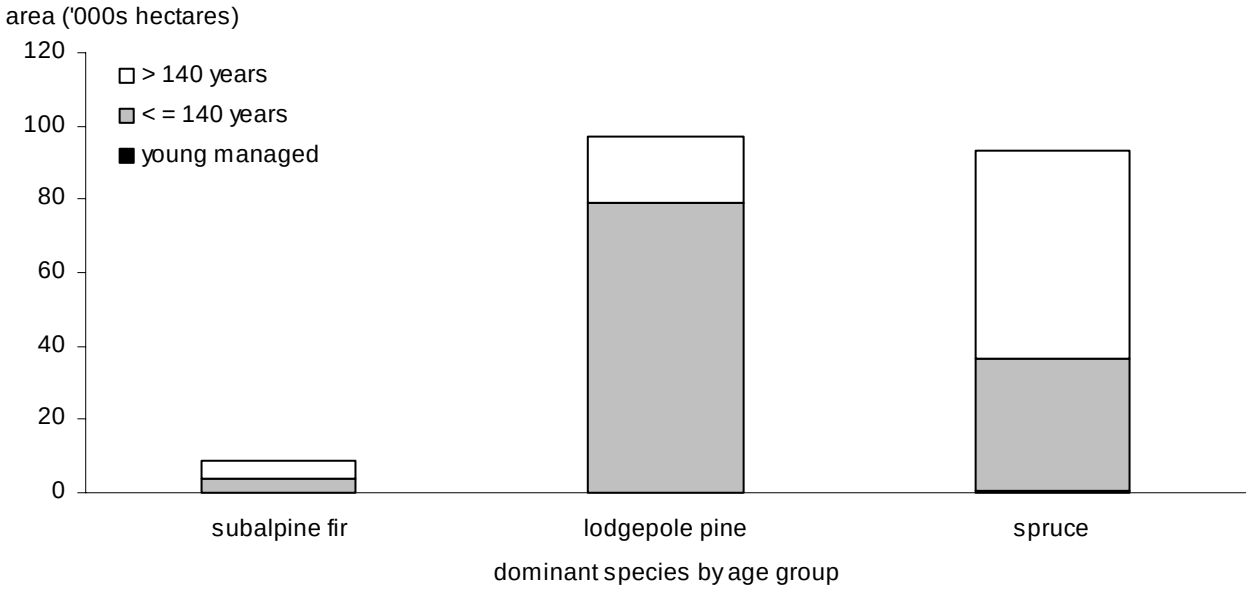

Figure 7. Area of dominant species by age group — Cassiar TSA timber harvesting land base, 2001.

Figure 8 shows the current age class distribution of forested stands within the timber harvesting land base. Sixty per cent of the stands are less than or equal to 140 years old, while 40% of the stands are older. Note that Figure 6 depicts only 5% of the productive crown forest land, or 1.3% of the entire TSA. The remainder of the Cassiar TSA could have a different age class distribution.

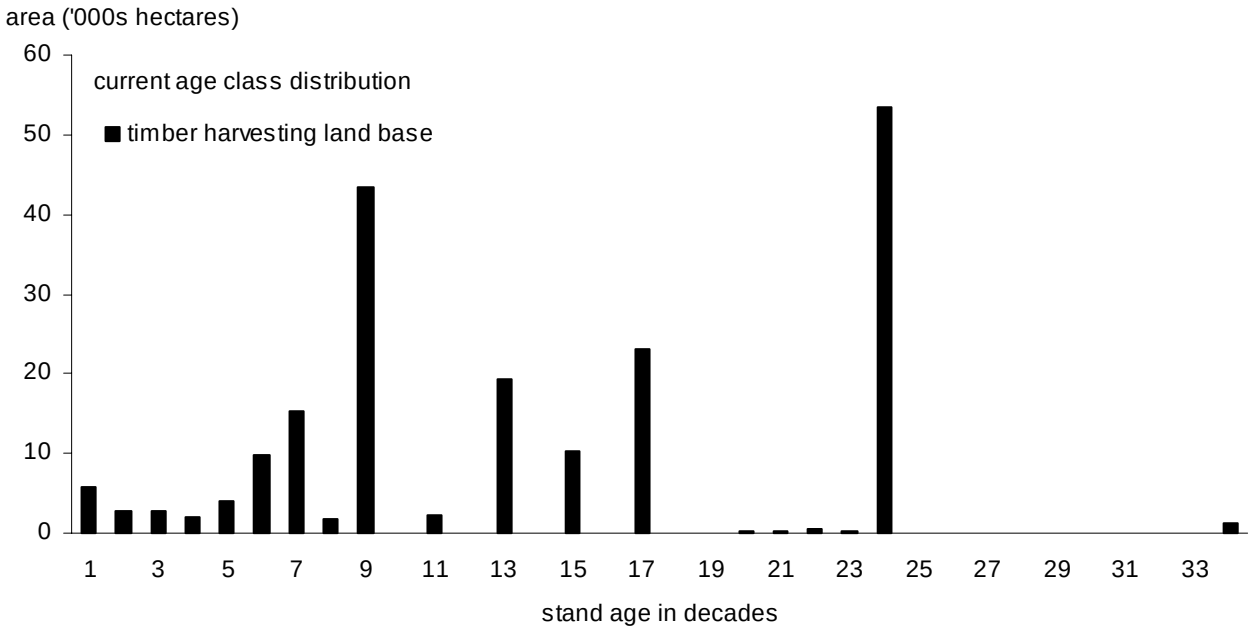

Figure 8. Current age class distribution — Cassiar TSA timber harvesting land base, 2001.

In most Timber Supply Review analysis reports, the age class distribution of the entire forest land base — that is, including forest outside the timber harvesting land base — is shown. However, in the Cassiar TSA, forest outside the timber harvesting land base comprises 95% of the forest area, and displaying it would dwarf the distribution in the timber harvesting land base.

3 Information Preparation for the Timber Supply Analysis

3.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time that could be the subject of growth and yield (for example, number of trees per area, tree diameter, tree height, and species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (in British Columbia, cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of dimensions, that establishes the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters for logs, both top and bottom, to ensure maximum utilization.

Two growth and yield models were used to estimate timber volumes for the Cassiar TSA analysis. The variable density yield prediction (VDYP) model* developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous* stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. Managed stands were defined as stands less than or equal to 15 years of age which have a history activity of 'L' on the inventory file to indicate that they have been logged.

Uncertainty in volume estimation and prediction stems from uncertainties in inventories that form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 6, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates*, the current timber inventory on the timber harvesting land base is approximately 40 million cubic metres. About 34.5 million cubic metres, or 86% are currently merchantable, that is, older than minimum harvestable age.

3.3 Management practices

Timber supply depends on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Cassiar TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Because there has been no industrial forestry in the Cassiar TSA for the last few years, staff in the Bulkley/Cassiar Forest District provided descriptions for the following management practices that would be in place if harvesting were to occur:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. Most areas in the Cassiar TSA would be harvested using a clearcut with reserves silviculture system and restocked by planting or natural regeneration.
- Forest health and unsalvaged losses — timber losses to fire and insect damage are expected to average 25 520 cubic metres per year over the 250 year analysis horizon.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.

Variable Density Yield Prediction model
A B.C. Forest Service computer program that generates average yields for naturally regenerated, untreated stands based on empirical data.
Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth process, crown competition, environmental factors and silvicultural practices.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

- Cutblock adjacency and green-up — in the Cassiar TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height for the integrated resource management (IRM)* area), before adjacent stands may be harvested. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. These guidelines were modelled by limiting the area of the IRM zones that do not meet green-up conditions to a maximum of 33% in the Dease-Liard, Iskut and Boundary supply blocks, and 20% in the Atlin supply block. The integrated resource management zone represents about 77% of the timber harvesting land base.
- Moose habitat in the CWH — the green-up requirement applied in this area is achieved when trees on a previously harvested area average more than three metres tall. No more than 33% of the area is allowed to be under cover of stands that have not reached green-up conditions. This area overlaps entirely with the grizzly bear and mountain goat habitat in the CWH. While about 8180 hectares of the total forest area has been mapped as moose, grizzly bear or goat habitat in the CWH, almost none is within the timber harvesting land base. Hence, the corresponding forest cover requirements have no effect on the timber supply.
- Moose habitat in the BWBS — the green-up requirement is achieved when trees on a previously harvested area average more than three metres tall. No more than 33% of the area is allowed to be under cover of stands that have not reached green-up conditions. This area represents about 29 600 hectares or 15% of the timber harvesting land base. In total, about 65 200 hectares of forest in the BWBS is classified as moose habitat.
- Grizzly bear, mountain goat, and moose habitat in the ICH — about 8070 hectares of the ICH has been mapped as grizzly bear, mountain goat, and moose habitat. About 1690 hectares or about 1% of this area overlaps with the timber harvesting land base. A maximum of 25% is allowed to be under cover of stands that have not reached three metres tall. In addition, at least 30% of the forested area must be older than 250 years.
- High value caribou winter habitat — harvesting activities are modified through forest cover requirements by ensuring that no more than 25% of the area is allowed to be under cover of stands that have not reached three metres tall. In addition, at least 30% of the forested area must be older than 140 years. This area represents 126 000 hectares of forested area, and about 13 500 hectares or 7% of the timber harvesting land base.
- Community watershed (CW) — Telegraph Creek is the only designated community watershed in the Cassiar TSA, and is entirely outside the timber harvesting land base. If forest management were to occur in community watersheds, a maximum of 5% of the forested area could be harvested within a 5-year period, as recommended by the *Forest Practices Code Community Watershed Guidebook*.
- Protection of environmentally sensitive areas — areas where soils, avalanche tracks, recreation activities, and forest regeneration problems have been identified. To maintain ecological or other resource values, these areas have been partially or wholly removed from the timber harvesting land base.

Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting must be kept within limits in some areas of the Cassiar TSA. A one-kilometre wide corridor along Highway 37 was removed from the timber harvesting land base to model management for visual requirements throughout the TSA.
- Minimum harvestable age (MHA) — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages were defined based on minimum height and volume. A minimum height of 19.5 metres and a minimum volume of 220 cubic metres were required for existing stands in the coastal/transitional areas of the Cassiar TSA. A minimum height of 19.5 metres and a minimum volume of 150 cubic metres were required for existing stands elsewhere in the TSA, and in managed stands.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit (LU)*, the *Forest Practices Code* lists targets for the proportion of the area in each biogeoclimatic variant* that should be covered by stands with old-forest characteristics. However, within the Cassiar TSA, biodiversity emphasis options (BEO) have not been established for each landscape unit. Forest outside of the timber harvesting land base, which comprises 94.7% of the forest in the TSA, currently meets most requirements for landscape-level biodiversity. To ensure that no areas are missed within the timber harvesting land base, a higher wildlife tree patch requirement of 4% was modelled in the analysis, which is higher than recommended in the *Landscape Unit Planning Guide* (LUPG).
- Harvest systems — the main harvest system is clearcutting with reserves*.

The above management practices were described in the data package for the Cassiar timber supply area, which was released in November 1999. As a result of public input and further discussions, some changes were made to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*
Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Clearcutting with reserves
A variation of the clearcut silvicultural system in which trees are retained, either uniformly or in small groups, for purposes other than regeneration.

Figure 9 displays the proportions of the timber harvesting land base subject to wildlife habitat emphasis. Additional areas are mapped as having wildlife habitat emphasis, but are outside the timber harvesting land base.

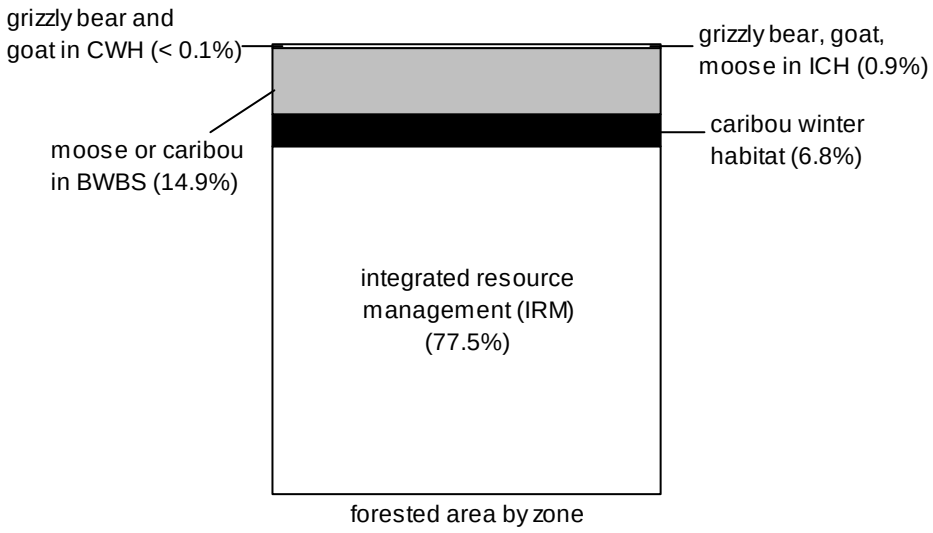

Figure 9. Timber harvesting land base by zone (management emphasis area) — Cassiar TSA, 2001.

3 Information Preparation for the Timber Supply Analysis

Figure 10 shows the proportion of timber harvesting land base by biogeoclimatic ecosystem (BEC) subzone or variant. It also shows the proportion of the total forested area in each BEC unit that is in the timber harvesting land base. For example, the BWBSdk1 variant makes up 36.3% of the timber harvesting land base area, while 7.6% of the total area of BWBSdk1 is within the timber harvesting land base. Ninety per cent of the timber harvesting land base is composed of interior BEC variants (BWBS and SWB); the remaining 10% are composed of coastal/transitional BEC variants (AT, CWH, ESSF, ICH, MH and SBS**).**

At the most, only 13.6% of any BEC variant is within the timber harvesting land base. This indicates that the productive forest outside of the timber harvesting land base can meet most landscape-level biodiversity objectives.

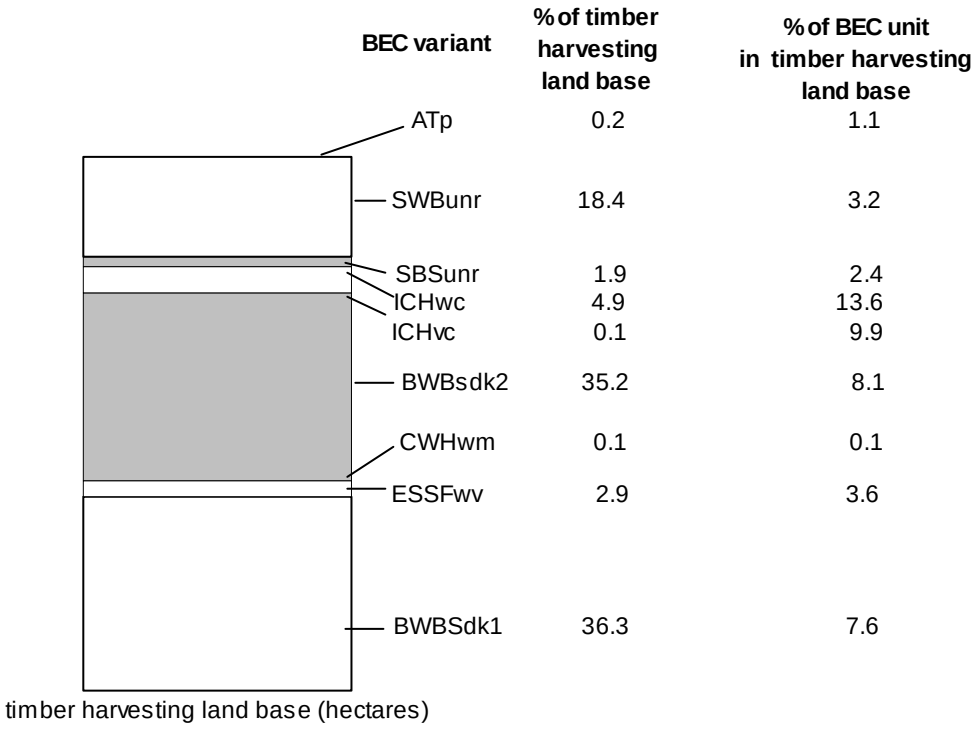

Figure 10. Area of productive forest by biogeoclimatic ecosystem variant — Cassiar TSA, 2001.

3 Information Preparation for the Timber Supply Analysis

Table 3. Area by biogeoclimatic classification

BEC variant	Productive forest (hectares)	% of productive forest (hectares)	Timber harvesting land base (hectares)	% of timber harvesting land base	% of BEC unit in timber harvesting land base
Unclassified	50	0	5	0	10.2
Atp	40 620	1.1	446	0.2	1.1
BWBSdk1	953 188	25.7	72 132	36.3	7.6
BWBSdk2	865 575	23.3	70 000	35.2	8.1
CWHwm	107 984	2.9	112	0.1	0.1
ESSFmc	276	0	0	0	0
ESSFwv	160 529	4.3	5 802	2.9	3.6
ICHvc	2 755	0.1	273	0.1	9.9
ICHwc	71 590	1.9	9 722	4.9	13.6
Mhunr	28 173	0.8	0	0	0
SBSunr	155 561	4.2	3 745	1.9	2.4
SWBmk	169 166	4.6	0	0	0
SWBunr	1 153 028	31.1	36 531	18.4	3.2
Total	3 708 494	100	198 768	100	

3 Information Preparation for the Timber Supply Analysis

3.4 Changes since the 1994 Cassiar TSA analysis

This section presents the major changes to the land base and forest management assumptions since the last analysis in 1994.

In the last analysis the forested area managed by the B.C. Forest Service was 3 667 434 hectares. It is now 3 708 494 hectares, an increase of about 40 000 hectares. This increase occurred because park area is now included in the TSA file**.**

- The timber harvesting land base is approximately 50% smaller than in the 1994 analysis. For the 1994 analysis, operable areas were approximated using inventory region and compartment boundaries. A recent operability study in the coastal area combined with an assessment in the interior has led to a substantial reduction in area considered operable, accessible and feasible to harvest. In the previous analysis, areas that could be harvested by helicopter and cable systems, as well as areas with marginal operability or low volumes were included in the timber harvesting land base. However, those areas were excluded from the timber harvesting land base for this analysis. Table 4 shows the change in area of timber harvesting land base.

Table 4. Changes in the timber harvesting land base

Current timber harvesting land base (hectares)	1994 timber harvesting land base (hectares)	Difference (hectares)	Difference (%)
198 768	393 755	194 987	– 50

- Implementation of the *Forest Practices Code* has led to the exclusion of forest to account for riparian reserves and wildlife tree patches (WTPs).
- The estimate of volume loss due to fire and insects has increased since the last analysis from 7600 cubic metres per year to 25 520 cubic metres per year. This increase can be attributed to the fire history review period used, and changes in timber harvesting land base (a factor in the calculation). The previous analysis examined a 10-year fire history database, while the current analysis examined data from the past 19 years.
- Detailed ecosystem mapping was not available in the previous analysis. In lieu of mapping, 12% of the timber harvesting land base by major tree species was reserved from harvest. In this analysis, however, biogeoclimatic ecosystem classification (BEC) mapping was available. The BEC zones were particularly useful in dividing the Cassiar TSA into coastal/transitional (southern) and interior (northern) sectors, instead of using administrative supply block boundaries to create the sectors. The BEC information was also useful in evaluating old-forest requirements.
- In the last analysis it was assumed that the environmentally sensitive areas (ESAs) identified on 39 maps were representative of the entire Cassiar TSA. For this analysis, stream buffers for riparian values, slope, and wildlife habitat mapping were used to account for ESAs for those mapsheets with no ESA information.

- The last analysis represented a 4-pass harvesting system in the south (Iskut and Boundary supply blocks) and a 3-pass harvesting system in the north (Atlin and Dease-Liard supply blocks). In this analysis, a 3-pass harvesting system was applied in the integrated resource management zone (IRM), except in the Atlin supply block where a 5-pass system was applied. Further constraints were placed on areas of known wildlife habitat.
- In this analysis, forest cover requirements for wildlife habitat were modelled, rather than removing wildlife ESAs from the timber harvesting land base. This results in less area being removed from the timber harvesting land base, and more area being under forest cover requirements than in the last analysis.

In summary, the timber harvesting land base has decreased by 50% and the definition of current practice has also changed since the last analysis. Given the extent of the change of the timber harvesting land base and the definitions of current management, direct comparisons between this and the previous analysis are difficult.

The analyses should be evaluated in the context of the management regime and related data inputs and assumptions applicable at the time (see Appendix A of the respective reports). As noted in the introductory section, there is uncertainty in information used in timber supply analyses, and forest management practices continually evolve. This is why the *Forest Act* requires the chief forester to review the timber supply and AAC for each TSA on a regular basis.

Any changes to the land base or management assumptions* that may occur or become effective after the completion of this timber supply analysis will be presented to the chief forester for consideration during the AAC determination, if possible.

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

4 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Cassiar TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (FSSIM version 3.0) 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 long period of time. Generally, only the results for the first 250 years are shown graphically in this report.

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 facilitates examination of 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. This analysis focuses on factors identified by the chief forester during the last AAC determination. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist 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 this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

5 Results

This section presents results of the timber supply analysis for the Cassiar TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 3, "Information Preparation for the Timber Supply Analysis." Because forest management is inherently a long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 6, "Timber Supply Sensitivity Analyses." However, it is important to keep in mind that the base case provides only a part of the timber supply picture for the Cassiar TSA, and should not be viewed in isolation of the sensitivity analysis*.

5.1 Base case harvest forecast

Figure 11 shows the base case harvest forecast for the Cassiar TSA. It is an even-flow harvest level equal to the current AAC of 400 000 cubic metres per year. This harvest level is maintained throughout the analysis period and is also known as the long-term harvest level (LTHL)*. The 1994 analysis projected a short- and medium-term level of 842 400 cubic metres per year, and a long-term harvest level of 867 400 cubic metres per year. However, the timber harvesting land base in the 1994 analysis was twice as large as the timber harvesting land base in this analysis.

The base case forecast was developed by attempting to maintain the current AAC in perpetuity, while maintaining a stable growing stock* into the future. Unsalvaged losses due to insects and fire estimated to be 25 520 cubic metres per year, have been subtracted from all harvest forecasts shown in this report.

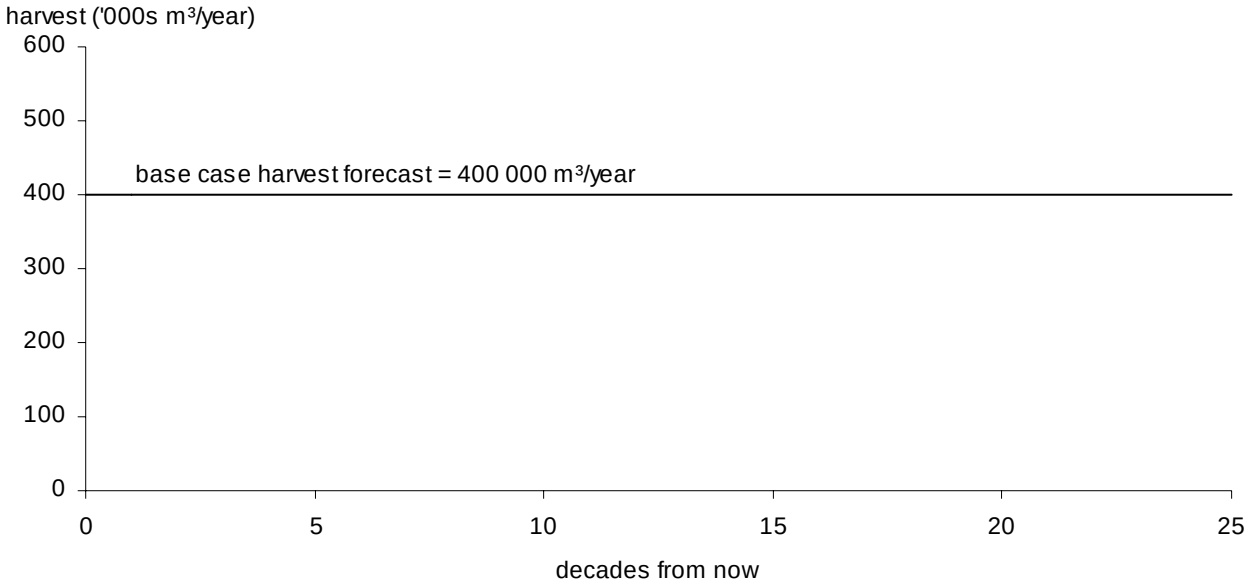

Figure 11. Base case harvest forecast for the Cassiar TSA, 2001.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

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 objectives and guidelines for non-timber values) and estimates of timber growth and yield.

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

5 Results

Currently, about 58% of the timber harvesting land base comprises stands with ages greater than the applicable minimum harvesting age, and a significant additional area currently aged between 81 and 90 years (see Figure 8) will achieve the minimum in the near future. Existing, stands contribute to all of the harvest over the next 120 years until younger managed forests have aged sufficiently. Figure 12 shows the transition of harvest from existing to managed stands for the base case. In the 13th decade, managed stands begin to contribute to the harvest. By the end of decade 22, the harvest is entirely from regenerated stands.

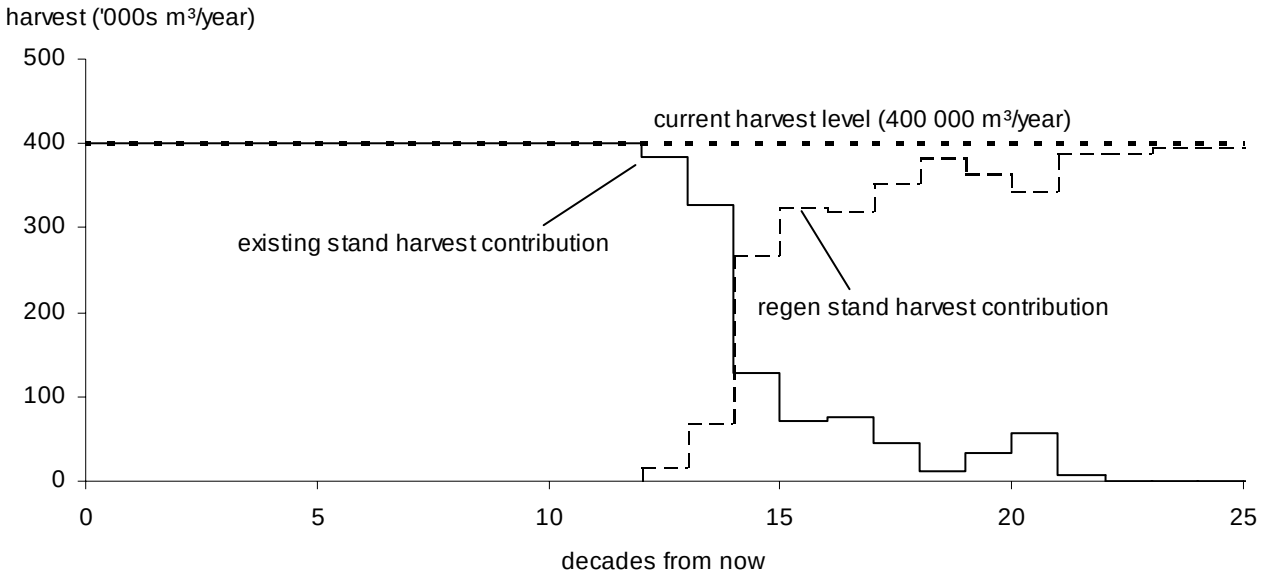

Figure 12. Harvest contributions from existing and managed stands — Cassiar TSA, 2001.

5 Results

Figure 13 shows the harvest from each of the four supply blocks by decade. The shifting harvest occurs because the model shifts the harvest among the supply blocks to meet age, biodiversity and other requirements.

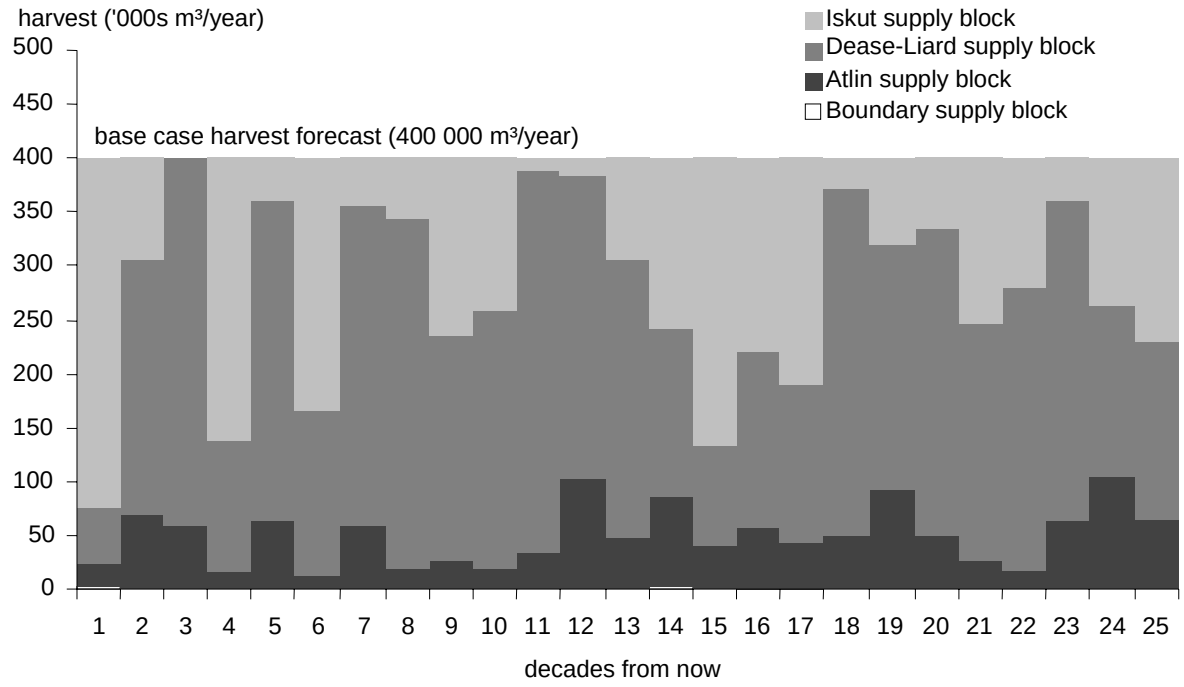

Figure 13. Harvest contribution from all supply blocks — Cassiar TSA, 2001.

The pattern of harvests among supply blocks shown in Figure 13 is only one of several possible distributions. However, the figure displays the overall proportional contributions of the various blocks. Over the first 100 years of the forecast, the contributions to the total base case timber supply are: Iskut 34%; Dease-Liard 57%, Atlin 9%, and Boundary 0.1%.

5 Results

Figure 14 shows the total volume of standing timber (growing stock) within the timber harvesting land base, and a breakdown of merchantable growing stock by existing and regenerated stands. Merchantable in this context means above minimum harvestable age. The increase in merchantable growing stock over the first 20 years corresponds to the aging of the large area currently between 81 and 90 years that reaches minimum harvestable age over the next two decades. Some managed stands reach merchantability starting in the 9th decade.

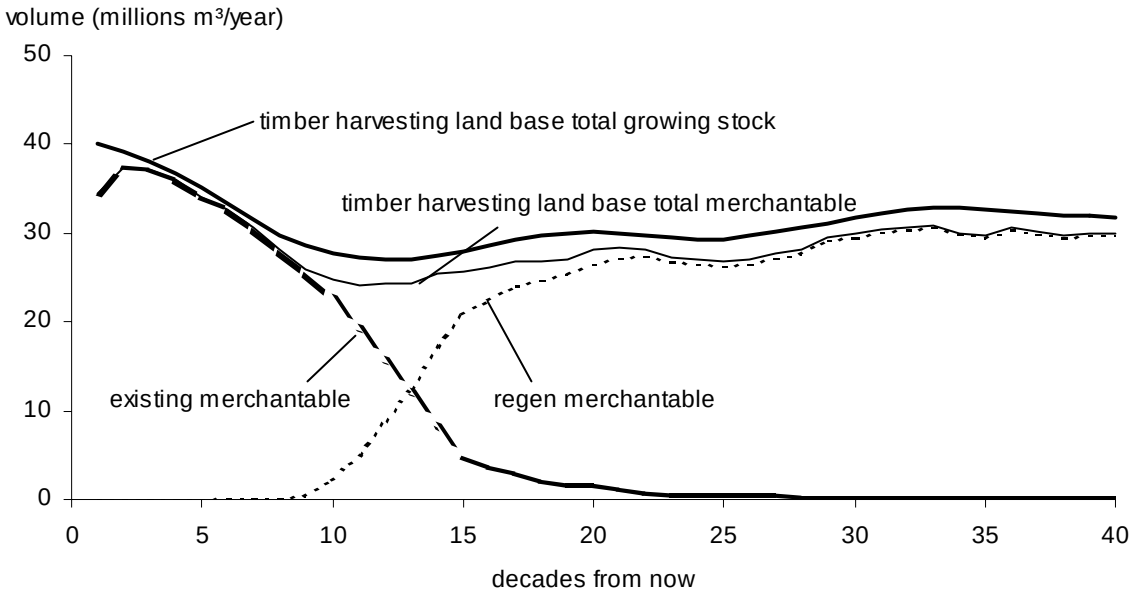

Figure 14. Total and merchantable growing stock — Cassiar TSA 2001.

Although in the long term the total level of growing stock oscillates slightly, the trend is constant, suggesting that the base case long-term harvest level can be maintained over the long term.

5.2 Area, average volume and average age harvested

Figure 15 tracks the change in the area-weighted harvest age resulting from the base case forecast. Older stands contribute most of the timber supply for the first 14 decades of the forecast, as the model seeks to harvest the oldest stands available after other constraints are met. From decade 13 onward, when regenerated stands begin to contribute to the harvest, younger stands less than 160 years old comprise more of the forecast harvest.

In decade 25, the area-weighted harvest age is 142 years.

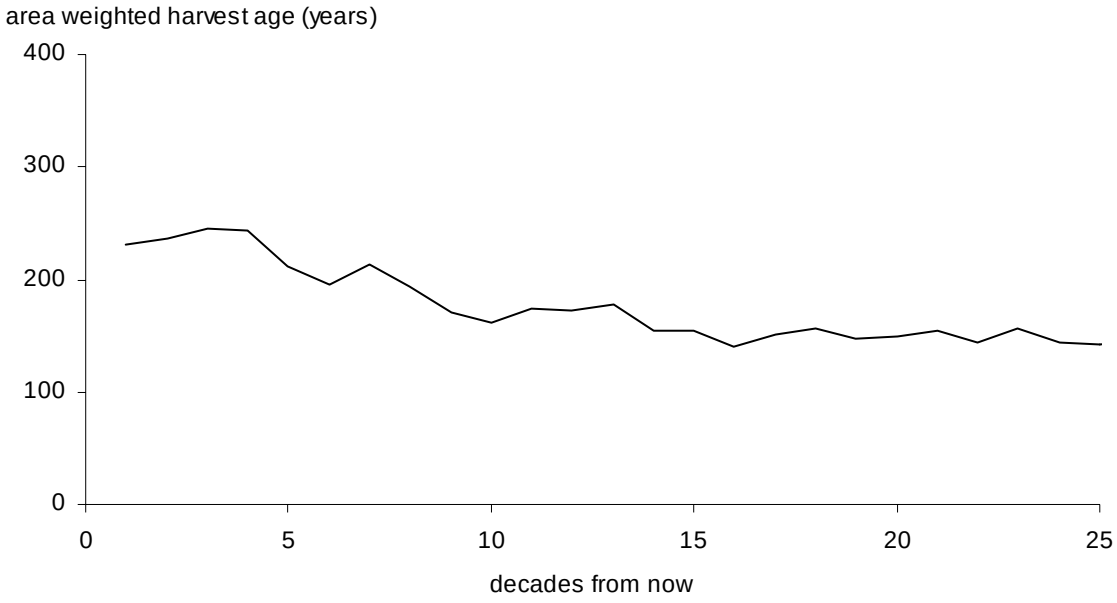

Figure 15. Average age of stands harvested over time — Cassiar TSA, 2001.

5 Results

Figure 16 shows the average area, and Figure 17 displays volume per hectare harvested per decade over the next 250 years under the base case harvest forecast. The area harvested fluctuates between approximately 1000-1500 hectares per decade and averages 1266 hectares over 250 years, although it shows a slight downward trend over the analysis horizon. Variations result due to differences in the species and site composition of the harvest. When higher volume stands make up a higher proportion of the harvest, the area harvested is lower since the overall harvest remains constant.

The initial average volume harvested is 321 cubic metres per hectare. The average volume harvested ranges between 278 and 405 cubic metres per hectare, and has an average of 338 cubic metres per hectare over the 250-year planning period. Volume per hectare harvested exhibits a slight upward trend over the 25-decade horizon.

Given the constant projected harvest level over the long term, the expectation is that at the maximum timber supply level, both area and volume per hectare harvested would be relatively constant. The decreasing area harvested, and increasing volume per hectare harvested suggest a somewhat higher harvest level could be achieved. This is discussed in Section 6.1, "Alternative harvest flows over time."

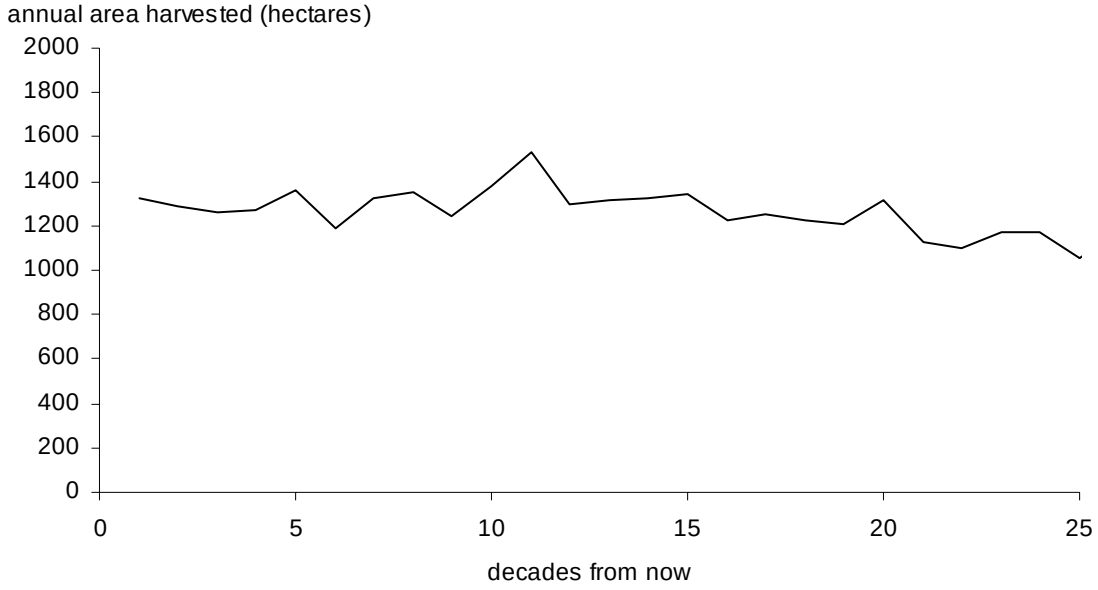

Figure 16. Average area harvested over time — Cassiar TSA, 2001.

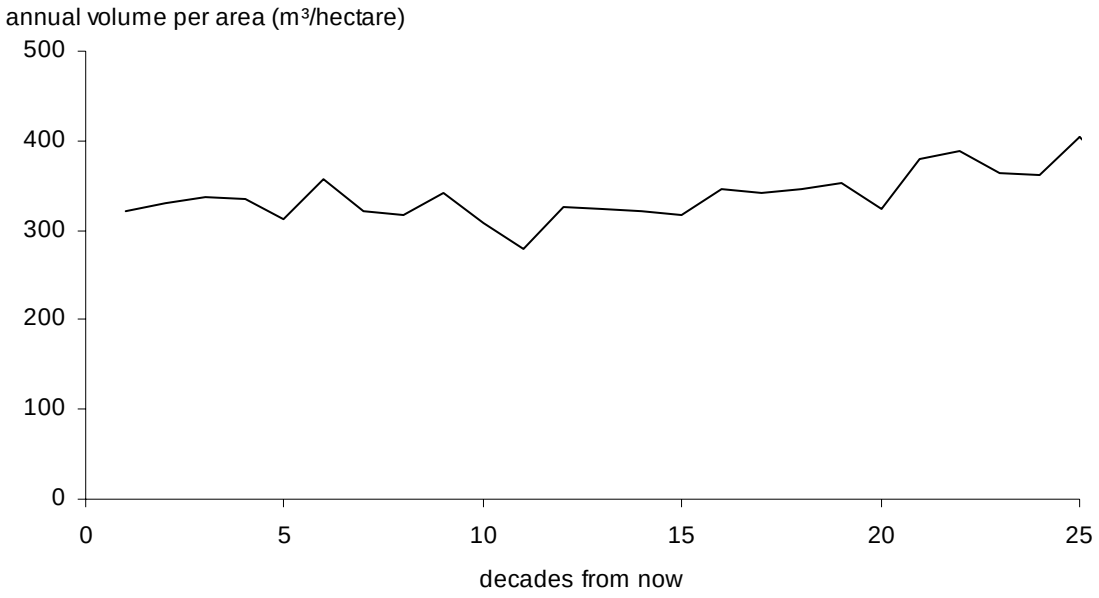

Figure 17. Average volume per hectare harvested over time — Cassiar TSA, 2001.

5.3 Age class profile over time

The charts in Figure 18 show how the age composition of the timber harvesting land base (THLB) in the Cassiar TSA changes under the base case harvest forecast.

One of the main factors affecting potential harvests over time in the Cassiar TSA is the current age class composition. Forests older than minimum harvestable age occupy about 58% of the timber harvesting land base, and an additional substantial area should achieve harvestable age in the near future. This means that one of the main factors defining the harvest forecast is the need to spread harvest of these older stands over enough time to enable current younger stands and future managed stands to reach harvestable condition. The current younger stands exist primarily due to fires, not harvesting.

Figure 18 shows that after 100 years, the majority of forest stands within the timber harvesting land base older than 170 years have been harvested and replaced with younger managed stands. After 250 years, the majority of forest stands within the timber harvesting land base are under managed conditions, and the forest age classes between 20 and 150 years are fairly evenly distributed.

5 Results

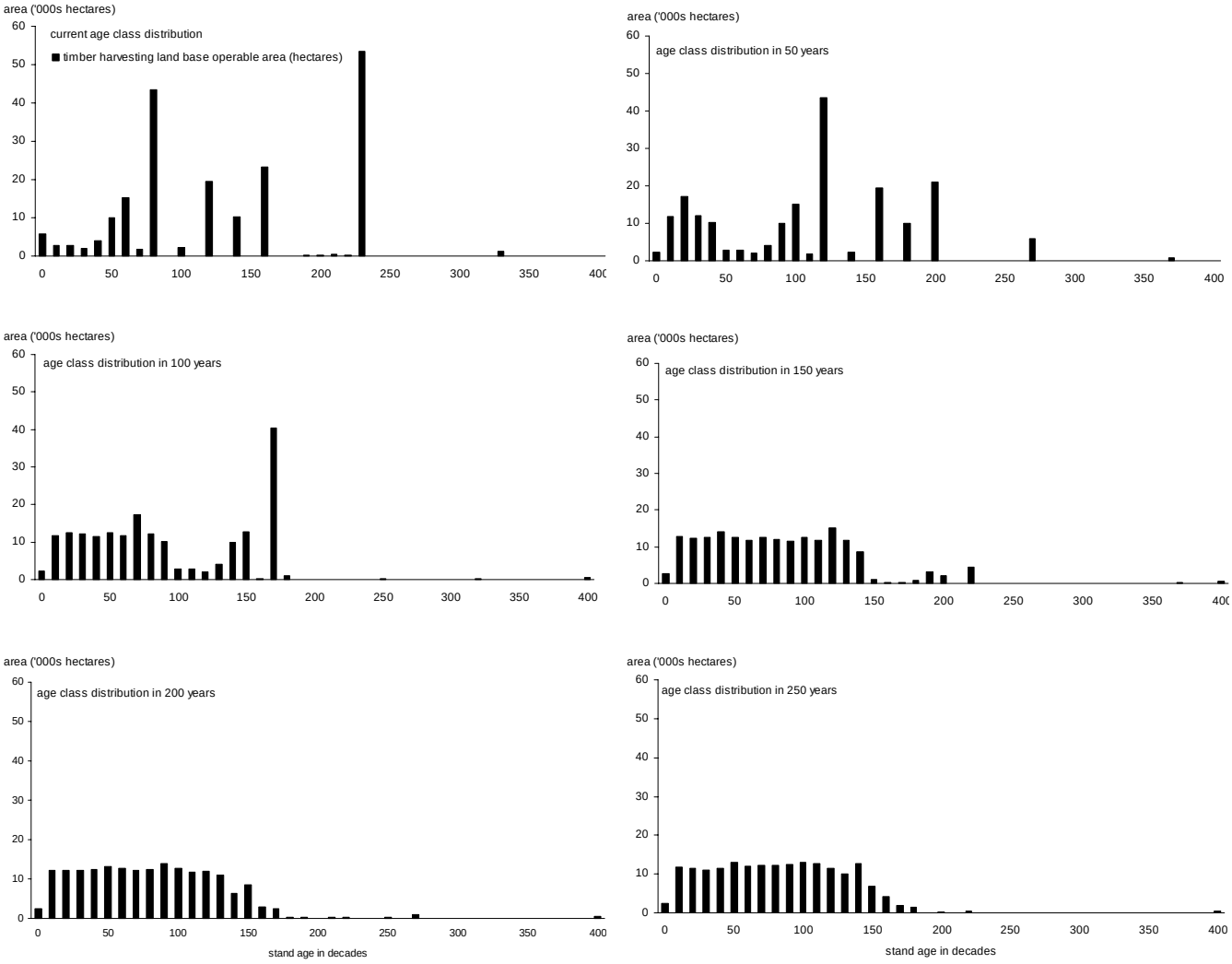

Figure 18. Changes in age class distribution over time — Cassiar TSA timber harvesting land base, 2001.

6 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 an evolving discipline 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 implications. In such a context, we cannot be certain that all data accurately reflect the current state of all forest values, how the forest will change, or how our management activities will affect the forest and its users. One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge.

Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed. Another important way of dealing with uncertainty is to assess how values of interest such as timber supply could change if the information used in the analysis is not certain — or if changes occur. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely, fairly large uncertainties could have negligible effects.

Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables and associated uncertainties have the most significance to assist decision-makers. It can clarify whether current best estimates provide an adequate basis for decisions, or whether uncertainty about important variables should lead to more conservative decisions (precautionary principle).

In the Cassiar TSA, the greatest uncertainty is the size of the timber harvesting land base. Therefore, most of the sensitivity analyses performed are related to the size of the timber harvesting land base. The sensitivity analyses test the robustness of the maximum even-flow harvest level of 441 000 cubic metres per year, and not the base case harvest forecast of 400 000 cubic metres per year. The results of the sensitivity analyses are discussed in this section.

6.1 Alternative harvest flows over time

The base case harvest forecast shown in Figure 11 was defined using criteria discussed in Section 5.1, "Base case harvest forecast," including the goals of maintaining the current AAC and a fairly constant growing stock level over the long term. The first goal seeks stability with respect to the current timber supply situation in the TSA, given the large uncertainties in the land base and management regime. The second goal is linked to maintaining the productivity of forested land, and is therefore an indicator of sustainability. However, there are many possible harvest flows with different starting harvest levels, rates of decline, and potential trade-offs between the short- and long-terms.

6 Timber Supply Sensitivity Analyses

Figures 19 and 20 display two alternative harvest flows based on the Cassiar TSA data and assumptions. Both show that there is considerable flexibility in harvest levels without affecting the long-term harvest level. A non-declining harvest level of 441 000 cubic metres is possible, herein referred to as the "maximum even-flow." All sensitivity analyses are compared to this level since the maximum even-flow more closely represents the full timber supply capacity of the Cassiar TSA timber harvesting land base. The base case level, while providing stability with respect to the current AAC, does not fully utilize the timber inventory and productive capability of the forest land. Therefore, the base case contains a fair amount of buffer against any changes that would reduce supply. Conversely, a maximum even-flow forecast based on a change that increased supply (e.g., an expansion in the land base) would overestimate the true impact relative to the base case. Comparison to the maximum even flow therefore provides a better understanding of potential impacts of uncertainties on timber supply in the Cassiar TSA.

Figure 19 shows that the harvest can initially be as high as 634 000 cubic metres per year, before decreasing by about 10% per decade to the maximum even-flow, long-term harvest level of 441 000 cubic metres per year.

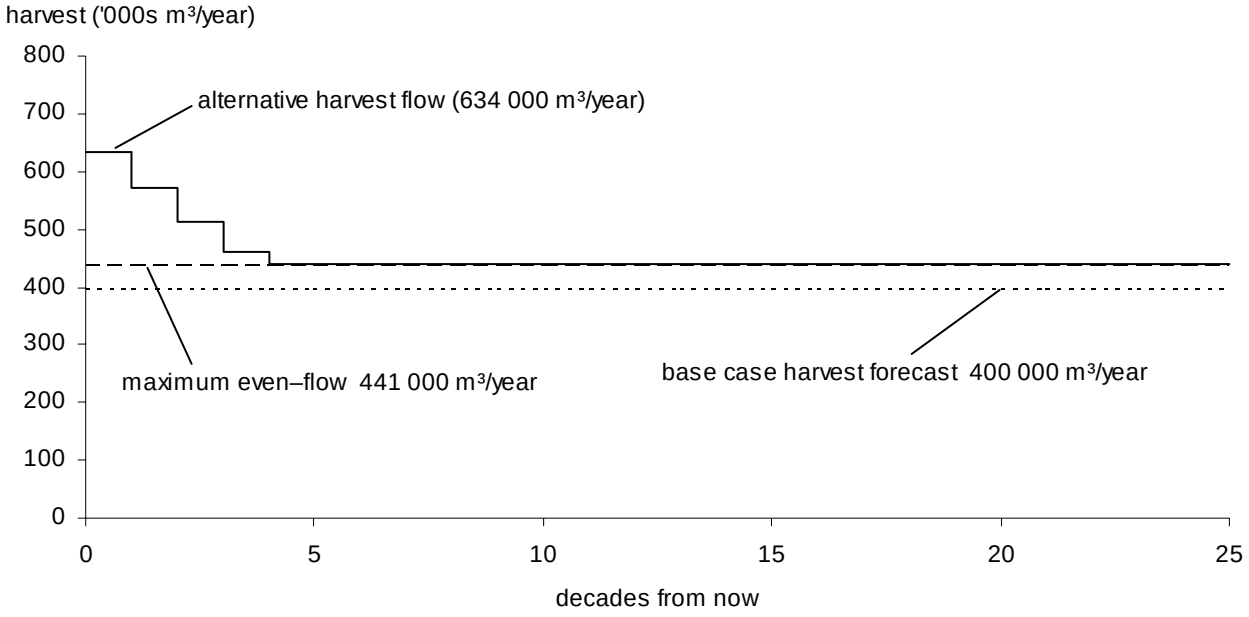

Figure 19. Alternative harvest flows-1 — Cassiar TSA, 2001.

6 Timber Supply Sensitivity Analyses

Figure 20 shows that the harvest can be maintained at 485 000 cubic metres per year, 10% above the maximum even-flow harvest level, for seven decades before decreasing to the long-term harvest level of 441 000 cubic metres per year. This long-term harvest level can be maintained while ensuring a stable growing stock over the long term.

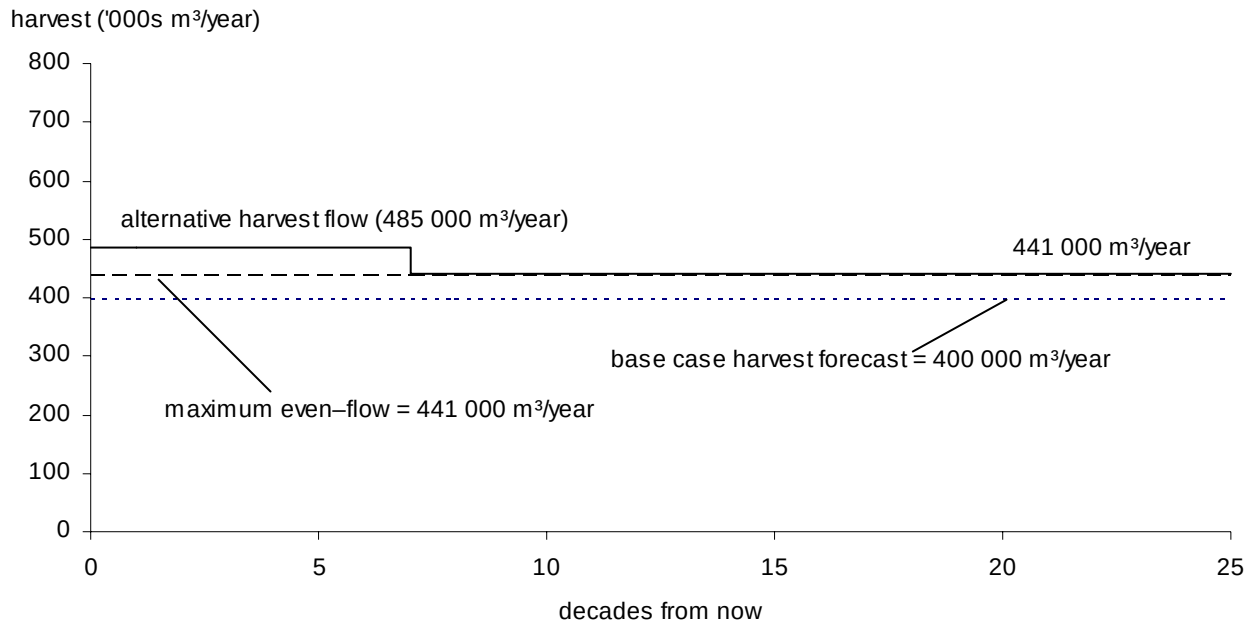

Figure 20. Alternative harvest flows-2 — Cassiar TSA, 2001.

6 Timber Supply Sensitivity Analyses

6.2 Uncertainty in the size of the timber harvesting land base

Uncertainty in the size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions. In the Cassiar TSA, uncertainty around these factors is high because a lack of harvesting makes it difficult to know what areas are actually operable or merchantable, and ultimately, to assess whether the timber harvesting land base has been accurately estimated. In developing the criteria to define the land base, forest district staff attempted to define types of areas that would likely be harvested if harvesting were to occur at the time of data package completion. These criteria were further examined after the data package was released in November 1999. Bulkley/Cassiar Forest District staff decided that, based on harvesting history and low timber values, areas with high proportions of pulpwood, areas of marginal operability, and areas of low-volume pine stands would likely not be harvested over the next 5 years. Therefore, these types were excluded from the base case and their contributions to the timber harvesting land base (77 943 hectares combined) were evaluated through sensitivity analyses. These changes to the original 1999 data package are noted in Appendix A. Since that time, however, a new forest licence opportunity has been advertised. Part of the requirements for this licence will be to utilize pulp stands.

In addition, the area known as "Muskwa-Kechika" was officially transferred from the Cassiar TSA to the Fort Nelson TSA in January 2000. This area was therefore removed from the base case timber harvesting land base, rather than through critical issue analysis as noted in the November 1999 data package.

Impacts of general increases and decreases of 10%, 20% and 40% of the timber harvesting land base were also analysed.

Table 5 shows the base case and a range of other land bases examined in the sensitivity analyses. Figures 21 and 22 shows the resulting harvest forecasts. Graphs of all harvest forecasts have not been included.

Table 5. Area of the base case and land base sensitivity analysis

Forecast	Timber harvesting land base (hectares)	Short-term harvest level (m^3/year) — net NRLs	Long-term harvest level (m^3/year) — net NRLs
Base case	198 768	400 000	400 000
Maximum even-flow case	198 768	441 000	441 000
Increase timber harvesting land base by 10%	218 645	485 000	485 000
Decrease timber harvesting land base by 10%	178 891	396 900	396 900
Increase timber harvesting land base by 40%	278 275	617 400	617 400
Decrease timber harvesting land base by 40%	119 261	264 600	264 600

6 Timber Supply Sensitivity Analyses

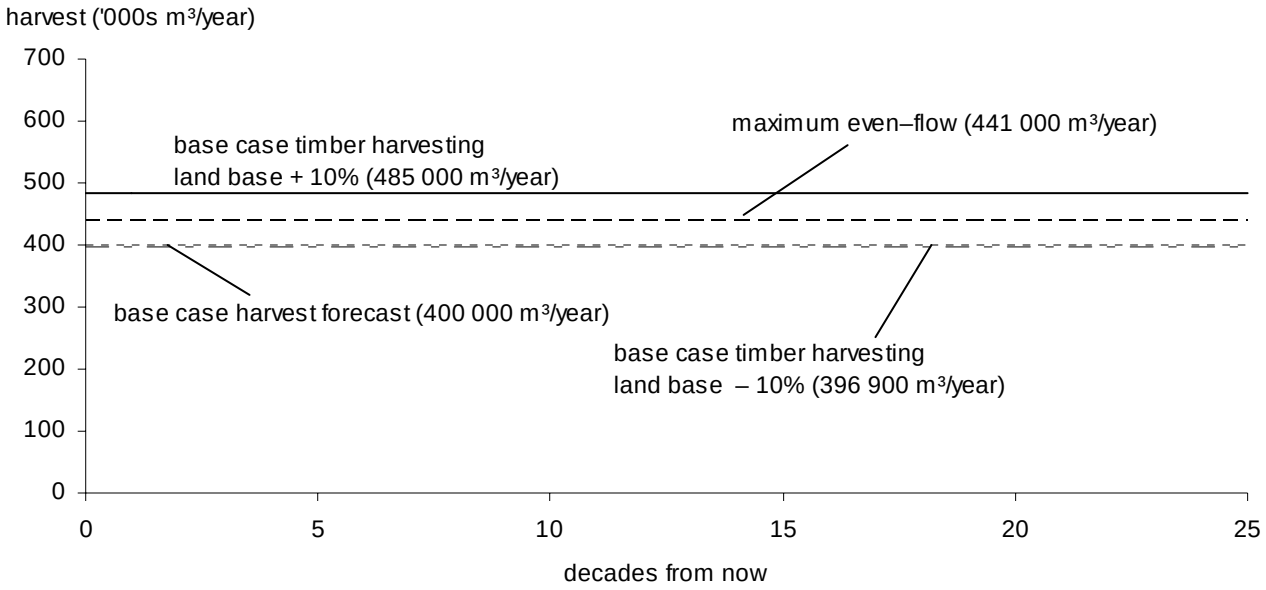

Figure 21. Sensitivity analysis of changes to base case timber harvesting land base + or – 10% — Cassiar TSA, 2001.

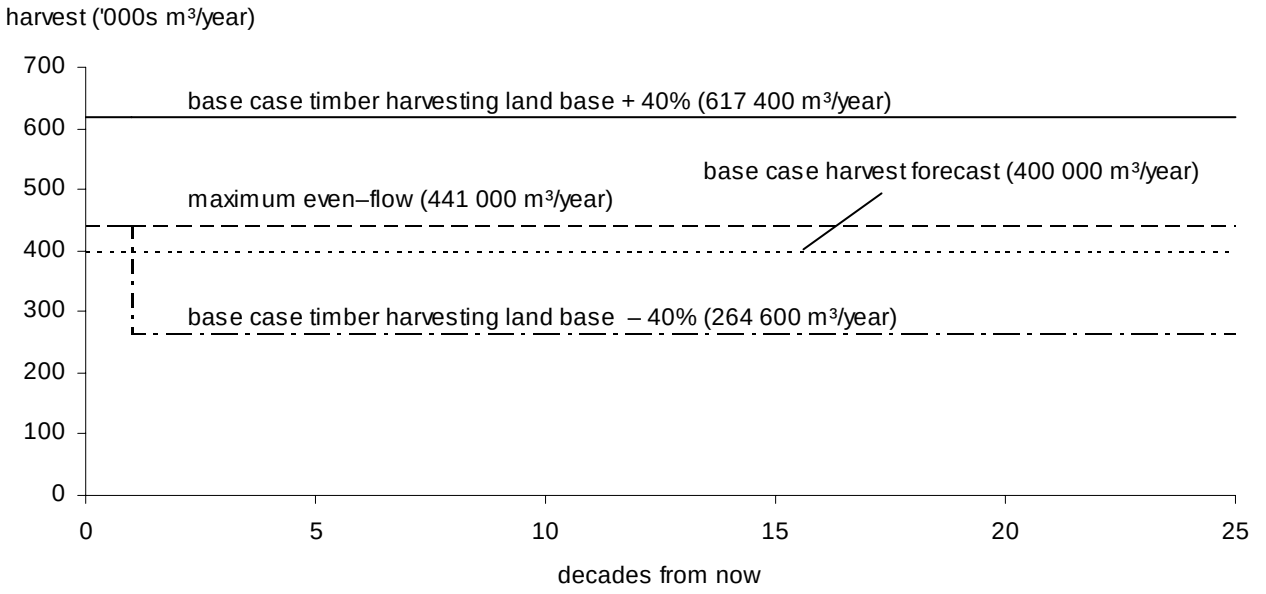

Figure 22. Sensitivity analysis of changes to base case timber harvesting land base + or – 40% — Cassiar TSA, 2001

6 Timber Supply Sensitivity Analyses

If the timber harvesting land base is overestimated by 10%, the maximum even-flow harvest level would be 396 900 cubic metres per year, 10% lower than the maximum even-flow level of 441 000 cubic metres per year. However, as shown in Figures 19 and 20, there is considerable flexibility to harvest the existing stock of old timber without affecting the long-term harvest level, if a regime other than a maximum even-flow harvest were chosen. For example, on the same reduced land base, a harvest level of 441 000 cubic metres per year can be maintained for six decades before dropping by 10% in decade 7 to a long-term harvest level of 396 900 cubic metres per year. If the timber harvesting land base is 40% smaller, the same projected harvest level of 441 000 cubic metres per year could be maintained for one decade before dropping by 40% to the new long-term harvest level of 264 600 cubic metres per year.

If the timber harvesting land base is 10% larger than assumed, the harvest forecast can be increased to a new long-term harvest level of 485 000 cubic metres per year, as shown in Figure 21.

If the timber harvesting land base is overestimated by 20% (not shown), the projected harvest level of 441 000 cubic metres per year could be maintained for 30 years before declining to the new long-term harvest level of 352 800 cubic metres per year.

This evaluation shows that the short- and medium-term timber supply shown in the maximum even-flow forecast is not sensitive to area reduction factors of 10% or less, but becomes more sensitive as the reduction factors increase.

6.2.1 Muskwa-Kechika area (Fort Nelson TSA)

The data package stated that the Muskwa-Kechika area of the Cassiar TSA would be included in the base case land base. However, it was transferred to the Fort Nelson TSA after the data package was released. For the analysis, this transfer was handled as a reduction to the productive forest land base, and not as a reduction to the total area of the Cassiar TSA. The area represented by this transfer totals 1.6 million hectares. This area was subjected to the land base definition process summarized in Table 2. After all other exclusions, 27 452 hectares remained as potential timber harvesting land base, representing 12% of the productive forest after other exclusions. This remaining area was excluded from the timber harvesting land base. If this area were included in the timber harvesting land base, the even-flow harvest level would be 59 000 cubic metres per year higher than the maximum even-flow harvest.

6.2.2 Utilization of pulpwood, marginally operable timber and low-volume pine

In the Cassiar TSA, 30 295 hectares of pulp-quality stands (3449 hectares of which is marginally operable), 43 788 hectares of marginally operable timber (not including pulp-quality stands) and 7310 hectares of low-volume pine stands that could be eligible for harvest under good markets were excluded from the timber harvesting land base.

According to criteria in the data package, the base case timber harvesting land base would have included these areas. However, forest district staff re-evaluated the viability of harvesting these types and found them to be unmerchantable under market conditions at the time of analysis. As a result, these areas were not included in the base case timber harvesting land base. Figures 23, 24 and 25 illustrate the effects of including these types in the timber harvesting land base.

Figure 23 shows that if the pulpwood stands had been included in the timber harvesting land base for the Cassiar TSA timber supply analysis, the harvest level could have been increased from the maximum even-flow harvest level of 441 000 cubic metres per year to 492 000 cubic metres per year.

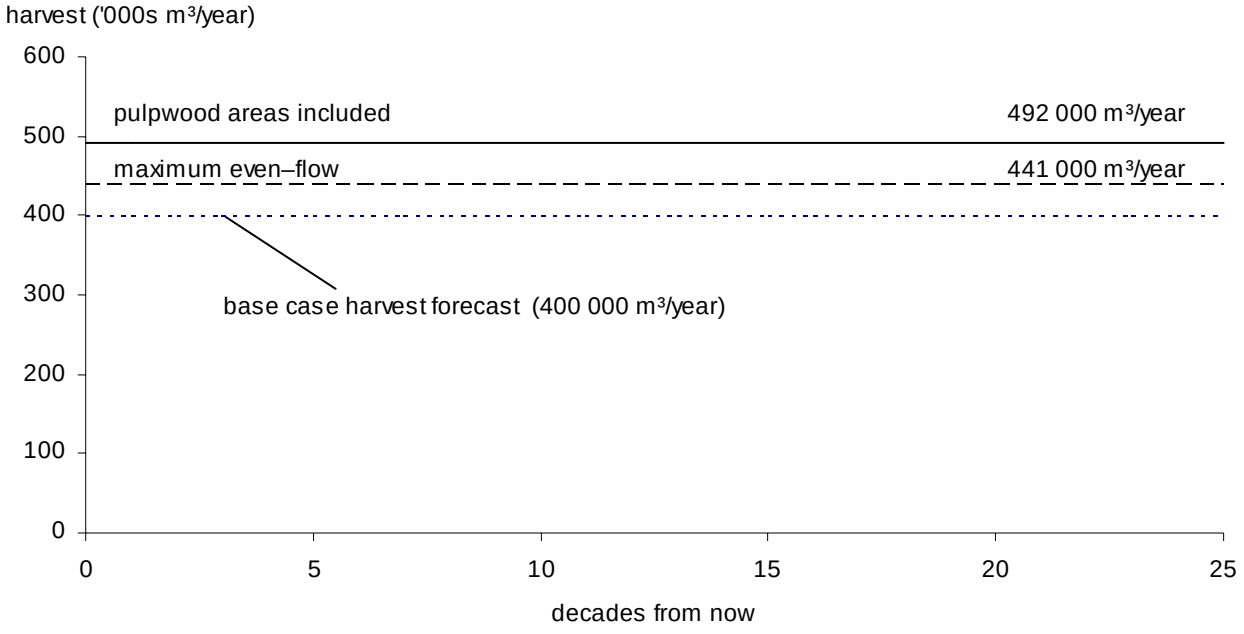

Figure 23. Sensitivity analysis of inclusion of pulp quality stands — Cassiar TSA, 2001.

6 Timber Supply Sensitivity Analyses

Figure 24 shows that if the area of marginally operable timber had been included in the timber harvesting land base for the Cassiar timber supply analysis, the maximum even-flow harvest level could have been increased from 441 000 cubic metres per year to 523 000 cubic metres per year.

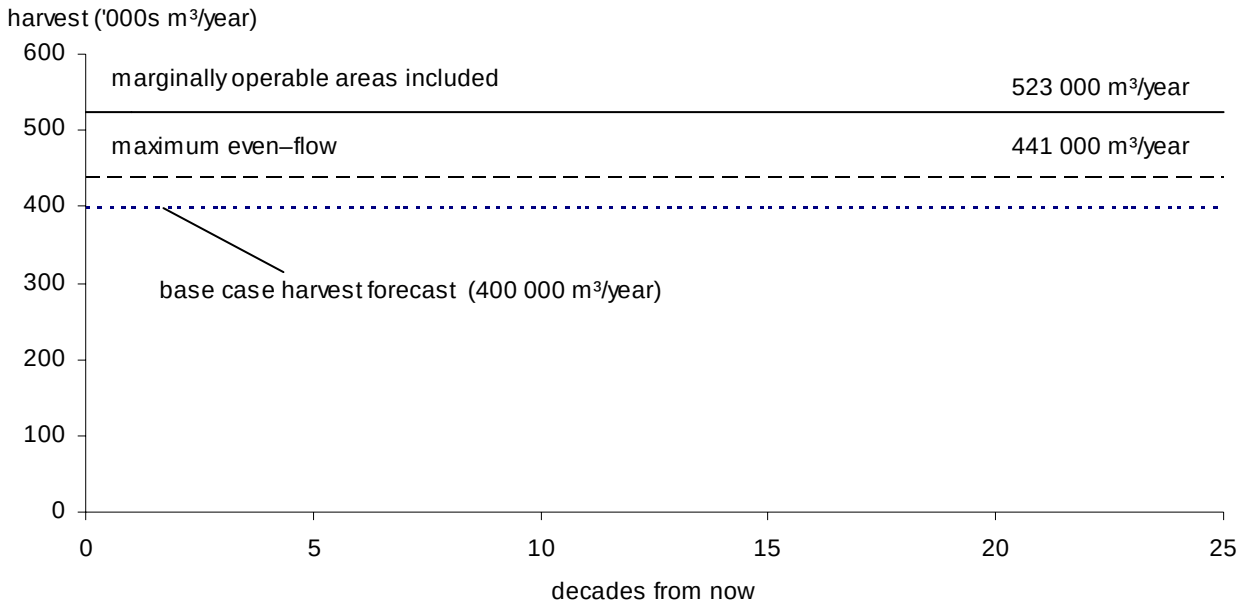

Figure 24. Sensitivity analysis of inclusion of marginally operable areas — Cassiar TSA, 2001.

6 Timber Supply Sensitivity Analyses

Figure 25 shows that if the area of low volume pine had been included in the timber harvesting land base for the Cassiar TSA timber supply analysis, the maximum even-flow harvest level could have been increased from 441 000 cubic metres per year to 450 000 cubic metres per year.

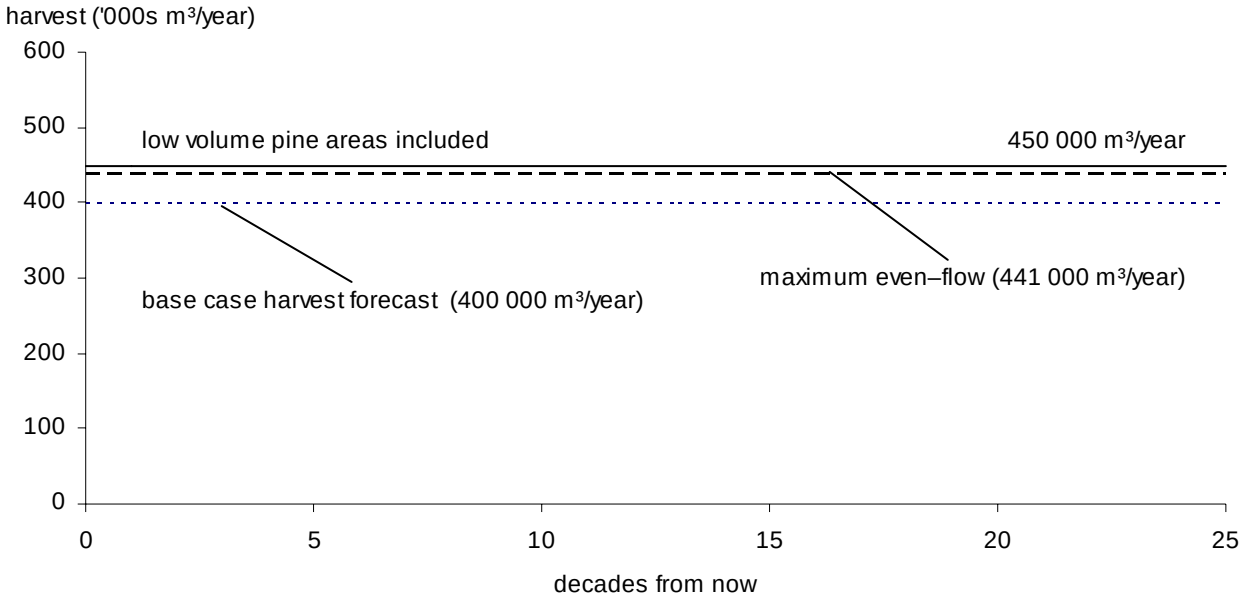

Figure 25. Sensitivity analysis of inclusion of low volume pine areas — Cassiar TSA, 2001.

6.2.3 Cassiar Iskut-Stikine land and resource management plan recommendations

The *Cassiar Iskut-Stikine Land and Resource Management Plan* was approved by government in October 2000. Since this approval took place after the timber supply analysis was initiated, the recommendations were not included in the base case. They were, however, examined in a critical issue analysis so that their impacts could be determined.

The critical issue analysis examined the following regime to represent the land and resource management plan (LRMP) table recommendations:

- remove the recommended protected areas from the timber harvesting land base;
- defer harvesting in the Klappan River area for 15 years;
- retain 6% of the timber harvesting land base for wildlife tree patches (4% was used in the base case); and
- increase the exclusions made in the base case for riparian areas by 2% to reflect best management practices.

Since the current timber harvesting land base already excludes most of the area within the proposed protected areas, the effect of removing the remainder of these areas is only a reduction of 236 hectares. Of note is that the timber harvesting land base in this analysis is smaller than that reported in the *Cassiar Iskut-Stikine Land and Resource Management Plan Timber Supply Analysis*, November 1998. That analysis included substantial portions of the recommended protected areas within the timber harvesting land base.

The planning table recommended that the Klappan River area be deferred for 15 years. Since 10-year periods were used in this analysis, the deferrals were modelled as lasting for two analysis periods or 20 years. The deferral proved to have no impact on the timber supply. This is because there is substantial mature timber currently available for harvesting in other areas of the TSA.

Six per cent of the productive forest was excluded to account for wildlife tree patch (WTP) retention. Although the LRMP recommendations will most likely result in an average of 12% of all cutblocks being retained as wildlife tree patches, it was assumed that half of this would overlap with riparian reserves or inoperable areas. Using the larger exclusions, the area reserved for wildlife tree patches increased from 12 673 hectares in the base case to 14 814 hectares in the land and resource management plan scenario. This difference represents a decrease of about 1% in the timber harvesting land base.

The productive forest was reduced by an additional 2% to account for the planning table recommendations regarding riparian area management. Based on this recommendation, the area reserved for riparian areas increased from 33 194 hectares in the base case to 35 706 hectares in the land and resource management plan case. This difference represents a decrease of about 1% to the timber harvesting land base.

6 Timber Supply Sensitivity Analyses

Figure 26 shows that if all of the land and resource management recommendations were included, the maximum even-flow harvest level could be maintained for 150 years before decreasing to the new harvest level of 437 000 cubic metres per year. The long-term level is less than 1% lower than the maximum even-flow forecast.

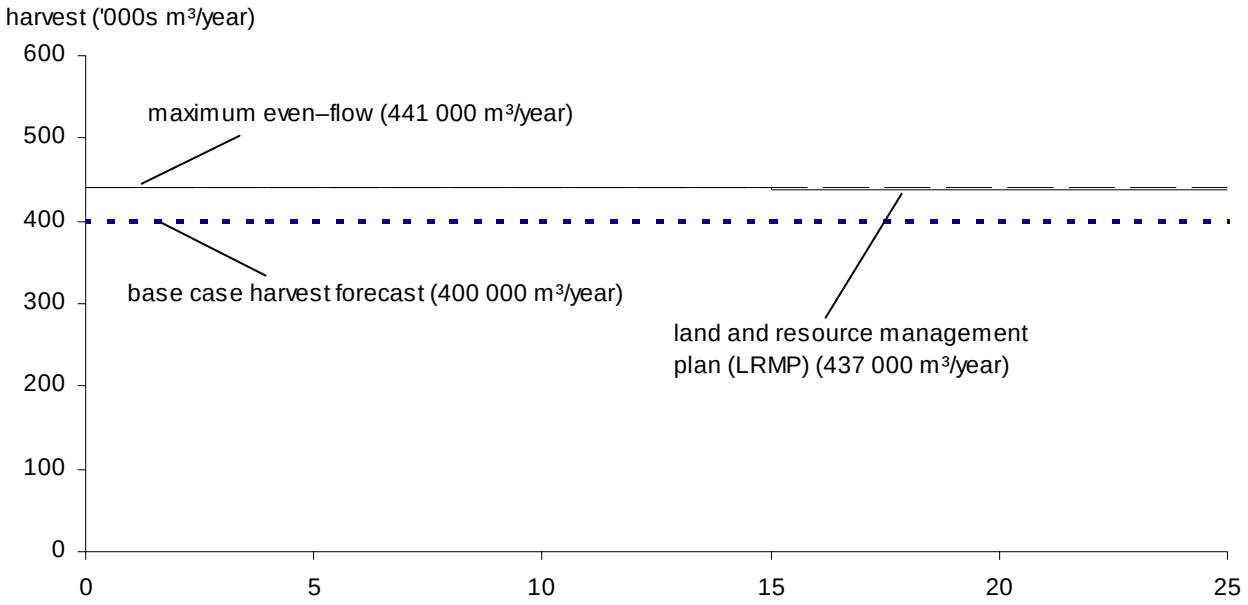

Figure 26. Sensitivity analysis of land and resource management plan recommendations — Cassiar TSA, 2001.

6.3 Uncertainty in the estimate of catastrophic losses due to fire

The non-recoverable loss factor used in this analysis was 25 520 cubic metres per year (see Appendix A). Of that volume, 24 108 cubic metres is attributable to losses to forest fires. In 1982, the Eg fire burned 182 725 hectares, or 11.65 million cubic metres of gross timber volume. Approximately 12.8% of the area burned was within the timber harvesting land base. Since most of this burned area was recently transferred to the Fort Nelson TSA as the Muskwa-Kechika area, only 12 hectares remained in the timber harvesting land base for the Cassiar TSA. The fire occurred in the BWBSdk2 variant within natural disturbance type (NDT)* 3, where the average period between fires is 75 – 200 years for fires ranging up to 200 000 hectares (*Iskut-Stikine Fire Model*, Prince Rupert Forest Region, April 1999).

This fire was not included in the estimate of non-recoverable losses (NRL) for the base case because it was believed that representing the effects of large events as a long-term average would not appropriately reflect their impact on the forest inventory. Nevertheless, some consideration of the potential effects of such events is warranted given the potential size of fires in the area. Therefore, the extent of the Eg fire is being used as an example of a large fire that could impact the timber supply.

There are no salvage operations in the Cassiar TSA. Therefore, all losses due to fire are net losses. Table 6 presents the losses and resulting harvest levels (based on a maximum even-flow harvest level of 441 000 cubic metres per year) that can be expected if a fire of the same magnitude as the Eg fire was to occur on the timber harvesting land base. Because it is unknown how frequently such a fire would occur, a range of periods between fires is provided. The following calculation was used to derive the figures in Table 6.

The Eg fire burned 11 654 248 cubic metres of timber * 12.8% = 1 491 744 cubic metres.

For example, if a fire of this magnitude were to return every 100 years, the annual loss would be:

1 491 744 m^3/100 years = 14 917 m^3/year

Table 6. Unsalvaged losses due to fire for various periods between fires of the magnitude of the 1982 Eg fire

Period between fires (years)	Unsalvaged losses (m^3/year)	Resulting harvest level (from 441,000 m^3/year)
10	149 174	291 826
25	59 670	381 330
50	29 835	411 165
75	19 890	421 110
100	14 917	426 083
125	11 934	429 066
150	9 945	431 055
175	8 524	432 476
200	7 459	433 541

In conclusion, the results of these calculations suggest that the base case harvest forecast (400 000 cubic metres per year) could be achieved if the time between events such as the Eg fire is 37 years or more.

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.

6 Timber Supply Sensitivity Analyses

6.4 Uncertainty in estimates of stand yields

6.4.1 Uncertainty in estimates of existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield.

Although uncertainty in existing stand yields was not identified as a critical issue by the chief forester in his 1995 AAC determination, a standard inventory audit was completed then published in 1997. The implications of the results were assessed through analysis, and the results are discussed here.

The objective of the audit was to assess the overall accuracy of the current (1970 to 1975) Ministry of Forests inventory. Because the Cassiar TSA is very large, it was divided into a northern stratum (Dease-Liard and Atlin timber supply blocks) and a southern stratum (Iskut and Boundary timber supply blocks).

The timber harvesting land base for the Cassiar TSA changed significantly since the last timber supply review. As such, the inventory audit results could not be applied to the current timber harvesting land base. Therefore, the audit results were re-compiled to correspond with the new timber harvesting land base and re-stratification of the TSA from southern and northern to coastal/transitional and interior units (based on biogeoclimatic ecosystem classification).

The re-compiled audit results show that inventory derived volumes overestimate ground measured volumes to a statistically significant degree in stands 60 years and older. The ratio of the audit to inventory volumes is 0.88 for coastal/transitional areas and 0.67 for interior areas. These represent overestimates relative to the ground-measured volumes of 14% and 49%, respectively.

New yield tables were created for existing unmanaged stands by applying the appropriate coastal/transitional or interior ratio. New minimum harvestable ages were then calculated for these yield tables and are shown in Table 7. The new ages are higher because of the reduced yields.

Table 7. Comparison of minimum harvestable ages for existing stands

Location	Base case minimum harvestable age (range in years)	Adjusted minimum harvestable age (range in years)
Coastal/transitional analysis units*	58 – 160	64 – 182
Interior analysis units	53 – 120	70 – 171

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

6 Timber Supply Sensitivity Analyses

Figure 27 shows that if the timber volumes in existing stands are overestimated to the magnitude suggested in the audit, the base case level of 400 000 cubic metres per year could be maintained for the first decade only. Following that, the harvest level would decrease to 353 000 cubic metres per year where it could be maintained until the end of decade 17. Only at decade 18 could the harvest level be increased to the maximum even-flow harvest level. It can be maintained at that level for the remainder of the planning horizon. The return to the maximum even-flow level is achievable because regenerating stands are projected to grow according to managed stand, not existing stand, yield tables.

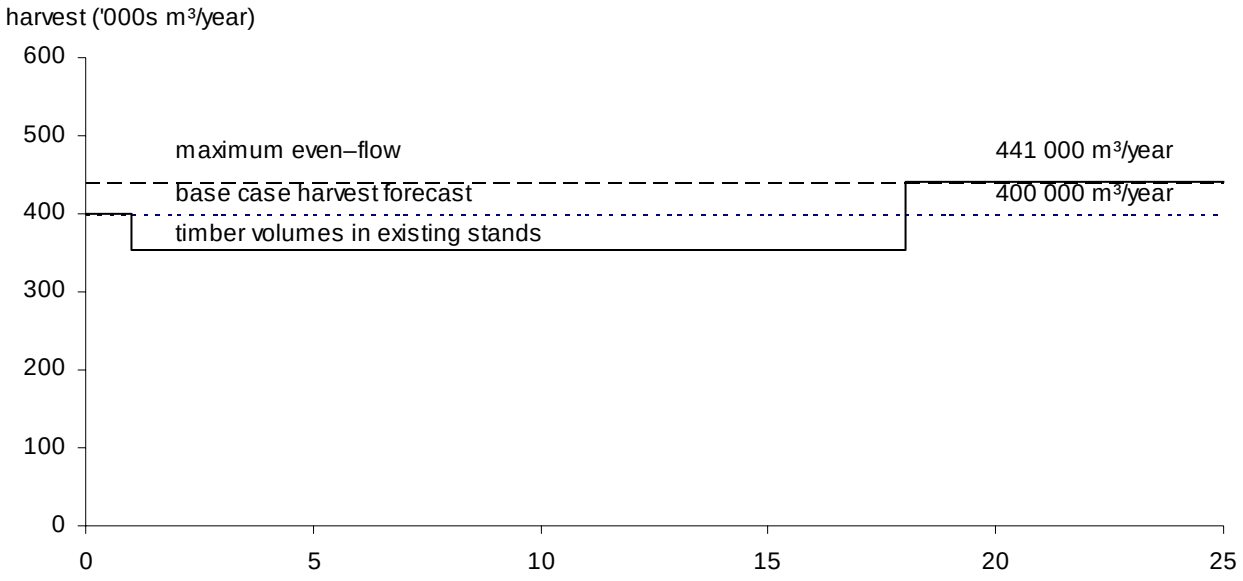

Figure 27. Timber volumes in existing stands — Cassiar TSA, 2001.

The impacts of the new yield tables and minimum harvestable ages were also examined separately. The higher minimum harvestable ages had no additional impact over the new yield tables. This is because of the abundance of existing forests that are above minimum harvestable age.

6.4.2 Uncertainty in estimates of managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimates of existing stand yields (potential inaccuracies in the forest inventory and the growth and yield models). It also exists because of the limited experience and data that is available for regenerated managed stands in British Columbia.

There are no specific issues directly related to managed stand yield estimation in the Cassiar TSA, other than site productivity estimates. Estimating the future productivity of sites currently occupied by existing old-growth forests is difficult since it is not possible to know with certainty how the productivity of a regenerated stand will compare to the productivity of the existing stand it replaces. The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size.

The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand. At older ages, site productivity estimates may be incorrect because tree heights do not represent potential productivity — for example due to local overstocking or top breakage — and it is very difficult to accurately determine ages of old trees.

An alternative approach to estimating post-harvest site index is the *Site Index — Biogeoclimatic Ecosystem Classification* (SIBEC) study (Forest Renewal B.C. and Ministry of Forests, B.C., 1997). Results present a first approximation of estimates of average site index for coniferous crop tree species according to site units of the biogeoclimatic ecosystem classification (BEC) system of B.C. The estimates are presented in site index-site unit (SISU) tables and the correlation between site index and site units varies from weak to moderately strong across species and sites. The method for approximating site index assignments is described in Appendix A, Section A.8.

Site index adjustments are not included in the base case as there are no local data to support them. Therefore, potential impacts of assigning site index according to the SIBEC data was examined in the Cassiar TSA through a critical issue analysis. Timber supply analysis inputs affected by changes in estimated future productivity (managed stand volume estimates, green-up ages and minimum harvestable age) were re-calculated based on average adjusted site productivity.

The impact of the new yield tables was examined first, with the impacts of the new minimum harvestable ages and green-up ages subsequently layered on one at a time.

When new yield tables were used, the maximum even-flow harvest level increased by 2%, to 450 000 cubic metres per year. When adjusted minimum harvestable ages were combined with the adjusted yield tables, the maximum even-flow harvest level increased by 4% to 459 000 cubic metres per year. The adjustments to regenerated stand volumes and minimum harvestable ages allowed for a higher harvest level from the existing stand growing stock since more managed stand volume is projected to become available earlier. Including adjusted green-up ages with these other changes had no effect on the maximum even-flow harvest level.

The results indicate that an even-flow harvest is not highly sensitive to site index adjustments in the range indicated in the SIBEC information.

The results of the critical issue analysis included in this section need to be viewed with the following cautions:

- The site index of the old component might not be underestimated to the extent suggested in the data package. However, no local information is available to validate this observation.
- The *Site Index — Biogeoclimatic Ecosystem Classification* study results apply broadly province-wide. No specific studies were performed to calibrate the results for the Cassiar TSA. Therefore, the results of the critical issue analysis only provide insight into the possible timber supply impacts associated with site productivity information.
- The biogeoclimatic ecosystem classification inventory for the Cassiar TSA is based on small-scale mapping (1:250 000) at the variant level. The *Site Index-Biogeoclimatic Ecosystem Classification* (SIBEC) study results are applicable at the site series level, not at the coarser variant level. Approximations, discussed in Appendix A were used to apply the SIBEC study in the Cassiar TSA.

7 Summary and Conclusion of the Timber Supply Analysis

Since the last timber supply analysis for the Cassiar TSA, the timber harvesting land base has been re-defined, estimated annual losses to fire and insects have increased, and the *Forest Practices Code* has been implemented.

Overall, the timber harvesting land base is 50% smaller than in the previous analysis. Based on current inventory, growth and yield information, and approximations of forest management objectives and practices in the Cassiar TSA, the results of this analysis indicate that the current AAC of 400 000 cubic metres per year can be maintained over the long term. An assessment of alternative levels of harvest shows that the timber supply is robust. The rate of harvest can be set to 441 000 cubic metres per year as a maximum even-flow harvest level, or as high as 634 000 cubic metres per year followed by a controlled decline to the long-term potential harvest (at 441 000 cubic metres per year).

Note that in the 1994 analysis, the base case showed an initial harvest level of 842 400 cubic metres per year and a long-term harvest level of 867 400 cubic metres per year, well above the AAC of 140 000 cubic metres per year in effect at that time. However, an AAC of 400 000 cubic metres per year was determined due to several uncertainties in the assumptions used in that analysis. This analysis focussed on those uncertainties, and as a result, the 1994 timber harvesting land base was reduced by approximately half. As well, a higher estimate of unsalvaged losses due to fire and insects was assumed in this analysis.

The timber supply forecast for the Cassiar TSA is driven by several factors. Currently 58% of the timber harvesting land base is above minimum harvestable age (40% of it is greater than 140 years old). This abundance of mature growing stock provides stability in short-term timber supply against uncertainty, i.e., increases to green-up age or decreases in yield estimates. The transition of harvest to managed stands is forecast to start in about 13 decades, and is mostly complete by 22 decades from now. This long transition suggests that there is substantial existing growing stock that can absorb downward pressures, and alternatively could allow a sustainable increase if future information or practices indicate that long-term productivity is higher. It is the long-term productivity that mostly defines the even-flow forecast.

The management assumptions in the *Cassiar Iskut-Stikine Land and Resource Management Plan* were not included in the base case because government had not approved the recommendations made by the planning table at the time the analysis was initiated. However, the recommendations were incorporated in a critical issue analysis. This analysis shows that if the recommendations were implemented, the timber harvesting land base would be reduced by 2506 hectares (about 1%) and after 150 years from now, the harvest forecast would be 4000 cubic metres per year lower than in the maximum even-flow case of 441 000 cubic metres per year.

Staff from the Bulkley/Cassiar Forest District believe there is uncertainty about the estimate of the size of the timber harvesting land base associated with minimal harvesting performance and lack of access. They also believe that there may be future opportunities to harvest in areas currently outside the timber harvesting land base i.e., pulp quality stands. Nonetheless, the base case harvest forecast shows that the current AAC can be maintained without including these marginal areas in the timber harvesting land base.

As well, if site indices from the *Site Index — Biogeoclimatic Ecosystem Classification* study are used, the harvest level could potentially be increased to 459 000 cubic metres per year, and remain there for the entire planning horizon, an increase of 4% above the maximum even-flow.

Analysis showed that if the non-recoverable losses due to a fire with the magnitude of the Eg fire were to recur, and were averaged out over time, the existing timber inventory is sufficient to withstand those impacts if such a fire were to return as often as every 37 years. This is true because the base case is robust enough to withstand impacts of up to 41 000 cubic metres per year. However, if such a fire were to occur more frequently, the even-flow forecast could drop below the current AAC.

7 Summary and Conclusion of the Timber Supply Analysis

Uncertainty about the existing stand volume estimates suggests that harvest levels at the current AAC might only be achievable for one decade before decreasing to 353 000 cubic metres per year until decade 18, when timber supply can be increased to the maximum even-flow harvest level of 441 000 cubic metres per year.

In conclusion, this analysis indicates that, based on current inventory, growth and yield information, and forest management practices, together with the uncertainties therein, the current rate of harvest in the Cassiar TSA can be maintained at 400 000 cubic metres per year in both the short- and long-terms. This analysis also suggests that an even-flow harvest level of 441 000 cubic metres per year could be maintained, based on the base case inputs. This latter finding indicates that the base case harvest forecast can withstand downward impacts of up to 41 000 cubic metres per year before short- or medium-term reductions would be required.

8 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Cassiar TSA to the level of activity that could be supported as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines the short- to long-term harvest levels as projected in the base case harvest forecast. The base case is intended to reflect current forest management objectives, requirements and practices; consequently, the socio-economic analysis does not evaluate alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Cassiar TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Cassiar TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by undertaking a socio-economic analysis using the harvest forecasts as projected in the base case.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands related, processing, and silviculture. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Indirect and induced employment figures were calculated using the Cassiar TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

8 Socio-Economic Analysis

8.1 Current socio-economic setting

8.1.1 Overview

The socio-economic analysis focuses on the timber supply from the Cassiar TSA, located in the northwestern portion of B.C.

8.1.2 Population and demographic trends

The Cassiar TSA, despite being the largest TSA in the province, is the least populated and most remote. According to the 1996 Census the population of the TSA decreased significantly since 1991 — from 2,975 to 2,000 — due in large part to the 1992 closing of the Cassiar asbestos mine which employed a large portion of the area's labour force. By the end of 2001, the population of the TSA is expected to reverse its decline and to grow by about 6% to approximately 2,125 people.

The Cassiar TSA includes the communities of Dease Lake (1996 population approximately 700), Atlin (400), Telegraph Creek (300), Iskut (200), and Good Hope Lake and Lower Post (150 each). Highway 37, which was constructed in the 1960s to provide access to tidewater at Stewart for the Cassiar asbestos mine, passes through Dease Lake. The road also provides a link between the Alaska Highway and central B.C.

8.1.3 Economic profile

The Ministry of Energy and Mines considers the Cassiar area to be one of the highest ranked metallic mineral potential areas in the province. Total direct mining employment in the area (resident and non-resident) is currently estimated at approximately 150 jobs. Current resident employment in mining is about 50, which comprises about 8% of total basic resident employment. Because of very high average incomes, mining is currently the single most important source of private sector basic income in the TSA. Many of the prospective deposits in the TSA require improved infrastructure and a substantial increase in proven reserves and/or higher metal prices for a viable operation. The distance of the area from B.C. Hydro's inter-connected grid is also a significant cost factor and impediment to development.

Total direct tourism employment in the Cassiar TSA is estimated at approximately 200, of which about 100 are local residents. Most of the employment is based directly or indirectly on the "back-country" tourism portion of the sector (e.g., guide-outfitting). The Tatshenshini – Alsek Wilderness Park, the Stikine River, including the Grand Canyon, the Iskut and Klappan Rivers, Mount Edziza and Spatsizi Plateau wilderness parks and the Iskut Lakes chain are attractions which will continue to bring tourist dollars to the region. Surveys undertaken for the *Cassiar Iskut--Stikine LRMP* indicate that the recent strong growth in this sector offers good short- to medium-term potential for the creation of up to 300 additional jobs in guide-outfitting and other wilderness tourism.[3]

(3) *Cassiar Iskut-Stikine LRMP Consensus Recommendations Package*, Holman and Terry, August 2000. The job estimate is based on a survey of existing tourism operators and takes into account the growth potential of the operators, as well as the estimated carrying capacity of the areas in which they operate.

Figure 28 illustrates the shares of total employment by industry sector, which existed in the Cassiar TSA in 1996 (the latest year for which this type of data is available). Although it suggests a fair degree of dependence on forestry, there has been no significant timber harvesting in the TSA since 1997.

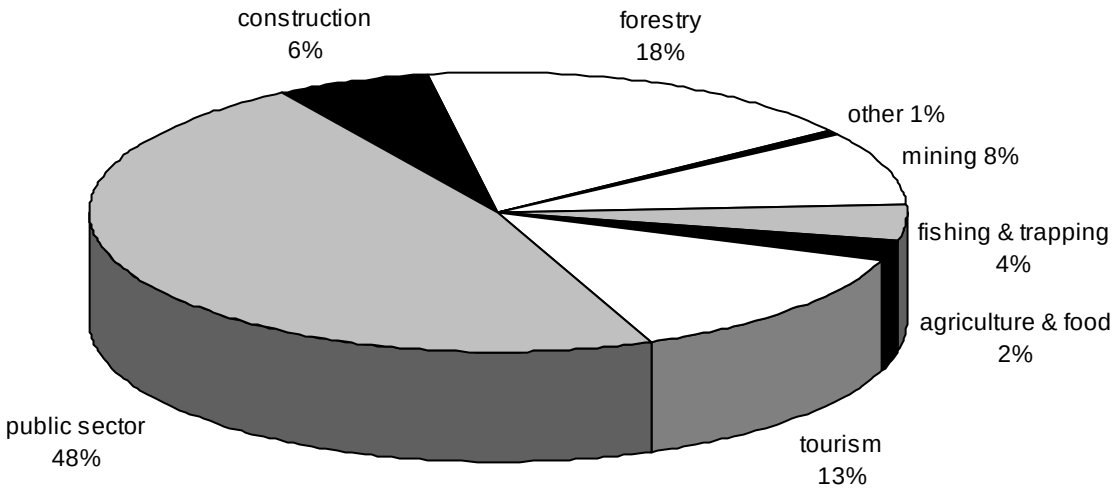

Figure 28. Major employment by sector for the Cassiar TSA, 1996.

Notes: 'Forestry' consists of harvesting-related activity and manufacturing. 'Other' consists of finance, insurance, real estate and other business services. 'Public Sector' consists of local and provincial government, health and education.

Source: B.C. Ministry of Finance and Corporate Relations. The 1996 Forest District Tables (April 1999).

During 1996, the forest sector supported numerous jobs in the region through logging companies and employees purchasing goods and services from local businesses. Aside from direct impacts, this spending was an indicator of the basic role forestry had in the economy. Each 100 direct forestry jobs in the Cassiar TSA were estimated to support a further 35 to 64 indirect and induced jobs*[4], depending on the type activity (logging or wood products manufacturing). In comparison, each 100 mining and mineral processing jobs support approximately 55 additional positions, while the public sector and tourism support six to 18 additional positions per 100.

A breakdown of 1996 income dependencies (including direct, indirect and induced impacts) confirms forestry's historical and potential importance to the TSA. During 1996, 26% of all basic, after tax income and about 26% of all local employment was forestry dependent[5] even though there are no permanent processing facilities in the TSA. There are several small, portable mills that periodically supply lumber for local projects, however almost all of the harvested timber is exported to sawmills south of the TSA.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

(4) B.C. Ministry of Finance and Corporate Relations. The 1996 Forest District Tables, April 1999.

(5) Ibid.

8.2 Cassiar TSA forest industry

8.2.1 Current allowable annual cut

The chief forester set the allowable annual cut (AAC) for the Cassiar TSA at 400 000 cubic metres effective at the beginning of 1996, up significantly from 140 000 cubic metres, the pre-1996 level. The AAC was partitioned into three timber supply blocks as follows:

- 240 000 cubic metres per year in the Iskut/Boundary timber supply block;
- 120 000 cubic metres per year in the Dease-Liard timber supply block;
- 40 000 cubic metres per year in the Atlin timber supply block.

The Minister of Forests did not fully apportioned the AAC, pending further land-use planning and analysis. The current apportionment is outlined in Table 8.

Table 8. Allowable annual cut apportionment, by licence type — Cassiar TSA

Licence types	AAC (m^3/year)	Per cent of total (%)
Forest licences — non-replaceable	120 000	30.0
Small Business Forest Enterprise Program (SBFEP)	2 500	0.6
Forest Service Reserve	12 500	3.1
Not apportioned	265 000	66.3
Total	400 000	100.0

Source: Ministry of Forests — 2001.

Actual annual harvest levels are permitted by legislation to vary from the annual levels assigned to the licences (under cut control provisions), which enables the licensees to respond to market conditions and other factors.

8.2.2 Cassiar TSA harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year indicates the economic activity supported by the timber supply area. If actual annual harvest levels are consistently less than the AAC, then the economic activity is below its full potential. This gap between actual and allowable harvest activity will influence the potential short-term impacts of changes to the AAC.

Traditionally, annual harvest activity in the Cassiar TSA has been fairly sporadic. This results from its remoteness from markets, its lack of infrastructure, and the cyclic quality of local demand. Approximately 400 full-time harvesting and processing jobs would normally be projected, given the AAC currently set for the Cassiar TSA.

The AAC for the TSA makes up about 5% of the total level set for the Prince Rupert Forest Region (7.4 million cubic metres), which in turn accounts for about 10% of the total annual provincial harvest (71 million cubic metres). Table 9 summarizes the actual volume of timber harvested in the TSA from 1996 to 1999.

Table 9. Volumes billed, by licence type — Cassiar TSA, 1996-1999

Licence type	(cubic metres per year)				
	1996	1997	1998	1999	Average
Small Business Forest Enterprise Program	25 464	59 245	223	0	21 233
Forest Service Reserve	9 797	4 563	1 194	1 681	4 309
Total	35 261	63 808	1 417	1 681	25 542

Source: Ministry of Forests.

8.2.3 Cassiar TSA major licensees

Although volumes have been apportioned for forest licences, there are no replaceable forest licences currently issued in the Cassiar TSA. Recently, a non-replaceable forest licence (for 10 years) has been advertised for 120 000 cubic metres per year in the Iskut/Boundary timber supply block. Unlike other TSAs, Cassiar timber supply is generally only offered and sold by short-term sales agreements, and mostly restricted to firms registered in the Ministry's Small Business Forest Enterprise Program. Mills in the Terrace-Houston regions (Kalum and Morice TSAs) have used sales under the Forest Service Reserve program to mitigate temporary sawlog shortages. These types of sales have resulted in variations in the actual annual harvest levels in the Cassiar TSA.

Processing facilities

There are no permanent timber processing facilities in the Cassiar TSA. Almost all of the wood harvested in the Cassiar TSA is transported to sawmills south of the TSA.

8.2.4 Forest sector employment summary

In this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forest sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage, log scaling, and planning;
- silviculture activity including all planting and other basic and intensive operations; and
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and in close to the same proportions.The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities may occur up to three to six years after harvesting, and sometimes longer. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced or intensive silviculture includes spacing, fertilizing, and pruning*. In the Cassiar TSA, as in the rest of the province, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silvicultural contractors.

Primary timber processing employment

There are no permanent processing facilities in the TSA. From time to time, small-scale portable mills are set up to supply lumber requirements for local projects.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

8 Socio-Economic Analysis

Forest Service employment

The Cassiar TSA is administered by the Bulkley/Cassiar Forest District office in Smithers (Bulkley TSA). Currently, 50 people work in the forest district office in Smithers, and another three in the field office in Dease Lake. These jobs are not included in the analysis of forestry sector impacts, but are included in the public sector.

Forestry employment and employment coefficient summary — Cassiar TSA

Table 10 summarizes employment supported by the 1996 – 1999 average harvest level in the Cassiar TSA, and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

1. TSA employment and employment coefficients, which relate to residents of the Cassiar TSA who are employed within the Cassiar TSA; and
2. Provincial employment and employment coefficients, which correspond to all forest sector employment in the province that relies on the Cassiar timber supply; including both residents of the Cassiar TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forest sector within the Cassiar TSA and to highlight the contribution that the Cassiar TSA forest sector makes to the provincial economy.

The average annual harvest from the TSA from 1996 to 1999, was 25 542 cubic metres, far less than the AAC. If the full AAC of 400 000 cubic metres was harvested, it could potentially support a much higher level of employment.

Table 10. Cassiar TSA employment and employment coefficients

Activity	TSA person-years	TSA coefficients	Provincial person-years	Provincial coefficients
Harvesting	3	0.13	9	0.36
Silviculture	2	0.07	4	0.17
Processing	0	0.00	11	0.45
Total direct	5	0.20	25	0.97
Indirect + induced	1	0.04	25	0.98
Total employment	6	0.24	50	1.96

Note: Employment estimates are person-years based on average 1996-1999 employment levels and the average 1996-1999 harvest of 25 542 cubic metres per year. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates. For further discussion please see the economic assessment methodology in Appendix B.

More detailed information regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

8.2.5 Employment income — Cassiar TSA

From 1997 to 1999, the average annual income for direct forest sector employees was approximately $48,600 (depending on the type of forestry activity); and $30,300 for indirect and induced employment (in 1998 dollars). Based on these averages, which correspond to the 1996-1999 average harvest level, harvesting, silviculture, and processing of timber from the Cassiar TSA generate an estimated $1.2 million in direct wages and salaries and $0.8 million in indirect and induced wages and salaries, annually throughout the province (see Table 11).

Table 11. Average annual direct and indirect/induced incomes and total employment income, 1996 -

	Average annual income[a] (1998 dollar value)	Total annual income[b] ($ millions)	Total income[c] ($ per '000s m³)
Direct	$48,600	$1.2	$45,150
Indirect / induced	$30,300	$0.8	$32,950
Total income		$2.0	$78,100

(a) Statistics Canada, Survey of Employment Payrolls and Hours.

(b) Based on employment levels in Table 10 (25 direct, 25 indirect and induced).

(c) Based on 1996-1999 average harvest of 25 542 cubic metres per year.

8.2.6 Provincial government revenues

Provincial government revenues from the forestry industry include stumpage, royalties and rent payments, other taxes such as logging, corporate capital, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees.

From 1996 to 1999, average stumpage and rent payments for Crown timber in the Cassiar TSA were approximately $0.9 million per year. Forest and corporate taxes and revenues generated $11,000, while employment supported by the Cassiar TSA timber harvest accounted for $165,000 in provincial income taxes (see Table 12).

Table 12. Average annual provincial government revenues, 1996 - 1999

	Average annual revenue 1996 – 1999 ($ 1998 thousands)	Revenue[a] ($ per '000s m³)
Stumpage, rents and royalties	911.5	35,690
Industry taxes	11.1	433
Provincial income tax	165.2	6,468
Total government revenues	1,087.8	42,591

(a) Based on 1996-1999 average harvest of 25 542 cubic metres per year.

8.3 Socio-economic implications of the base case harvest forecast

The timber supply analysis suggests that a harvest level of 400 000 cubic metres per year (the current AAC) could be maintained over the long term. The socio-economic analysis focuses on the short- to medium-term period, and considers:

- the implications of alternative harvest levels for both the Cassiar TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Cassiar TSA; and
- regional timber supply implications.

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing, and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the magnitude of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture, and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

Table 13 estimates the range of impacts the base case harvest forecast may have on employment and income. Ranges are utilized to reflect the uncertainties associated with workforce mobility given the availability of employment insurance and social assistance payments and their dampening effects in the shorter term. The lower end of the range reflects the diminished short-term impacts which result because employment insurance and social assistance provide income support to workers outside the TSA who would otherwise consider moving to the area. The upper end of the range represents long-term impacts when new workers finally do enter the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers staying away and accessing social assistance payments, and some moving to the new area — is more likely to occur.

8.3.1 Short- and long-term implications of alternative harvest levels

Cassiar TSA employment and income impacts

For accounting purposes, TSA employment and income corresponds only to workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Cassiar TSA timber processed at mills outside the TSA. Table 13 indicates the employment and income that could be supported within the Cassiar TSA by the base case harvest forecast. If fully harvested and processed, the base case harvest level of 400 000 cubic metres could support approximately 90 person-years of direct employment and another 25 indirect and induced person-years of employment within the timber supply area. Approximately $3.5 million (1998 dollar value) total after-tax annual income would be supported by the Cassiar TSA timber supply.

Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Cassiar TSA, regardless of the location of the impacts. If the base case harvest level of 400 000 cubic metres is fully harvested and processed, the Cassiar TSA could support at least 428 person-years of direct forestry employment and a further 523 person-years of indirect and induced employment across the province and contribute $27 million ($1998) in total after-tax annual income.

Provincial government revenue impacts

Based on current tax and stumpage rates, the base case harvest level of 400 000 cubic metres per year has the potential to provide approximately $21 million annually to the provincial government (1998 dollar value), $19 million more than the actual 1996 – 1999 average harvest level provided (assuming current taxation and stumpage rates do not change).

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Table 13. Socio-economic impacts of the base case harvest forecast — Cassiar TSA, 2001

	Current	Base case harvest level 1 – 250 years
Timber supply ('000s m³)		
AAC	400	400
Harvest level (average 1996-1999)	25.5	
Cumulative change		375
Cassiar Timber Supply Area		
Employment	(person-years)	(person-years)
Direct	5	88
Indirect + induced	1	26
Total	6	114
Cumulative change in total person-years		100-108
Net employment income	($ 1998 millions)	($ 1998 millions)
Direct	0.2	3.0
Indirect + induced	0.0	0.6
Total	0.2	3.5
Cumulative change in total income		3.2 – 3.3
Province (includes Cassiar TSA)		
Employment	(person-years)	(person-years)
Direct	25	428
Indirect + induced	26	523
Total	51	951
Cumulative change in total person-years		751 – 901
Net employment income	($ 1998 millions)	($ 1998 millions)
Direct	0.8	14.7
Indirect + induced	0.6	12.1
Total	1.4	26.8
Cumulative change in total person-years		21.9 – 25.4
Provincial government revenues	($ 1998 millions)	($ 1998 millions)
Provincial income tax	0.2	3.1
Stumpage and rent	0.9	15.7
Other B.C. revenues	0.1	1.9
Total B.C. revenues	1.2	20.7
Cumulative change in total revenue		19.0 – 19.5

Notes: Provincial employment includes both Cassiar TSA employment and employment supported outside the TSA by Cassiar TSA harvested timber.

Income figures in Table 13 are net of taxes while those in Table 11 are gross income.

The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The upper limit is based on the assumption of full and immediate labour force mobility. The lower limit is based on the assumption that in the short-term employment insurance and other social assistance payments will reduce the induced impacts of a higher harvest level.

8.3.2 Community-level impacts

In 1996, harvesting in the Cassiar TSA provided 18% of the basic employment in the TSA even though the average 1996-1999 harvest levels were less than 10% of the AAC. The 1999 actual harvest levels were negligible; nonetheless, it is possible that the harvesting and processing components of the forestry industry could increase in the TSA over the longer term. Given this potential, changes to the timber supply might be expected to have a fairly significant impact on the overall economic trends of the region.

8.3.3 Nature, production capabilities, and timber requirements of processing facilities

In the longer term, harvest activity may increase substantially in the TSA. Although there are currently no significant local processing facilities this situation could change in response to local and regional market conditions.

8.3.4 Regional timber supply implications

The future of the regional timber supply is important to primary processing facilities in the individual, regional TSAs. In the Prince Rupert Forest Region as a whole, the previous timber supply review led to an overall reduction in the coniferous AAC of 6.8%, or about 600 000 cubic metres. In two to three decades, the annual timber supply from the Prince Rupert Forest Region may fall by another 5%, or 400 000 cubic metres, assuming that existing timber supply projections remain the same.

Mill level impacts will not occur solely as a result of changes in the volume of timber harvested from the TSAs in which they are located; they will also result from harvest changes that occur across the region. It is not possible to predict, however, which mills and regions will be most affected, or if new "value-added" operations will offset or exacerbate some of these changes.

8.4 Summary

The forestry sector is an important source of employment and income for the Cassiar TSA. Between 1996 and 1997 (the last years in which there was significant harvesting activity), 20 to 25% of the TSA's basic employment resulted from the Cassiar TSA harvest. Current harvesting activity in the TSA is negligible. If the base case harvest level of 400 000 cubic metres is fully harvested and processed, it could support approximately 950 person-years of employment across the province, including 115 jobs within the TSA.

9 References

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10 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcutting with reserves	A variation of the clearcut silvicultural system in which trees are retained, either uniformly or in small groups, for purposes other than regeneration.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

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Employment coefficient — The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier — An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

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

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

Forest inventory — An 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 other forest values such as recreation and visual quality.

Forest Practices Code — Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Forest type — The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Free-growing — An established seedling of an acceptable commercial species that is 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 (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock — The volume estimate for all standing timber at a particular time.

10 Glossary

Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
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 objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

10 Glossary

Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operability	Classification of an area considered available 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.
Partition	A portion of the AAC that is attributable to certain types of timber and/or terrain.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Riparian habitat	The stream bank and flood plain area adjacent to streams or water bodies.

10 Glossary

Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth process, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Ungulate	A hoofed-herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	A B.C. Forest Service computer program that generates average yields for naturally regenerated, untreated stands based on empirical data.

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Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

In November 1999, a data package for the Cassiar Timber Supply Area timber supply review was released for public review. As a result of public input and further study, a number of data and management assumptions have been changed. This appendix presents the revised data package used to produce the timber supply analysis. Following is a summary of these changes:

- exclusion of pulpwood, marginally operable and low-volume pine stands from the timber harvesting land base;
- definition of pulpwood;
- increase in the area reserved for wildlife tree patches;
- transfer of the Muskwa-Kechika area to the Fort Nelson TSA;
- definition of low-timber growing potential;
- definition of stands susceptible to balsam bark beetles;
- change in the estimate of annual losses to balsam bark beetles;
- change in regeneration assumptions;
- definition of not satisfactorily restocked (NSR).

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 Cassiar TSA timber supply analysis. This information represents current objectives and criteria that guide 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. Because there is presently little harvesting activity in the Cassiar TSA, it is difficult to define "current management." Therefore, this information is based on the data package for the previous timber supply review (TSR), and focuses on key factors identified by the chief forester in his last AAC determination. These factors and the issues surrounding them are discussed in Section A.1, "Critical Issues."

Future forest management objectives that may be intended, but are not currently implemented and enforced, are excluded from 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, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Critical Issues

During the last AAC determination, the chief forester directed staff to resolve uncertainty with respect to the size of the timber harvesting land base; site productivity; northern growing conditions; forest cover requirements for wildlife habitat; green-up for cutblock adjacency; riparian habitat; and unsalvaged losses due to fire, insects and disease.

This section describes these factors and the critical issues surrounding them.

The first factor, size of the timber harvesting land base, was reviewed separately for the southern (coastal/transitional) and northern (interior) portions of the TSA, in terms of operability.

The operable corridor in the southern half of the Cassiar TSA (Boundary and Iskut supply blocks) was identified through a timber harvesting feasibility project. The project identified harvest method (conventional ground-based, cable, or helicopter), product classes (sawlog and pulpwood by species groups), and physical accessibility. Harvest method and product classes were used to determine harvest feasibility classes of high, medium, or low. High feasibility was assigned to high volume sawlog and pulpwood stands that could be harvested by ground-based logging methods. The land base for the southern half only included high feasibility sawlog stands that were physically accessible.

The operable corridor in the northern half of the Cassiar TSA (Atlin and Dease-Liard supply blocks) was identified through aerial and ground assessments using primarily site index as a measure of productivity, and slope as a measure of harvesting feasibility. Existing volumes, height, wood quality and accessibility were also considered in the assessment.

After the data package was approved in November 1999, Bulkley / Cassiar Forest District staff further examined some areas for their potential operability. They concluded that some additional areas should be removed from the operable corridor. The areas included pine stands with low volumes and stands that were of a pulp quality that would likely not be harvested in the next 5 years. Marginally operable stands were also removed from the timber harvesting land base, based on the following information:

- high costs associated with road improvements to allow hauling and to ensure public safety;
- high transportation costs to processing sites and markets;
- no demonstrated logging performance, other than at a very small scale;
- accessible only by water.

In his last AAC determination, the chief forester noted that the analysis had overestimated site productivity, the second factor, for stands on immature poor and medium sites for spruce, subalpine fir and hemlock. Since then, staff from the Prince Rupert Forest Region research and inventory sections, and the Research and Forest Practices branches have developed an ecosystem-based process for estimating site indices that more accurately reflects site productivity. It is now believed that site productivity is actually underestimated. A critical issue analysis examines the potential timber supply implications of uncertainty around site productivity.

The third factor, northern growing conditions, proved to be less critical than was originally believed. A 5% increase to operational adjustment factors (OAF1) for regenerated stand yield curves was applied during the previous AAC determination to account for unique northern conditions, such as a short growing season, severe climate and soil limitations. This issue was more recently investigated by the Regional Growth and Yield Forester and by the Regional Research Silviculturalist. They concluded that a short growing season would be offset by longer daylight hours, and that the climate and soil conditions would be reflected in the site index of the growing sites. Thus, no adjustments were made to OAFs in this analysis.

A.1 Critical Issues

The fourth factor was addressed by using high-value wildlife habitat maps supplied by the Ministry of Environment, Lands and Parks (MELP). These maps exist only for grizzly bear, goat, moose and caribou in the Iskut and Boundary supply blocks, and for caribou only in the Dease-Liard supply block. Forest cover constraints were applied to these areas known to have high-value wildlife habitat. Specifically, a 3-pass harvesting system was modelled for the entire integrated resource management area that covers these maps. Because high-value habitat maps do not exist for the Atlin supply block, a 5-pass harvesting system was modelled to account for these habitats that may be present there and would have otherwise been missed.

The fifth factor, time to reach green-up height for spruce, subalpine fir and hemlock, was believed to have been underestimated in the previous analysis. Therefore, an adjustment was made during the AAC determination. However, recent information showed that the stands examined were actually suppressed, and thus were not fully utilizing the potential of the site. This suppression was confirmed by a study for spruce *(Juvenile Height Development in Interior Spruce Stands of British Columbia*, by Gordon Nigh and Bobby Love). The study noted that following harvest, management of these stands will produce trees that can fully utilize the site, and that grow at faster rates than trees that were suppressed on the same site. Therefore, no adjustments were made in this analysis for expected time to reach green-up.

The sixth factor examined was riparian habitat. Pre-*Forest Practices Code* standards were applied in the last analysis, where a land base withdrawal was approximated to account for riparian habitat management. In this analysis, a percentage of the forested area was excluded from the timber harvesting land base by applying percentages derived from a geographic information system (GIS) buffering exercise on all mapped streams, lakes and wetlands. This incorporated reserve and retention practices from the *Forest Practices Code Riparian Area Management Guidebook* and on-the-ground practices. It was assumed that the percentages of reductions for riparian reserves and management zones for comparable BEC variants in the Atlin and Dease-Liard supply blocks (outside the CIS LRMP area) were consistent with those for the Iskut and Boundary supply blocks within the CIS LRMP area.

The seventh factor was unsalvaged losses due to fire, disease and insects. It was concluded during the previous AAC determination that the estimates used in that analysis were too low. To better account for unsalvaged losses due to fire, the fire history of the selective suppression era from 1980 – 1998 was chosen to best represent current management.

To better account for epidemic losses to balsam bark beetle, an operational study conducted in subalpine fir-leading stands in the Bulkley TSA, south of the Cassiar TSA was interpreted. Losses to disease occurred in small, isolated patches that could not be quantified.

A.2 Inventory Information

The inventory information used in this analysis combines the Ministry of Forests forest cover inventory for the Cassiar TSA (updated to 1999) with non-standard overlays added to provide information on forest conditions as well as the management considerations listed in Table A-1.

Table A-1. Inventory information

Data	Vintage	Update	Scale
Biogeoclimatic units	1995	—	1:250 000
Forest cover	1970	1993	1:20 000
TRIM planimetric base/contours	1995	—	1:20 000
Fort Nelson LRMP land use zones, including protected areas	1995	—	1:50 000
Cassiar Iskut-Stikine (CIS) LRMP boundary	1997	—	1:500 000
Draft CIS LRMP resource management zones	1998	—	1:250 000
Existing protected areas	1997	—	1:250 000
Draft landscape units	1993	1997	1:50 000
Timber feasibility mapping for CIS LRMP	1998	—	1:400 000
Accessible corridor for CIS LRMP area	1998	—	1:400 000
Operable corridor (outside the CIS LRMP)	1999	—	1:500 000
Existing land use zones (Lower Stikine Management Plan)	1997	—	1:500 000
Visual corridor along Highway 37	1999	—	1:20 000
High value habitat mapping for ungulates and grizzly bear	1999	—	1:400 000
Riparian mapping	1998	—	1:20 000
Community watersheds	1980	—	1:50 000
Agriculture land reserves	1996	—	1:50 000

A.3 Zone and Analysis Unit Definition

A.3.1 Management zones (groupings) and objectives

For the purpose of modelling current forest management, some groups were defined based on forest management objectives as shown in Table A-2.

Table A-2. Objectives to be tracked

Objectives	Inventory definition
Community watershed	Non-standard mapped layer
Harvest levels by supply block	Timber supply block as identified on inventory maps
Critical wildlife habitat	Non-standard mapped layer
Green-up for cutblock adjacency by landscape unit	Areas not subject to other specific objectives
LRMP proposed protected areas	Non-standard mapped layer

A.3.2 Analysis unit characteristics

To facilitate modelling of stand growth and silviculture treatments, individual forest stands were grouped according to dominant tree species (inventory type group) and timber growing capability (site index). Table A-3. shows the variables used to define each analysis unit.

The Cassiar TSA was divided into a coastal/transitional area and an interior area, based on biogeoclimatic ecosystem classification (BEC) zone boundaries. This breakdown reduced the variability around analysis unit yield curves related to different climatic conditions. The coastal/transitional area incorporates the CWH, ESSF, ICH, SBS, and MH zones, while the interior area incorporates the BWBS and SWB zones.

Regenerated analysis units are those units that are less than 15 years old, and have an activity code of 'L' (harvesting).

A.3 Zone and Analysis Unit Definition

Table A-3. Definition of analysis units

	Analysis unit (leading species)	Criteria		
		Inventory type groups	Site index range[a] (metres)	Timber harvesting land base area (hectares)
	Coastal/transitional units			
1.	Spruce (Sx), good	21–26	> = 25.1	460
2.	Spruce (Sx), medium	21–26	17.1 – 25.0	1 107
3.	Spruce (Sx), poor	21–26	< 17.1	5 728
4.	Pine (Pl), good	28–31	> = 19.1	3 580
5.	Pine (Pl), medium	28–31	14.6 – 19.0	2 426
6.	Pine (Pl), poor	28–31	< 14.6	936
7.	Subalpine fir (Bl), good	18–20	> = 16.1	53
8.	Subalpine fir (Bl), medium	18–20	13.1 – 16	786
9.	Subalpine fir (Bl), poor	18–20	< 13.1	4 512
10.	Hemlock (Hw), good	12–17	> = 17.1	0
11.	Hemlock (Hw), medium	12–17	14.1 – 17.0	0
12.	Hemlock (Hw), poor	12–17	< 14.1	16
	Interior units			
21.	Spruce (Sx), good	21–26	> = 25.1	322
22.	Spruce (Sx), medium	21–26	17.1 – 25.0	8 247
23.	Spruce (Sx), poor	21–26	< 17.1	71 581
24.	Pine (Pl), good	28–31	> = 19.1	4 094
25.	Pine (Pl), medium	28–31	14.6 – 19.0	38 616
26.	Pine (Pl), poor	28–31	< 14.6	50 595
27.	Subalpine fir (Bl), good	18–20	> = 16.1	1 277
28.	Subalpine fir (Bl), medium	18–20	13.1 – 16	2 132
29.	Subalpine fir (Bl), poor	18–20	< 13.1	1 317
	Regenerated units (from NSR)			
102	Spruce (Sx), medium	21–26	17.1 – 25.0	76
103	Spruce (Sx), poor	21–26	< 17.1	194
104	Pine (Pl), good	28–31	> = 19.1	89
105	Pine (Pl), medium	28–31	14.6 – 19.0	7
107	Subalpine fir (Bl), good	18–20	> = 16.1	76
108	Subalpine fir (Bl), medium	18–20	13.1 – 16	58
123	Spruce (Sx), poor	21–26	< 17.1	284
125	Pine (Pl), medium	28–31	14.6 – 19.0	190
128	Subalpine fir (Bl), medium	18–20	13.1 – 16	9

(a) Site index reference age is 50 years.

A.4 Definition of the Timber Harvesting Land Base

The timber harvesting land base was defined by netting down the following classifications in the order presented.

A.4.1 Land not managed by the B.C. Forest Service

Productive forest in ownership codes 62 C (forest management unit) and 69 C (forest reserves) contribute to the timber harvesting land base of the Cassiar TSA. However, since ownership codes in the forest cover inventory were not up-to-date for provincial parks, the parks were added to the database in a separate layer and were assigned a timber supply block code of 99Z. Timber supply block code 99Z and all ownership codes other than 62C and 69C were removed from the land base considered to contribute to timber supply. The areas removed contribute to meeting biodiversity objectives.

A.4.2 Non-forest

Non-forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) areas do not contribute to the timber supply analysis land base. These categories include areas such as sparse alpine forest, ice, lakes, swamps, rocks and rivers.

A.4.3 Non-commercial cover

Non-commercial brush types (TYPID_PR = 5) were excluded from the timber harvesting land base.

A.4.4 Environmentally sensitive areas

Table A-4. shows the criteria used to account for environmentally sensitive areas in which harvesting is not expected to occur.

Table A-4. Description of environmentally sensitive areas

ESA category	ESA description	Reduction per cent (%)
Es 1	Very sensitive soils	100
Es 2	Sensitive soils (moderate)	25
Ep 1	Regeneration problems	80
Ep 2	Regeneration problems	25
Ea 1 & 2	Avalanche risk	100
Er 1	Recreation	100
Er 2	Recreation	100
Ew 1	Wildlife	0
Ew 2	Wildlife	0

ESA mapping is available for only 39 of the 1,181 Cassiar TSA forest cover maps. The land base reductions shown in the above table were used only for those 39 maps that are in the vicinity of the Iskut River.

A.4 Definition of the Timber Harvesting Land Base

A.4.5 Inoperable areas

Table A-5. describes the criteria used in defining inoperable areas.

Table A-5. Description of criteria for inoperable areas

Inventory description	Code	Reduction per cent (%)
Alsek and Kechika timber supply blocks	Supply block = A, D	100
Operable corridor	Operable = I	100
Timber harvest feasibility (Iskut and Boundary timber supply blocks — CIS LRMP area)	L, M (Low, Moderate)	100
Slope class (outside of CIS LRMP)	> = 35%	100

Only those stands within the operable corridor which could be harvested by conventional systems were included in the timber harvesting land base.

For the Cassiar Iskut-Stikine (CIS) LRMP area, timber harvest feasibility mapping identifies areas as having high, moderate or low feasibility for timber harvesting. High feasibility is limited to higher volume sawlog and pulpwood stands that can be harvested with conventional, ground-based harvesting methods, and are reasonably accessible in the short term (slope class is less than 35%). Lower volume sawlog and pulpwood stands, areas that require cable or helicopter harvesting methods and areas that are difficult to access, have been assigned moderate or low feasibility. Low and moderate feasibility areas were removed from the timber harvesting land base. The feasibility mapping is based on fieldwork conducted in 1998 and 1999. In addition, there is an operable corridor in the CIS LRMP area, which is based on physical and economic accessibility, including terrain, distance to markets and wood quality.

For the area outside the CIS LRMP (Alsek, Atlin, Dease-Liard, and Kechika timber supply blocks), there is an operability line that defines an operable corridor, outside of which all land was excluded from the timber harvesting land base. All area in the Alsek and Kechika supply blocks is classified as inoperable. The operability line is based on the amount of timber to which a road provides access; difficulty of access; and on volumes and quality of wood accessed. This operability line was drawn from fieldwork undertaken in 1998 and 1999 and subsequent district review in early 2000. Slope class further defines this operability line.

A.4 Definition of the Timber Harvesting Land Base

A.4.6 Sites with low timber growing potential

Table A-6. shows the criteria used to define stands with low-timber growing potential.

In the data package, it was noted that the minimum height and age criteria would be converted to site index, in order to identify which existing stands would likely never meet the minimum height and age requirements in the future. These are included in Table A-6.

Table A-6. Description of sites with low timber growing potential

		Characteristics				
	Inventory type group	**Age class**	**Height class**	**Volume (m^3/hectares)**	**Site index (m @ 50 years)**	**Reduction per cent (%)**
Low height	All	5–9	< = 2	—	—	100
	12–17 (H)	1–4			< 10.3	100
	18–20 (B)	1–4			< 10.5	100
	21–26 (Sb)	1–4			< 10.6	100
	21–26 (Sx)	1–4			< 8.8	100
	28–31 (Pl)	1–4			< 12.6	100
Low volume	All			< 220 (mature[a])	< 10 (immature)	100

(a) Mature is defined as age class 5+ (over 80 years) for lodgepole pine, and age class 7+ (over 120 years) for other coniferous species.

The parameters listed in Table A-6. above have also contributed to the definitions of feasibility and operability used in Table A-5. Therefore, the reductions may overlap.

A.4.7 Problem forest types

Problem forest types were identified as those stands leading in whitebark pine, yellow pine, tamarack and deciduous species. They were entirely excluded from the timber harvesting land base.

A.4.8 Visually sensitive corridor

Visual quality objectives (VQOs) have not been approved for the Cassiar TSA. Since there is no recent history of harvesting in visually sensitive areas, there is no recent experience regarding adjustments to practices that would be necessary to protect such areas. Therefore, the same assumptions as for the 1994 (TSR 1) analysis were modelled, where a 500-metre no-harvest buffer was applied along each side of Highway 37.

A.4.9 Roads, trails and landings

The estimated loss to current and future roads, trails and landings is 6.9% each.

A.4 Definition of the Timber Harvesting Land Base

A.4.10 Riparian reserve and management zones

To account for management along streams and around lakes and wetlands, a percentage of the forested area was excluded from the timber harvesting land base. The percentages are listed in Table A-7. They were derived from a geographic information system buffering exercise on all mapped streams, lakes and wetlands. This incorporated reserve and retention practices from the *Forest Practices Code Riparian Area Management Guidebook,* and from on the ground practices.

Table A-7. Riparian reserve and management zones

Location (BEC unit)	Riparian reserve zone (RRZ) (% of timber harvesting land base)	Riparian management zone (RMZ) (% of timber harvesting land base)	Total reduction to timber harvesting land base (hectares)	Total reduction to timber harvesting land base (%)
ATP	0	0	0	0
BWBSdk1	8.6	6.8	12 786	8.6
BWBSdk2	8.6	6.8	13 281	8.6
BWBSunr	8.6	6.8	0	8.6
BWBSvk	8.6	6.8	0	8.6
CWHwm	35.1	20.5	326	35.1
ESSFmc	0	6.7	0	0
ESSFwv	0	6.7	0	0
ICHvc	7.5	9.4	30	7.5
ICHwc	9.4	5.5	1 758	9.4
Mhunr	0	5.2	0	0
SBSunr	12.3	6.7	1 235	12.3
SWBdk	5.7	5.5	0	5.7
SWBmk	5.7	5.5	16	5.7
SWBunr	5.7	5.5	3 762	5.7
SWBvk	5.7	5.5	0	5.7
Total			33 194	

A.4 Definition of the Timber Harvesting Land Base

The riparian reserve zones were entirely excluded from the timber harvesting land base, while the riparian management zones were included. This is based on an assessment of current practice in the Bulkley TSA.

It was assumed that RRZ and RMZ percentages for comparable BEC variants in the Atlin and Dease-Liard Supply Blocks (outside the CIS LRMP area) were consistent with those for the Iskut and Boundary Supply Blocks (within the CIS LRMP area).

A.4.11 Wildlife trees (WT) and wildlife tree patches (WTP)

The WTP requirements of Table 20b of the *Biodiversity Guidebook* were applied, as there are no approved landscape units and biodiversity emphasis options for the Cassiar TSA, and old-seral requirements were not applied (see Section A.5.4, "Forest cover requirements").

Using principles from the *Forest Practices Code Biodiversity Guidebook*, forest district staff estimated that the requirement for WTPs was 8%. Based on the assumption that half of this requirement is already contained within riparian reserve zones and inoperable areas, the timber harvesting land base was reduced by 4%. The data package had originally stated that there would be a 2% reduction to account for WTPs. Upon their further assessment, forest district staff concluded that an additional 2% was necessary as a safety measure in case landscape-level biodiversity requirements could not be fully met outside the timber harvesting land base.

An area reduction was used to model wildlife tree patch requirements rather than a volume reduction, because it more accurately reflected the area upon which harvesting would occur. These wildlife tree patches are generally larger than two hectares and are left to maintain stand structure within the landscape over time. They will contribute to meeting old-seral stage forest requirements at the landscape level. It was assumed that these wildlife tree patches will not be economical to harvest at a later date, nor will they be available for subsequent harvesting in the stand.

A.4.12 Low-volume pine

Since the data package was approved, the minimum volume for the interior supply blocks (Dease-Liard and Atlin) has been increased from 150 to 220 cubic metres per hectare for lodgepole pine. Pine stands between 150 and 220 cubic metres per hectare have been identified as low volume pine, and are not part of the timber harvesting land base. Table A-6. reflects this change.

A.4 Definition of the Timber Harvesting Land Base

A.4.13 Marginally operable areas

In January 2000, forest district staff further examined some areas for their potential operability. They concluded that the following were marginally operable areas that should be removed from the timber harvesting land base.

1. Telegraph and Tuya areas
    - would have high costs associated with road improvements to allow hauling and to ensure public safety, would have high transportation costs to processing sites and markets;
    - have no demonstrated harvesting performance, other than at a very small scale.
2. Areas north of the Stikine River
    - have long distances of dead road from the highway (i.e., it develops no volume along the way, so all costs must be carried for substantial periods); and
    - have no demonstrated harvesting performance.
3. Areas west of Atlin
    - are inaccessible, except for water transport.

Reductions to the timber harvesting land base for these areas were modelled by using mapsheet numbers, medium feasibility criteria and the boundary of the Stikine proposed protected area. The mapsheets include all of 104M, 104N001, 104N011, 104N021, 104N031, 104N041, 104N051, 104N061, 104N071, 104N081, and 104N091.

A.4.14 Pulp quality stands

The timber profile for the Cassiar TSA includes a significant component of pulp-quality stands, which has not been historically harvested. The data package noted that a critical issue analysis would address the impact of removing pulp-quality stands from the timber harvesting land base. However, since the data package was released, Bulkley/Cassiar Forest District staff re-examined the criteria used to define the timber harvesting land base. They acknowledged that there has been no history of harvesting in pulp stands, and therefore excluded them from the timber harvesting land base.

The definition of pulp quality has been modified from the data package description. Stands are classed as 'pulp' quality (likely to yield more than 50% pulp upon harvest) if one of the following criteria is met:

Table A-8. Pulpwood definition

Component	Inventory type group	Age class	Average total tree height (metres)	Site index	Volume
Mature	18–20	> 6	< 24		> 50% subalpine fir and hemlock
Immature	18–20	< = 6		< = 14.4	> 50% subalpine fir
All	12 and 15–17				> 50% hemlock and subalpine fir

A.4 Definition of the Timber Harvesting Land Base

A.4.15 Exclusion of specific, geographically defined areas

Muskwa-Kechika

The November 1999 data package indicated that a sensitivity analysis would assess the impact of removing the Muskwa-Kechika area from the timber harvesting land base. However, the Muskwa-Kechika was subsequently transferred from the Cassiar TSA to the Fort Nelson TSA in January 2000. The area transferred was 1 662 909 hectares. This transfer was handled as a reduction to the timber harvesting land base of 27 452 hectares, but not as a reduction to the total area of the Cassiar TSA. The potential timber supply contribution of the Muskwa-Kechika area was assessed in a critical issue analysis.

Cultural heritage resources

Archaeological overview and cultural heritage value inventories for the Cassiar TSA are not available. There are known trails of 410 kilometres, but because there is no experience regarding management practices along such trails, no adjustments were incorporated in this analysis.

A.5 Forest Management Assumptions

A.5.1 Utilization levels

The utilization level defines the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) (1.3 metres) by species. The provincial standards were used in the analysis to calculate merchantable volume.

Table A-9. Utilization levels

Analysis unit	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Lodgepole pine	12.5	30	10
All others	17.5	30	10

A.5.2 Volume exclusions for mixed-species stands

The volume from deciduous species, Whitebark pine and tamarack growing with merchantable species was excluded entirely from the estimation of stand volume.

A.5.3 Minimum harvestable age derivation

Minimum harvestable age is the minimum age at which harvesting is expected to be feasible. Table A-10. lists the criteria that define this age for each analysis unit, and the resulting ages for existing natural and for regenerated managed stands.

A.5 Forest Management Assumptions

Table A-10. Minimum harvestable age criteria

Natural stand analysis unit	Description	Minimum criteria		Minimum harvestable age (years)	Managed stand analysis unit	Minimum criteria		Minimum harvestable age (years)
		Height class	Volume (m^3/ha)			Height class	Volume (m^3/ha)	
1	Spruce – G	3	220	60	101	3	150	36
2	Spruce – M	3	220	73	102	3	150	50
3	Spruce – P	3	220	115	103	3	150	78
4	Pine – G	3	220	63	104	3	150	44
5	Pine – M	3	220	90	105	3	150	62
6	Pine – P	3	220	114	106	3	150	70
7	Subalpine fir – G	3	220	70	107	3	150	57
8	Subalpine fir – M	3	220	112	108	3	150	74
9	Subalpine fir – P	3	220	160	109	3	150	100
10	Hemlock – G	3	220	58	110	3	150	56
11	Hemlock – M	3	220	75	111	3	150	66
12	Hemlock – P	3	220	95	112	3	150	93
21	Spruce – G	3	150	55	121	3	150	36
22	Spruce – M	3	150	66	122	3	150	49
23	Spruce – P	3	150	106	123	3	150	90
24	Pine – G	3	150	53	124	3	150	50
25	Pine – M	3	150	71	125	3	150	70
26	Pine – P	3	150	88	126	3	150	89
27	Subalpine fir – G	3	150	65	127	3	150	59
28	Subalpine fir – M	3	150	80	128	3	150	72
29	Subalpine fir – P	3	150	120	129	3	150	99

The minimum harvestable age occurs when both the minimum height and volume criteria are met.

The volume criterion for existing stands in the coastal/transitional analysis units is higher than for regenerated stands because a greater volume per hectare is required to offset the higher cost of initial road access into more challenging terrain.

A.5 Forest Management Assumptions

A.5.4 Forest cover requirements

Forest cover requirements may be examined at a number of different levels. With the requirement to retain different forest characteristics across the landscape, it is important to consider the role of non-contributing forest (productive forest which does not contribute to the timber harvesting land base) in achieving forest cover requirements (i.e., maximum allowable disturbance or minimum area retention).

Since minimal harvesting and related forest practices have occurred in the Cassiar TSA, Table A-11. reflects management objectives and guidelines that would apply if harvesting did occur. All constraints were applied to the timber harvesting land base.

A.5 Forest Management Assumptions

Table A-11. Forest cover requirements

Resource emphasis (landscape unit if applicable)	Maximum allowable disturbance (% area)	Green-up height (metres)	Green-up age (years)	Minimum retained area (%)	Minimum age for retention (years)
IRM – cutblock adjacency (Dease-Liard, Iskut and Boundary supply blocks)					
Coal	33	3	16.0		
Cry	33	3	20.1		
Dease Lake	33	3	19.7		
Dease River	33	3	19.8		
Iskut	33	3	20.8		
Jennings	33	3	24.5		
Kakiddi	33	3	23.9		
Klappan	33	3	25.3		
Little Rancheria	33	3	24.3		
Lower Kechika	33	3	12.0		
Middle Dease	33	3	22.5		
Middle Stikine	33	3	22.6		
Snowbank	33	3	22.5		
Swift	33	3	22.8		
Tahltan	33	3	17.1		
Tuya	33	3	21.5		
Upper Iskut	33	3	17.6		
Upper Liard	33	3	18.7		
IRM – cutblock adjacency for caribou (Atlin supply block)					
Atlin	20	3	25.9		
Gladys	20	3	20.3		
Nakina	20	3	24.7		
Teslin	20	3	21.5		
Moose in CWH (MCWH)	33.3	3	None in timber harvesting land base		
Grizzly bear and goat in CWH (GCWH)	20	3	24.0	30	250
Moose in BWBS (CARM)	33.3	3	23.4		
Grizzly bear, goat and moose in ICH (GGMI)	25	3	20.7	30	250
High value caribou habitat (CAR)	25	3	17.3	30	140
Community watersheds	5	5 years			

A.5 Forest Management Assumptions

Green-up age

Green-up ages were used to model the average time for a stand to reach a specified height. The procedures used to estimate the average green-up ages were to calculate the average area-weighted site index for each analysis unit then calculate the per cent by major species in the inventory type group in an analysis unit.

The site index and major species and inventory type groups were used as input to the Ministry of Forests, Research Branch *Site Tools* program to calculate the time to reach green-up height.

For each type of forest cover requirement, the average area-weighted age for the required green-up height was calculated from the age-height data for each analysis unit.

The integrated resource management (IRM) green-up requirement for cutblock adjacency and the wildlife habitat requirements were applied by landscape unit.

Wildlife habitat

The Ministry of Environment, Lands and Parks (MELP) supplied high-value habitat mapping from interpretations of radio-collared studies conducted by the Spatsizi Association of Biological Research, and other studies. These maps exist only for grizzly bear, goat, moose and caribou in the Iskut and Boundary supply blocks, and for caribou only in the Dease-Liard supply block.

A 3-pass harvesting system was modelled for the integrated resource management area that covers these maps. For the Atlin supply block, where high-value habitats are not mapped, a 5-pass harvesting system was modelled in the integrated resource management area to account for any unidentified high-value habitats.

Outside the integrated resource management area, and where high-value habitat maps exist, harvesting systems with a range of passes from 3 to 5 were modelled according to Table A-11.

Community watersheds

One registered community watershed that services the community of Telegraph Creek was identified where additional forest cover requirements are required. The practice is to limit harvesting, within a five-year period, to a maximum of 5% of the total forested area within a community watershed. This forest cover requirement reflects the guideline provided in the *Forest Practices Code Community Watershed Guidebook*. However, this community watershed was found to be outside the timber harvesting land base.

Landscape-level biodiversity

Forest cover requirements for landscape-level biodiversity (primarily old-growth retention) were not applied. Although the computer can model landscape-level biodiversity by including the forested land outside of the timber harvesting land base, it assumes that this area ages continuously over the analysis time frame. This would lead to an accumulation of old growth outside of the timber harvesting land base with the result that, after some time, all of the old-growth requirements would be fulfilled outside of the timber harvesting land base. This is not a realistic assumption in the Cassiar TSA because of the large amount of fires that occur. Therefore, higher wildlife tree patch requirements were modelled instead.

A.5 Forest Management Assumptions

A.5.5 Unsalvaged losses

Table A-12. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (m^3/year)
Balsam bark beetle	1 412
Fire	24 108
All	25 520

Fire

Data from the selective suppression era (1980 to 1998) was used to calculate the annual unsalvaged loss to fire. All losses due to fires are unsalvageable, and all fires less than four hectares were not counted. The total volume loss over the 19-year period was 4 447 066 cubic metres. This equates to 234 056 cubic metres per year. To determine what proportion of the losses occurred within the timber harvesting land base, the following formula was used:

$$\text{Timber harvesting land base} = \frac{198\ 768 \text{ hectares}}{\text{Forested area in operable corridor} = 1\ 931\ 100 \text{ hectares}} = 10.3\%$$

This gives an unsalvaged loss for fire of 234 056 cubic metres per year * 10.3% = 24 108 cubic metres per year.

Balsam bark beetle

Susceptible stands were defined as age classes 7-9 subalpine fir-leading stands in the ESSF and SWB zones. Since endemic levels of pests are believe to be accounted for in natural stand yield curves (VDYP), only epidemic losses to balsam bark beetle were investigated for susceptible stands in the ESSF (where the occurrence of balsam bark beetle is increasing to severe levels). This was done by interpreting an operational study conducted in subalpine fir-leading stands in the Bulkley TSA, south of the Cassiar TSA. All losses to balsam bark beetle were considered unsalvageable.

The November 1999 data package reported the estimated annual loss in the Cassiar TSA subalpine fir-leading stands was 0.65 cubic metres per hectare per year. This figure was later changed to 0.68. The data package also reported that the weighted-average subalpine fir volume per hectare was 196 cubic metres per hectare. This was also changed since then to 205 cubic metres per hectare. However, these changes did not impact the estimate of volume loss due to balsam bark beetles.

A.5.6 Basic silviculture and regeneration assumptions

Minimal harvest has occurred in the Cassiar TSA in the past 5 years. However, within the past 10 years most harvesting has used the clearcut with reserves silviculture system, with only one entry. The area provided within the reserves equates to wildlife tree patch size requirements specified by Table 20b of the *Biodiversity Guidebook*.

Because the reserves equate to the wildlife tree patches, further reductions to the timber harvesting land base were not made to accommodate the reserves.

A.5 Forest Management Assumptions

Table A-13. shows the proportion of each analysis unit treated under each silviculture regime and the expected average regeneration delay. The regeneration assumptions were applied to existing and regenerated analysis units.

Recent regeneration and future stands were grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service Table Interpolation Program for Stand Yields (TIPSY) growth and yield model.

Table A-13. Regeneration assumptions by analysis unit

		OAFs[e] %		Method		Species		Density stems/hectare
Analysis unit	**Regen delay (years)**	**1**	**2**	**Type**	**%**	**Code**	**%**	**Initial**
Spruce – G/M[a]	2	15	5	Plant	100	Sw	60	2000
1, 2, 21, 22						Pl	40	2000
Spruce – P	2	15	5	Plant	100	Sw	80	2000
3, 23						Pl	20	2000
Pine – G/M[b]	2	15	5	Plant	100	Pl	50	2000
4, 5, 24, 25						Sw	50	2000
Pine – P	2	15	5	Plant	60	Pl	100	2000
6, 26				Natural	40	Pl	100	5000
Subalpine fir – G/M	2	15	5	Plant	100	Sw	50	2000
7, 8, 27, 28						Pl	50	2000
Subalpine fir – P	2	15	5	Plant	100	Sw	50	2000
9, 29						Pl	50	2000
Hemlock –G/M[c]	2	15	5	Plant	80	Sw	80	2000
10, 11						Pl	20	2000
	2 –10	15	5	Natural	20	Hw	80	4000
						Bl	20	4000[d]
Hemlock – P	2	15	5	Plant	80	Sw	100	2000
12	2	15	5	Natural	20	Hw	100	4000

(a) Only the spruce curve was used.

(b) 12.5 cm utilization was used on pine sites only.

(c) Interior western hemlock curve was used.

(d) Initial density was changed from 2000 to 4000 stems/ha from data package.

(e) See Section A.7 for explanation of operational adjustment factors (OAFs).

The table above reflects the regeneration assumptions that were applied after harvesting the mature stand analysis units. The regeneration delay figures are based on an analysis of regeneration delay conducted for all areas harvested prior to 1995. Site indices from existing analysis units were retained for regenerated stands.

The data package included analysis unit 13, cedar; however, the inventory shows no cedar-leading stands in the timber harvesting land base.

A negative regeneration delay indicates advanced regeneration. The figure represents the number of years it would likely take before planted seedlings would grow to the same height as advanced-growth regeneration that exists at time of harvest.

A.5.7 Immature plantation history

All coniferous, merchantable species up to 10 years old, and 50% of coniferous species aged 11-20 growing on stands which have been harvested (Activity = "L"), were assumed to have had their density controlled. Therefore, these stands were assigned to a managed stand yield table (MSYT).

A.5.8 Not satisfactorily restocked (NSR) areas

Land classified in the Cassiar TSA inventory file as type identity 4 or 9 was included in the timber harvesting land base as not satisfactorily restocked land. The areas were first removed from the timber harvesting land base, re-assigned a leading species if necessary, and then added back into the land base at the estimated rate at which the NSR area will be restocked.

The total area of NSR within the timber harvesting land base of the Cassiar TSA is 7874 hectares. It was determined by:

a) calculating the proportion of each analysis unit in age classes 1 and 2 (excluding NSR). See Table A-14.

b) assigning ages to NSR areas as follows:

- If the current age was less than or equal to 15 years and there was a harvesting history, then the NSR age was equal to zero. Harvest depletions in the inventory file are current only to 1992. Because the forest district promptly restocks all harvested stands, where the file indicates a stand was harvested, it is unlikely to still be NSR in 1999.
- Otherwise, a 20-year regeneration delay was assumed for natural regeneration. In that case, the NSR age is equal to the current age minus 20 years.

c) The NSR areas were assigned to analysis units using the proportions calculated for step (a).

A.5 Forest Management Assumptions

Table A-14. shows the total area on the file in age classes 1 and 2, excluding NSR area. Table A-15. shows the area of NSR by analysis unit used in the analysis.

Table A-14. Area in age classes 1 and 2 by analysis unit

Analysis unit	Area (hectares)
1	46.77
2	37.52
4	93.99
5	262.54
8	367.66
9	103.23
12	10.86
21	222.15
22	1 031.27
23	1 888.20
24	455.06
25	3 985.17
27	149.27
28	178.00
29	0.98
Total	**8 832.69**

Table A-15. Area of NSR by analysis unit

Analysis unit	Area (hectares)
1	147.81
2	118.57
4	297.05
5	829.73
8	1 161.92
9	326.25
12	34.34
21	139.25
22	646.41
23	1 183.55
24	285.24
25	2 497.96
27	93.56
28	111.57
29	0.62
Total	**7 873.82**

A.6 Volume Estimates for Existing Stands

The variable density yield prediction (VDYP) model, version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. The following tables show the volume estimates by analysis unit for existing natural stands. Table A-16. shows the analysis units in the coastal/transitional areas, while Table A-17. shows the analysis units in the interior area of the Cassiar TSA.

Table A-16. Timber volume tables for existing natural stands (cubic metres per hectare) in the coastal/transitional area

Table	1	2	3	4	5	6	7
Age (years)	Spruce–G	Spruce–M	Spruce–P	Pine–G	Pine–M	Pine–P	Subalpine fir–G
10	0	0	0	0	0	0	0
20	0	0.45	0.13	0.14	0.16	0.29	0
30	0	1.8	0.71	42.73	1.29	1.8	18
40	64.73	28.26	3.12	106.49	44.09	18.33	73.6
50	150.09	91.12	17.42	160.99	88.05	54.52	125.6
60	223.64	152.08	45.28	207.35	127.19	87.19	175.3
70	285.9	205.3	83.21	247.03	161.94	116.86	220.3
80	338.25	251.44	120.4	281.15	193.05	143.68	260.7
90	381.55	289.98	153.4	311.23	221.29	168.39	296
100	417.77	322.75	182.72	337.98	246.99	191.16	328
110	448.44	350.67	208.77	361.84	270.66	212.25	357.3
120	474.46	374.63	231.85	383.34	292.56	231.85	384.2
130	497.3	397.45	253.88	403.47	313.2	250.26	412
140	515.6	416.44	273.23	417.2	327.37	263.25	435.8
150	530.93	432.48	290.35	427.93	338.51	273.64	457.7
160	542.59	445.76	305.1	435.63	346.77	281.4	477.7
170	552.05	457.07	318.12	440.63	352.17	286.64	496
180	559.41	466.62	329.62	442.88	354.75	289.39	512.4
190	564.55	474.57	339.71	442.4	354.44	289.71	527.3
200	570.22	482.34	349.25	445.1	357.39	292.65	542.4
210	575.17	489.48	357.98	447.98	360.41	295.73	557
220	579.77	495.93	365.99	450.77	363.56	298.76	570.7
230	583.9	501.86	373.31	453.55	366.53	301.69	584.2
240	587.53	507.26	379.99	456.27	369.37	304.45	596.9
250	590.83	512.1	386.15	458.76	372.06	307.1	609.2
260	593.8	515.6	390.69	461.06	374.47	309.16	612.4
270	596.36	518.74	394.82	463.19	376.75	311.02	615.5
280	598.56	521.54	398.63	465.19	378.82	312.79	618.5
290	600.52	524.01	402.05	467.08	380.68	314.33	621.3
300	602.31	526.22	405.18	468.82	382.45	315.77	623.9
310	603.8	528.24	408.04	470.36	384	317.02	626.3
320	605.1	530.02	410.61	471.75	385.34	318.13	628.6
330	606.27	531.64	412.93	473.02	386.6	319.07	630.8
340	607.28	533.12	415	474.2	387.69	319.92	632.9
350	608.1	534.43	416.93	475.25	388.59	320.64	634.8

(continued)

A.6 Volume Estimates for Existing Stands

Table A-16. Timber volume tables for existing natural stands (cubic metres per hectare) in the coastal/transitional area (concluded)

Table	8	9	10	11	12
Age (years)	Subalpine fir–M	Subalpine fir–P	Hemlock–G	Hemlock–M	Hemlock–P
10	0	0	0	0	0
20	0	0	0	0	0.28
30	0.02	0	1.89	0.01	1.17
40	20.46	0.26	84.4	7.13	3.14
50	51.85	12.44	169.47	77.55	32.25
60	85.13	32.45	243.66	140.44	81.82
70	119.45	61.42	307.99	195.84	127.74
80	148.07	84.56	363.85	244.18	169.25
90	172.91	105.29	407.19	280.84	204.75
100	195.36	124.37	442.57	310.13	235.65
110	215.75	142.01	471.62	333.55	262.61
120	234.28	158.29	495.37	352.08	286.12
130	254.97	175.63	523.79	375.96	310.95
140	274.51	191.8	549.45	396.45	334.08
150	292.82	207.02	572.42	414.51	355.44
160	309.98	221.26	592.87	429.96	375.14
170	326.18	234.71	610.83	443.33	393.37
180	341.46	247.27	626.82	454.52	410.23
190	355.77	259.05	641.26	463.64	425.87
200	369.83	270.72	654.34	473.72	440.52
210	383.29	281.96	666.16	482.95	454.23
220	396.07	292.85	676.98	490.56	467.02
230	408.38	303.36	686.81	497.26	479.06
240	420.2	313.53	695.74	503.41	490.32
250	431.59	323.37	703.95	509.04	500.93
260	433.09	325.7	710.92	514.29	510.8
270	434.48	327.92	717.37	519.14	520.12
280	435.8	330	723.25	523.64	528.85
290	437.01	331.93	728.63	527.79	537.14
300	438.11	333.85	733.57	531.7	544.93
310	439.17	335.59	738.04	535.38	552.25
320	440.15	337.22	742.15	538.84	559.11
330	441.08	338.75	745.9	542.05	565.63
340	442	340.23	749.31	545.16	571.77
350	442.85	341.58	752.46	548.03	577.6

A.6 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres per hectare) in the interior area

Table	21	22	23	24	25	26	27
Age (years)	Spruce–G	Spruce–M	Spruce–P	Pine–G	Pine–M	Pine–P	Subalpine fir–G
10	0	0	0	0	0	0	0
20	0	0	0	0.38	0.03	0.03	0
30	2.57	0.01	0	31.48	1.35	0.18	11.22
40	60.39	9.27	0.08	87.16	36.51	9.19	48.82
50	121.99	64.13	2.2	136.28	76.95	43.16	90.76
60	176.92	119.39	14.48	179.29	113.23	74.75	130.63
70	225.01	168.55	37.8	217.11	145.78	103.67	170.54
80	265.78	211.63	71.65	250.46	175.03	130.15	205.08
90	301.12	249.28	103.45	280.59	201.76	154.64	234.52
100	328.8	282.15	132.88	307.94	226.27	177.38	261.02
110	351.97	310.94	159.98	332.97	248.9	198.56	285.04
120	371.24	336.12	184.75	356.02	269.93	218.41	306.71
130	386.85	358.29	207.6	377.67	289.67	237.16	331.32
140	400.08	376.16	227.25	391.92	303.17	250.25	353.96
150	411.48	391.51	244.67	402.92	313.81	260.67	375.19
160	417.8	404.28	259.56	410.49	321.51	268.38	395.15
170	422.81	415.02	272.65	414.91	326.43	273.47	413.83
180	426.75	423.9	284.06	416.14	328.56	275.97	431.2
190	429.63	431.09	293.91	414.24	327.95	275.86	446.87
200	432.75	438.19	303.39	416.37	330.51	278.58	462.35
210	435.58	444.6	312.1	418.84	333.27	281.44	477.26
220	438.23	450.36	320.08	421.49	336.08	284.29	491.69
230	440.44	455.57	327.37	424.18	338.82	287.03	505.53
240	442.35	460.23	334.03	426.76	341.44	289.64	518.85
250	444.13	464.46	340.11	429.28	343.89	292.09	531.71
260	445.65	467.93	345.39	431.56	346.18	294.31	533.2
270	446.99	471	350.18	433.73	348.28	296.34	534.68
280	448.29	473.73	354.51	435.75	350.24	298.23	536
290	449.3	476.2	358.45	437.65	352.01	299.92	537.3
300	450.2	478.4	362	439.38	353.62	301.43	538.54
310	450.97	480.34	365.21	441.01	355.06	302.79	539.66
320	451.71	481.98	368.1	442.47	356.36	303.97	540.81
330	452.22	483.39	370.69	443.78	357.51	305	541.87
340	452.67	484.59	373.02	444.96	358.48	305.85	542.87
350	453	485.65	375.1	445.99	359.31	306.57	543.84

(continued)

A.6 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres per hectare) in the interior area (concluded)

Table	28	29
Age (years)	Subalpine fir–M	Subalpine fir–P
10	0	0
20	0	0
30	0.72	0
40	22.72	0.79
50	54.93	13.54
60	87.95	32.82
70	121.41	59.93
80	149.17	81.49
90	172.92	100.92
100	194.15	118.86
110	213.26	135.5
120	230.41	150.98
130	249.68	167.24
140	268.18	182.34
150	285.63	196.49
160	302.12	209.49
170	317.79	221.72
180	332.59	233.17
190	346.62	243.91
200	359.94	254.53
210	372.6	264.82
220	384.7	274.76
230	396.32	284.37
240	407.46	293.58
250	418.15	302.49
260	419.34	304.25
270	420.38	305.92
280	421.39	307.48
290	422.32	308.97
300	423.13	310.36
310	423.93	311.67
320	424.66	312.92
330	425.33	314.08
340	425.93	315.21
350	426.48	316.23

A.7 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands.

Operational adjustment factors (OAFs) were used to generate managed stand yield tables. OAF1 (15%) is a constant reduction at all ages to represent incomplete site occupancy, such as small canopy gaps or openings in a stand. OAF2 (5%) is an increasing reduction which represents losses such as decay that increase with stand age.

Tables A-18. and A-19. display the yield estimates for managed stands. Table A-18. shows the analysis units in the coastal/transitional areas, while Table A-19. shows the analysis units in the interior area of the Cassiar TSA. For some tables there was insufficient growth and yield information to model to 350 years. Therefore, volumes at the age where data ended were projected to 300 years of age.

A.7 Volume Estimates for Regenerated Stands

Table A-18. Timber volume tables for managed stands (cubic metres per hectare) in the coastal/transitional area

Table	101	102	103	104	105	106	107
Age (years)	Spruce–G	Spruce–M	Spruce–P	Pine–G	Pine–M	Pine–P	Subalpine fir–G
0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
20	0	0	0	2	0	0	0
30	60	11	0	39	8	3.2	5
40	214	69	3	120	35	31	39
50	360	158	18	206	87	71.6	99
60	444	240	56	281	141	118.4	173
70	494	315	108	345	193	152.2	236
80	520	371	166	390	242	181	292
90	524	408	214	418	282	210.4	339
100	529	435	260	439	321	238.8	372
110	530	456	305	456	349	260.2	396
120	530	471	338	470	370	277.6	416
130	530	482	364	480	385	292.6	430
140	530	482	384	480	396	305	442
150	530	482	400	480	406	315.4	451
160	530	482	412	480	415	324.4	458
170	530	482	422	480	422	332.8	461
180	530	482	431	480	427	338.2	463
190	530	482	438	480	431	343	465
200	530	482	444	480	434	347.4	467
210	530	482	447	480	437	351.4	467
220	530	482	451	480	437	354.8	467
230	530	482	454	480	438	358.2	467
240	530	482	453	480	438	361.2	467
250	530	482	452	480	437	362.6	467
260	530	482	451	480	436	362.2	467
270	530	482	450	480	434	361.6	467
280	530	482	449	480	433	361.6	467
290	530	482	448	480	432	361.2	467
300	530	482	446	480	431	361.2	467

(continued)

A.7 Volume Estimates for Regenerated Stands

Table A-18. Timber volume tables for managed stands (cubic metres per hectare) in the coastal/transitional area (concluded)

Table	108	109	110	111	112
Age (years)	Subalpine fir–M	Subalpine fir–P	Hemlock–G	Hemlock–M	Hemlock–P
0	0	0	0	0	0
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	2.64	0.8	0
40	8	1	30.32	7.44	0
50	37	6	102.76	46.08	1
60	81	20	189.88	108.4	11
70	132	48	263.88	179.04	41.2
80	183	80	334.2	239.44	85.4
90	228	115	386.04	296.08	136.4
100	267	150	423.56	344.36	182.4
110	267	180	451.12	381.6	224.2
120	267	211	474	409.36	264.6
130	267	239	493.8	430.16	304.4
140	267	266	507.68	448.56	336
150	267	286	519.48	463.64	363.6
160	267	303	526.16	476.52	383.6
170	267	316	530.76	486.28	401
180	267	328	530.76	493.92	415
190	267	337	530.76	501.72	426.8
200	267	345	530.76	503.84	437.2
210	267	352	530.76	505.84	445.6
220	267	358	530.76	508.24	453
230	267	363	530.76	509.68	459.4
240	267	368	530.76	510.84	465
250	267	373	530.76	511.68	469.6
260	267	375	530.76	512.2	473.2
270	267	376	530.76	512.6	476.6
280	267	377	530.76	513	480
290	267	379	530.76	513.2	482.2
300	267	380	530.76	513.2	480.8

A.7 Volume Estimates for Regenerated Stands

Table A-19. Timber volume tables for managed stands (cubic metres per hectare) in the interior area

Table	121	122	123	124	125	126	127
Age (years)	Spruce–G	Spruce–M	Spruce–P	Pine–G	Pine–M	Pine–P	Subalpine fir–G
0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0
30	60	22	0	11	1	0	4
40	214	86	1	68	11	4.2	35
50	360	163	5	150	48	21.4	93
60	444	240	22	230	99	60.6	163
70	494	301	57	299	155	94	227
80	520	357	101	355	207	125.4	282
90	524	394	150	393	252	154	330
100	529	418	190	420	294	185.4	364
110	530	435	229	441	326	211.8	389
120	530	450	267	457	351	231	409
130	530	462	303	469	371	247.8	424
140	530	471	329	477	385	262.6	436
150	530	477	351	477	398	276	446
160	530	479	367	477	408	287.2	453
170	530	479	381	477	417	297.6	458
180	530	479	392	477	423	307	460
190	530	479	401	477	428	313.4	461
200	530	479	409	477	432	319.2	463
210	530	479	415	477	435	324.2	464
220	530	479	421	477	436	329	464
230	530	479	426	477	437	333	464
240	530	479	429	477	437	336.8	464
250	530	479	431	477	436	340.2	464
260	530	479	433	477	435	343.2	464
270	530	479	435	477	434	346.6	464
280	530	479	437	477	433	346	464
290	530	479	436	477	432	345.6	464
300	530	479	434	477	431	344.6	464

(continued)

A.7 Volume Estimates for Regenerated Stands

Table A-19. Timber volume tables for managed stands (cubic metres per hectare) in the interior area (concluded)

Table	128	129
Age (years)	Subalpine fir–M	Subalpine fir–P
0	0	0
10	0	0
20	0	0
30	1	0
40	10	1
50	43	7
60	90	23
70	143	52
80	196	85
90	240	121
100	281	156
110	315	188
120	341	218
130	362	248
140	377	273
150	390	292
160	400	309
170	409	322
180	417	333
190	421	342
200	426	350
210	429	357
220	431	363
230	432	368
240	432	373
250	433	376
260	432	378
270	430	379
280	429	381
290	427	382
300	426	384

A.8 Site Index in Managed Stands

Volume estimates are uncertain in managed stands due to potential inaccuracies in the forest inventory and in the growth and yield model. Limited experience and available data also contribute to this uncertainty.

Site productivity is directly related to managed stand yield estimation. The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands are projected to reach merchantable size.

An alternative approach to estimating post-harvest site index is use of the *Site Index — Biogeoclimatic Ecosystem Classification* (SIBEC) study (Forest Renewal B.C. and Ministry of Forests, B.C., 1997). Results present a first approximation of estimates of average site index for coniferous crop tree species according to site units of the biogeoclimatic ecosystem classification (BEC) system of B.C. The estimates are presented in site index-site unit (SISU) tables and the correlation between site index and site units varies from weak to moderately strong across species and sites.

SIBEC site index adjustments were not included in the base case as there are no local data to ensure they are locally applicable. Therefore, the SIBEC data was examined through a critical issue analysis to test the sensitivity of the maximum even-flow case harvest forecast to uncertainty in site index estimates for managed stands.

The site indices of regenerated analysis units were determined using the following procedure:

- find the proportion of each analysis unit in each BEC subzone;
- assign a site unit (see note below) breakdown of 80% mesic/20% rich to each subzone, as advised by the Prince Rupert Forest Region ecologist;
- determine the regeneration prescription percentage by species;
- obtain site indices for the site unit and species from SIBEC tables (*Site Index Estimates by Site Series for Coniferous Tree Species in British Columbia*); and
- aggregate regenerated species with similar site indices into regenerated analysis units.

Note: The site unit breakdown was derived through conversations with the Prince Rupert Forest Region ecologist. Two classes of site units were identified for each subzone: mesic and rich. The mesic unit contains the mesic and sub-mesic site series, and the rich unit contains the more productive site series (i.e., 05 and 06). For each subzone, it was determined that the bulk of the unit was comprised of mesic conditions (80%), and that the remaining 20% were likely composed of rich sites.

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier —** employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- **Employment coefficient —** employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.
- **Timing of impacts —** employment impacts are shown to occur simultaneously with a change in the harvest level. While this assumption is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period, as levels of business and consumer spending adjust to changes in harvest levels.
- **Operating thresholds of mills —** it is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.
- **Government expenditures —** provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if a community's population significantly changes. This would amplify the community impacts of losses or gains in forestry sector jobs.
- **Proportional harvest reductions —** harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from B.C. STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and
3) timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

B.2 Economic Impact Analysis Methodology

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Cassiar TSA analysis are shown in Table B-1.

B.2 Economic Impact Analysis Methodology

Table B-1. Employment multipliers — Cassiar TSA

Forestry sub-sector	Cassiar TSA migration multiplier	Cassiar TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.29	1.21	2.14	1.80
Solid wood processing	1.32	1.21	2.29	1.93
Plywood	1.32	1.21	1.93	1.64
Pulp	1.57	1.44	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers in 1999 was:

$46,956 for those working in logging and forestry services;

$44,980 for those working in solid wood manufacturing; and

$58,136 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,732. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

B.2 Economic Impact Analysis Methodology

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B-2).

Table B-2. Estimates of provincial government revenues — Cassiar TSA

	Average annual revenue 1996–1999 ($ thousands)	Revenue ($ per '000s m^3)
Stumpage and related payments[a]	911.5	35,690
Forest industry taxes[b]	11.1	433
Employee income tax[c]	165.2	6,468
Total	1087.8	42,591

(a) Source: Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.