Fraser
Timber Supply Area
Analysis Report

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

June 1998

Canadian Cataloguing in Publication Data

Main entry under title:
Fraser timber supply area analysis report

Includes bibliographical references: p.
ISBN 0–7726-3573-0

1. Timber – British Columbia – Vancouver Region.
2. Forests and forestry – British Columbia – Vancouver Region – Mensuration. 3. Forest management – British Columbia – Vancouver Region.
4. Vancouver Forest Region (B.C.). I. British Columbia. Ministry of Forests.

SD438.B7F72 1998 333.75'11'097113 C98–960148–X

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 completed at least once 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 Fraser 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.**

The Fraser TSA covers about 1 107 060 hectares of area in the southwest mainland area of British Columbia. Within this area, 281 479 hectares are considered available for timber production and harvesting under current management practices. In the area available for timber harvesting, most of the forests are dominated by western hemlock, although there are also large areas dominated by Douglas-fir and western redcedar. Smaller areas are dominated by spruce, pine, larch and deciduous species such as alder and maple. Hemlock, Douglas-fir and western redcedar are the tree species most commonly used by the forest industry in the area.

The current allowable annual cut (AAC) for the Fraser TSA is 1.55 million cubic metres per year. Given current management assumptions, the analysis shows that the current AAC cannot be maintained in the short term. The base case harvest forecast indicates that the maximum harvest level in the first decade is 1.32 million cubic metres per year, about 15% below the current AAC. Over the following two decades the rate of harvest is projected to decline by about 15% and 9% respectively, per decade to 1.02 million cubic metres per year. In the long term (about 100 years into the future) when harvesting is occurring almost exclusively in second-growth managed stands, the rate of harvest may be increased to a steady long-term harvest level of about 1.2 million cubic metres per year.

The most important factors contributing to the projected decline in the timber supply are:

- Harvesting operations will be making a transition from older stands with high timber volumes per hectare (due to their old age) to younger second-growth stands with lower timber volumes per hectare.
- Significant changes in forest management have occurred since the last analysis. These changes include the creation of several large parks, completion of a spotted owl management plan, and implementation of Forest Practices Code (FPC) guidelines.
- An inventory audit completed for the Fraser TSA in 1997 indicated that the volume of timber in mature stands (60 years and older) is overestimated by an average of 23%. This overestimate of timber has been corrected in this timber supply analysis.

Due to the amount and complexity of information regarding forest dynamics, there exists some uncertainty in the data and assumptions used in this analysis which may affect the results. For example, the short-term harvest level is most affected by changes to the estimated volume of timber in existing mature stands, changes to the estimated area of the timber harvesting land base and changes in the way that cutblock adjacency requirements are accounted for in the analysis. There has been no indication to date that existing mature timber volumes (after adjustment based on the inventory audit) or the size of the timber harvesting land base should be changed.

Executive Summary

The way in which cutblock adjacency was modelled in the base case was decided following a field and map-based review. This review of the rate and location of harvest by landscape unit over time indicated the need to specifically account for the geographic concentration of harvesting activities in the past. This problem was addressed by applying the cutblock adjacency requirements at a finer scale than was initially planned. Unfortunately this review was time consuming and in the mean time the analysis was completed using the original information regarding scale of adjacency requirements. As a result, the sensitivity analyses discussed in Section 5, "Timber Supply Sensitivity Analyses" use the initial harvest forecast, rather than the base case, as a starting point and a reference from which changes in the forecast are measured. Since sensitivity analyses are intended primarily to test the relative sensitivity of the harvest forecast to changes, the forest management practices and modelling assumptions shown to have a significant effect on the harvest forecast will remain significant using either the "initial" or the "base case" harvest forecast as a reference.

In the long term, the rate of harvest is most affected by changes in the estimated productivity of regenerated stands and changes in the estimated area of the timber harvesting land base. There is evidence from the provincial Old-Growth Site Index (OGSI) Project to suggest that the estimated future productivity of current old-growth stands has been underestimated. However, no evidence exists that suggests that the productivity of existing second-growth stands, which make up the majority of forest stands in the Fraser TSA, has been underestimated.

The socio-economic analysis shows that the current Fraser TSA AAC of 1.55 million cubic metres per year can support approximately 1953 direct and a further 2300 indirect and induced person-years of employment across the province. About 85% of the direct employment accrues to residents of the Fraser TSA. A harvest level of 1.32 million cubic metres as indicated by the timber supply analysis would support 1659 direct and 1954 indirect and induced person-years of employment in the province — approximately 294 direct and 346 indirect and induced person-years of employment less than the current AAC level supports. Recent harvest levels have been somewhat below the current AAC, subsequently the impacts may be somewhat less.

Reducing the harvest level by a further 15% and 9% at the end of the first and second decades, respectively, would reduce provincial employment supported by the Fraser TSA, after the first decade to approximately 1410 direct and 1660 indirect and induced person-years of employment, followed at the end of the second decade to 1285 direct and 1513 indirect and induced person-years of employment. Thus, in just over 20 years, the timber supply reductions as suggested in the base case would reduce forestry related employment by about 1455 resulting in 2798 person-years of direct, indirect and induced employment supported by the Fraser TSA province wide.

The current AAC provides the provincial government with, on average $53.2 million per year. Under, the base case forecast, the initial reduction in the timber supply could reduce annual provincial government revenues by approximately $8 million, and by the end of two decades $18 million.

In conclusion, this analysis indicates that, based on current inventory and growth and yield information and current forest management practices, the current rate of harvest in the Fraser TSA cannot be maintained without causing larger timber supply shortfalls in the future. Several factors related to the current forest inventory and management regime could affect timber supply; however, there is no evidence available prior to completion of this analysis to suggest that the data and assumptions used in the analysis should be changed.

Table of Contents

Table of Contents

Table of Contents

Tables

Table of Contents

Tables (continued)

Figures

Table of Contents

Figures (continued)

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 area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with Section 8 *of the* Forest Act.

Introduction

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

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

The 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 provides information for the Chief Forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Fraser 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. A person-year is defined as a full-time job and part-time positions are converted to person-years. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment figures were calculated using the Fraser 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 order of magnitude indicators.

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

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.

1 Description of the Fraser Timber Supply Area

The Fraser Timber Supply Area is located in the southern mainland portion of the Vancouver Forest Region (Figure 1). Administered from the Chilliwack Forest District office in Rosedale, it covers approximately 1.1 million hectares. The Fraser TSA is the most densely populated TSA in the province, encompassing the major population centres of the lower mainland and the Fraser Valley. The forest industry provides a substantial source of revenue and employment in the Fraser TSA, with more than 100 major timber processing facilities. Although a large proportion of the timber processed within the Fraser TSA is harvested from areas outside of the TSA, timber harvesting is an important part of the local economy, especially in the smaller remote communities.

Tourism, recreation, biodiversity* and conservation values are also very important in the Fraser TSA. The area provides easily accessible forest recreation opportunities to the major population centres of the lower mainland and scenic values are also carefully managed as several major highway corridors transect the TSA. The Fraser TSA, along with the adjacent Soo TSA, also provide critical areas of habitat for the endangered northern spotted owl.

Forests in the Fraser TSA are dominated by stands of western hemlock and Douglas-fir. There is a long history of timber harvesting in the Fraser TSA and a large proportion of the current forest is comprised of "second-growth" stands established after past harvesting.

The current allowable annual cut (AAC) in the Fraser TSA of 1 550 000 cubic metres per year, was established in 1995. Many significant changes in forest management and forest inventory information have occurred since that time, and have been accounted for in the current timber supply review. These changes include:

- implementation of the Forest Practices Code;
- the creation of several new parks in the Fraser TSA;
- implementation of a management plan for the northern spotted owl;
- the completion of an audit to test the accuracy of the forest inventory;
- a comprehensive review of scenic areas management;
- revised criteria for determining whether forest stands are economically feasible to harvest; and
- implementation of a second-growth management strategy for the Fraser TSA.

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

1 Description of the Fraser Timber Supply Area

1.1 The environment

The Fraser timber supply area closely corresponds to the watershed of the Lower Fraser River Basin.
Three physiographic units shape the area:

- the Coast Mountains border it on the north and east; various tributaries and lakes drain into the Fraser River;
- the Fraser lowland, a broad plain of riverine and glacial deposits, extends east from Vancouver to the community of Hope; and
- the Fraser estuary covers the delta and tidal waters surrounding the outlet of the Fraser River.

With five biogeoclimatic zones and thirteen commercial tree species, the Fraser timber supply area is one of the most biologically diverse regions in the province. Table 1 summarizes the zones and their locations, the major tree species present, and other considerations such as wildlife values. The coastal western hemlock zone is the most abundant zone in this timber supply area.

Table 1. Biogeoclimatic zones of the Fraser TSA

Zone	Location	Tree Species	Other
Coastal western hemlock	Fraser lowland and estuary, sea level to 900 metres.	Dominant: western hemlock, amabilis fir. Minor: Douglas-fir, western redcedar.	Wettest zone in B.C. Highest diversity of vertebrates in this timber supply area. Highest diversity of birds, amphibians and reptiles in B.C.
Mountain hemlock	Between 900 and 2250 metres elevation.	Dominant: mountain hemlock, yellow-cedar, amabilis fir. Minor: western hemlock, western redcedar, Douglas-fir, western white pine.	Harsh conditions limit wildlife (short cool summers; long snowy winters). There are no reptiles and only a few species of amphibians.
Alpine tundra	Above 2250 metres.	Treeless except stunted individuals at lower elevations.	Wildlife diversity and density are low; some summer range.
Interior Douglas-fir	West of Manning Park, on lee side of Coast Mountains below coastal western hemlock.	Dominant: Douglas-fir.	
Engelmann spruce-subalpine fir	In eastern portion of timber supply area, just below alpine tundra.	Dominant: Engelmann spruce; subalpine fir.	

1 Description of the Fraser Timber Supply Area

The Fraser TSA area contains one of the richest and most diverse arrays of wildlife in Canada. More than 300 species of migratory and resident birds, 45 species of mammals, 11 species of amphibians and 5 species of reptiles range throughout the area (Environment Canada, 1992).

Population estimates do not exist for many of the non-game species nor for all species of reptiles and amphibians inhabiting the timber supply area. However, species considered at risk in the Chilliwack Forest District (which includes the Fraser timber supply area) are summarized in Table 2.

Table 2. Vulnerable, endangered and threatened species

Endangered or threatened (red-listed)		Vulnerable (blue-listed)	
spotted owl	mountain beaver	sandhill crane	grizzly bear
western grebe	snowshoe hare	double-crested cormorant	luscus wolverine
marbled murrelet	Pacific water shrew	turkey vulture	Trowbridge's shrew
yellow-billed cuckoo	long-tailed weasel	barn owl	Cascade golden-mantled ground squirrel
streaked horned lark	southern red-backed vole	short-eared owl	rubber boa
American peregrine falcon	Townsend's mole	Williamson's sapsucker	tailed frog
purple martin	Keen's long-eared myotis	great blue heron	Townsend's big-eared bat
Cultus Lake sculpin	western red bat	green heron	painted turtle
pygmy longfin smelt	spotted frog	Hutton's vireo	bull trout
white sturgeon	Pacific gopher snake	American bittern	brassy minnow
salish sucker	Pacific giant salamander	American avocet	
nooksack dace		Caspian tern	

Source: B.C. Conservation Data Centre, Ministry of Environment, Lands and Parks, March 10, 1997.

The northern spotted owl has the highest profile of the species of management concern, and is recognized as nationally endangered. In 1997, the government released its' decision regarding the management of the northern spotted owl. As a result of the decision, new northern spotted owl management guidelines have been implemented and inventories continue to be gathered which will form the basis for a long-term management strategy. The new management guidelines have been incorporated into this timber supply analysis.

At least 87 species of resident, semi-resident and migratory finfish and shellfish inhabit the rivers, streams and lakes of the Lower Fraser Valley basin. These include commercially valuable salmonid species of chum, pink and sockeye, as well as at least 17 species with significant value in the recreational fishery.

1 Description of the Fraser Timber Supply Area

Figure 1. Map of the Fraser Timber Supply Area.

2 Information Preparation for the Timber Supply Analysis

Much information is required for timber supply analysis. This information falls into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1997 by the Vancouver Forest Region, B.C. Forest Service. This file contains a considerable amount of information on the forest land in the Fraser TSA including 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). Stand characteristics such as tree height, stocking* and age have been projected to January 1997. Except for a few mapsheets shared with adjacent forest districts, the inventory file has been updated to account for timber harvesting up to December 31 1996 for the majority of the Fraser TSA..

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, and areas in power lines, highways, or town sites. A description of these areas specific to the Fraser TSA is provided below. These types of areas do not contribute to the timber supply of the Fraser TSA. Before assessing timber supply these non-contributing areas are identified and separated from the land base which represents the timber harvesting land base*. When deriving this data file, care is taken to make only a single separation for areas with more than one characteristic that would make it unavailable for harvesting (for example, where a park area is also suitable for wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is also removed from the Fraser 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.

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

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

2 Information Preparation for the Timber Supply Analysis

For the Fraser TSA, the following types of areas were considered not to contribute to the timber harvesting land base:

- non-Crown area — areas not managed directly by the B.C. Forest Service. Included in this category are the several new parks recently created through the Lower Mainland Protected Areas Strategy.
- non-productive 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.
- streamside buffers — areas assumed to be unavailable for timber harvesting in order to account for protection of riparian* and stream ecosystems.
- environmentally sensitive areas* — areas with soil types that would be highly susceptible to damage by timber harvesting activities, areas with a high potential for difficulty in re-establishing forests following harvesting, and areas with a high avalanche hazard.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (e.g. presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- problem forest types — areas covered by timber stands that are physically operable and have adequate productivity, but are not yet currently utilized or have marginal merchantability. These are the predominantly cottonwood, aspen and birch stands.
- recreation areas — areas of recreational significance, such as campgrounds, trails and lookout sites.
- existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development.
- future roads, trails, and landings — future losses of productive forest land to access development. These areas are initially included in the timber harvesting land base, and are subsequently removed as part of the first harvest.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 3 summarizes the areas in each category, and shows the area of the timber harvesting land base.

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

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

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.

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

Table 3. Timber harvesting land base for the Fraser TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	1 107 060	100	
Not managed directly by the B.C. Forest Service	179 443	16.2	
Non-forest	399 054	36.0	
Newly created parks[a]	21 539	1.9	
Total productive forest managed by the B.C. Forest Service (Crown forest)	**507 024**	**45.8**	**100**
Reductions to Crown forest:			
Non-commercial cover (brush)	943	0.1	0.2
Inoperable areas	133 115	12.0	26.3
Low productivity forest	34 256	3.1	6.8
Environmentally sensitive areas	21 262	2.0	4.2
Deciduous stands that are not utilized	5 614	0.5	1.1
High recreation values	34	–	–
Existing roads	14 650	1.3	2.9
Riparian reserves	15 670	1.4	3.1
Total current reductions[b]	**225 544**	**20.4**	**44.5**
Current timber harvesting land base (includes 10 100 hectares not satisfactorily restocked (NSR)* land)[c]	**281 480**	**25.4**	**55.5**
Future reductions			
Future roads	734	0.1	0.1
Long-term timber harvesting land base	**280 746**	**25.3**	**55.4**

(a) Parks recently created via the Lower Mainland Protected Areas Strategy including Pinecone Lake/Burke Mountain, Indian Arm, Liumchen, Chilliwack Lake, Mehatl Creek and Nahatlatch River.
(b) Reductions were performed in the order listed in the table.
(c) NSR includes: current NSR and backlog NSR.

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

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents the total Fraser TSA land base. More than one-half of the Fraser TSA is either not managed by the Ministry of Forests for forestry (e.g., private land, parks, etc.) or is non-forest (e.g., alpine areas, rock, ice). The chart also details the categories of forested Crown forest land and shows that about one quarter (25%) of the total area in the Fraser TSA is considered to be available for harvesting (the timber harvesting land base). The remaining forested Crown land is excluded due to physical or economical inoperability, low site productivity, deciduous types which are not utilized, environmental sensitivity, riparian reserves or to account for the area of forest roads.

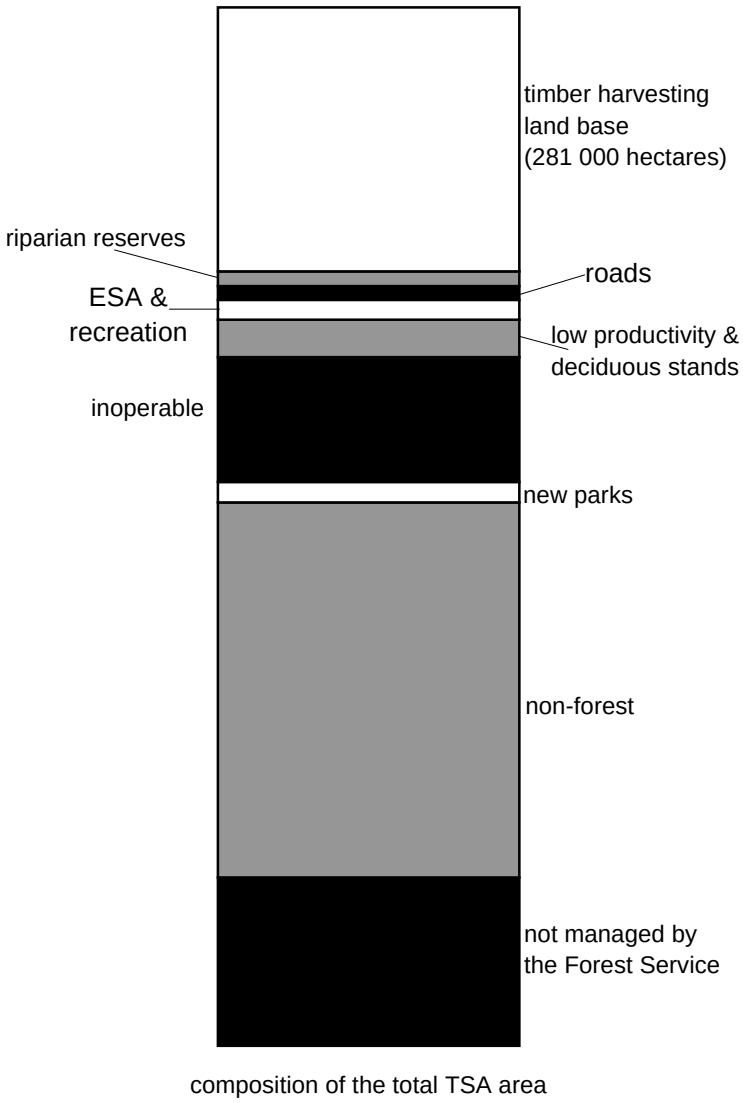


Figure 2. Composition of the total forest land bases — Fraser TSA, 1998.

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Western hemlock and Douglas-fir stands dominate most of the timber harvesting land base at 52% and 36% respectively. The remainder of the timber harvesting land base is covered by cedar- and spruce-leading stands (about 4% each), pine (1%) and alder/maple stands (3%). After harvest, coniferous stands are expected to be regenerated to the same leading species as is currently dominant in the stand. About 75% of currently deciduous-leading stands (alder/maple) are expected to be converted to coniferous stands after harvesting, with the remainder being regenerated back to alder and maple.

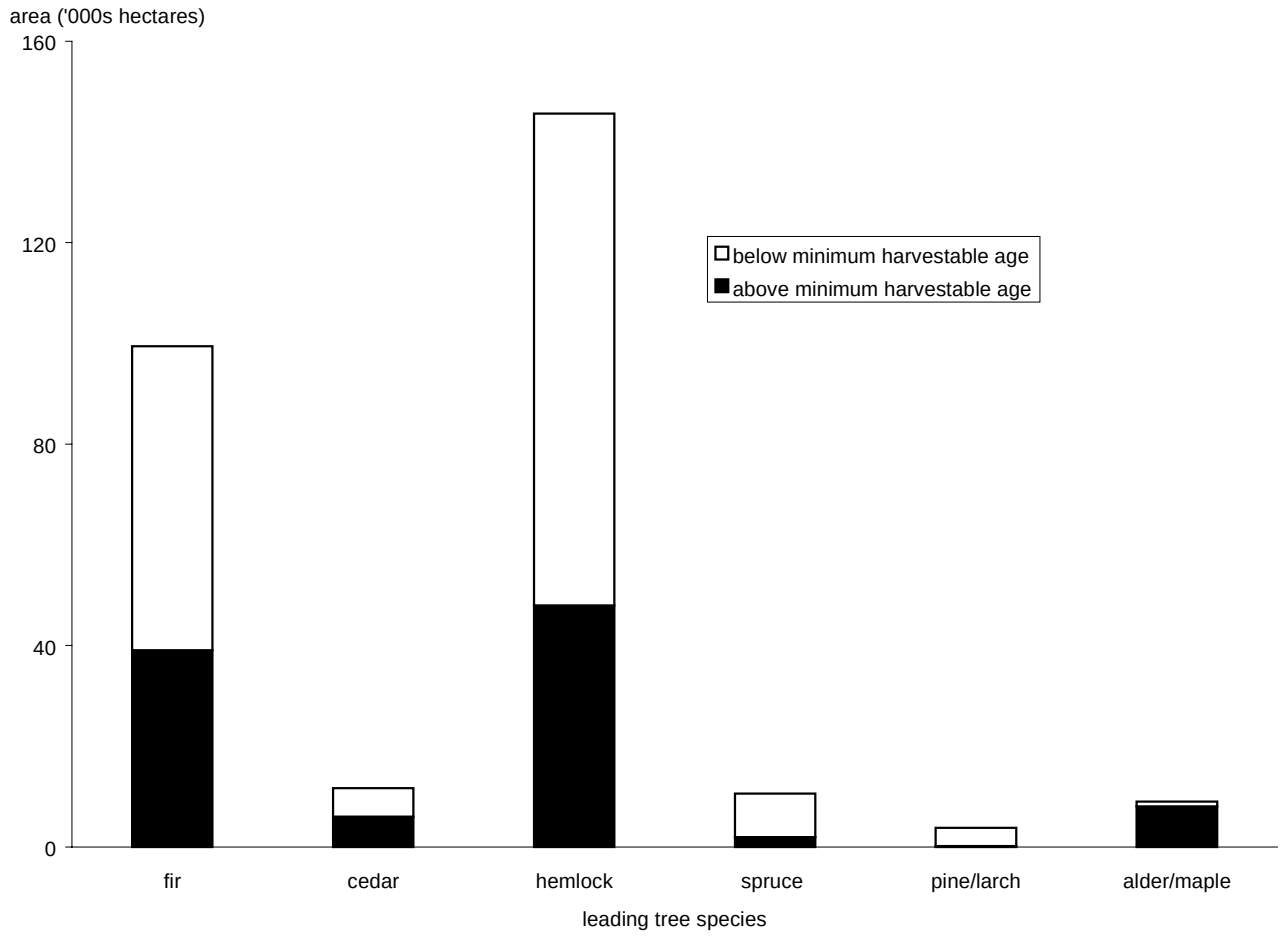


Figure 3. Area by dominant species — Fraser TSA timber harvesting land base, 1998.

Figure 3 also shows the proportion of area of each species that is younger or older than the minimum harvestable age (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 37% of stands in the timber harvesting land base are at or above the minimum harvestable age. For the more important commercial species groups (fir, hemlock and cedar) the proportion of younger and older stands is about the same as for the whole timber harvesting land base.

Figure 4 provides an overview of the distribution of site productivity within the timber harvesting land base, and the relative amount of area in each class that is older than the minimum harvestable age. About 70% of the sites in the timber harvesting land base are categorized as having good or medium productivity, and about 30% have poor productivity. Sites classified as having low productivity are excluded from the timber harvesting land base. The proportion of stands older than their minimum harvestable age in each site class indicates that past harvesting has concentrated more on good and medium productivity sites than on poor sites. However, there is still a large proportion of stands in each site class currently old enough to harvest.

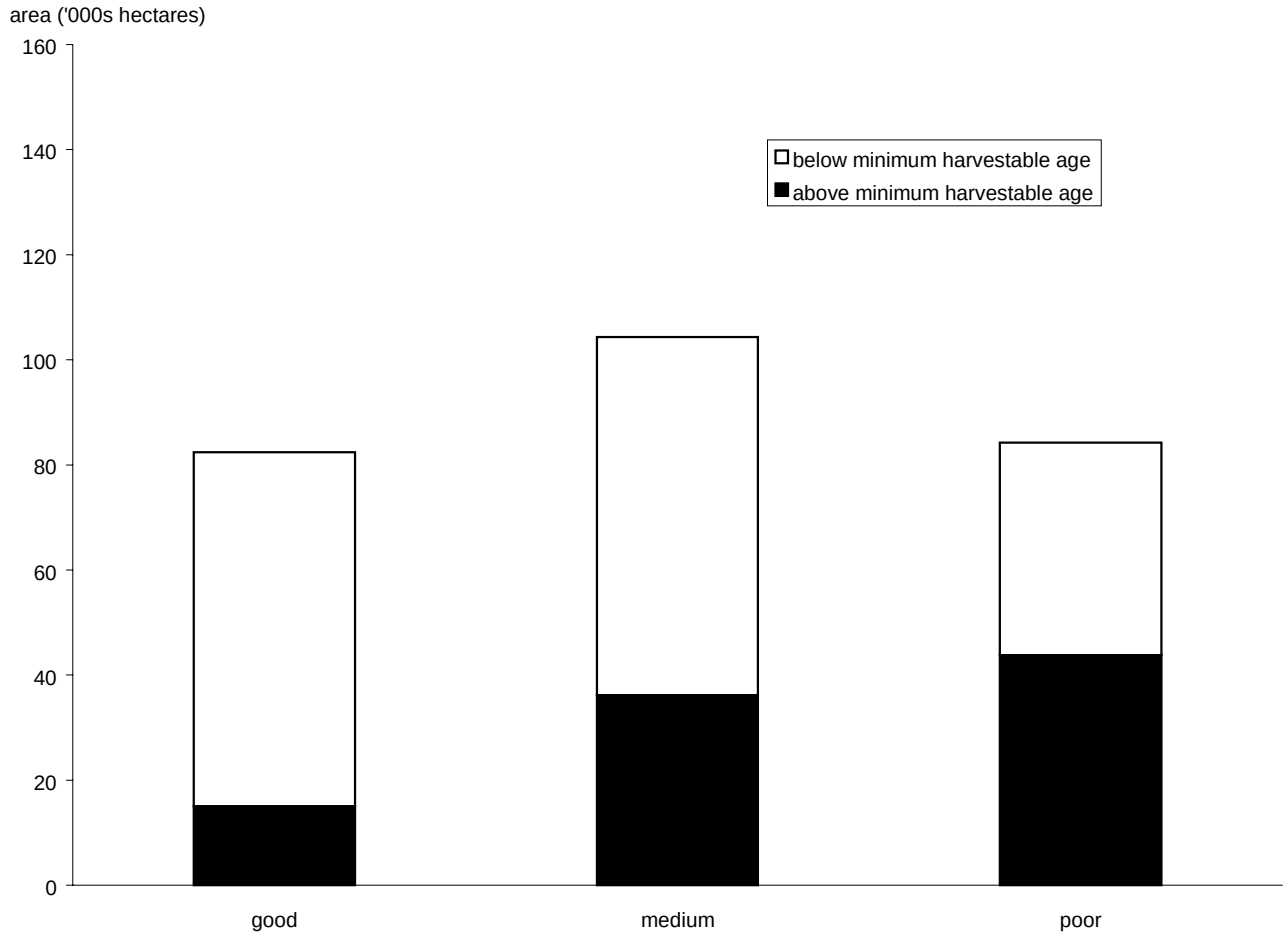


Figure 4. Area by site productivity — Fraser TSA timber harvesting land base, 1998.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age composition of forested stands in the Fraser TSA. About 21% of the total forest and about 15% of stands included in the timber harvesting land base are currently older than 250 years. A relatively large proportion of the timber harvesting land base (61%) is in stands younger than 60 years. A large proportion of this area under 60 years is expected to be available for harvest within the next 20 to 30 years. A second-growth management plan is currently being implemented by the Chilliwack Forest District staff to deal with the required shift of harvesting operations from predominantly older stands to second-growth stands.

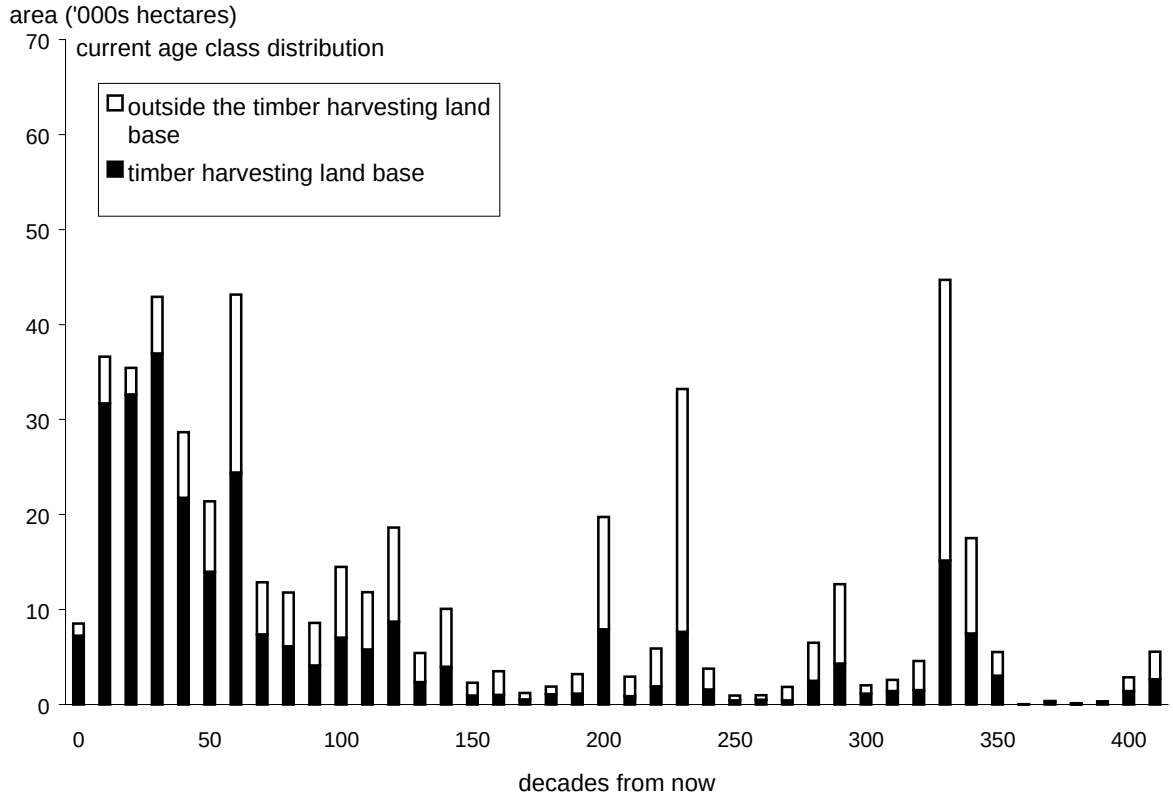


Figure 5. Current age class composition — Fraser TSA productive forest land base, 1998.

The age class distribution of forested stands excluded from the timber harvesting land base also affects the harvest forecast. In the case of the Fraser TSA, a significant portion of the total land base is covered by these stands which, although they do not contribute timber volume to the harvest forecast, do provide desired stand conditions such as old-forest attributes. Thus, the contribution of area outside the timber harvesting land base to meeting non-timber management objectives can affect how much harvesting can be conducted and the pattern of the harvesting within the Fraser TSA. A large proportion of the requirements for old-forest attributes within each landscape unit in the Fraser TSA are met by forested areas that are not part of the timber harvesting land base.

2.2 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 (for example, number of trees per area, tree diameter, tree height, 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 establish the minimum tree and log sizes that must be removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Fraser TSA analysis. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating timber volumes for all existing stands and managed deciduous stands. Prior to using the VDYP model to estimate volumes for existing stands, several adjustments were made to the forest inventory information used as input to VDYP. An inventory audit completed in 1997 indicated that the projected timber volumes for mature forest stands (older than 60 years) were generally overestimated by an average of 23%. It was also determined through the audit process that part of the reason for the overestimate was incorrect stand age and tree height information on the forest inventory maps. In order to correct the inventory before completing the timber supply analysis, adjustments based on the audit field samples were applied to the forest inventory information and stand timber volumes.

The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate timber volumes for managed coniferous stands. All stands harvested over the last 10 years, hemlock stands harvested over the last 20 years, Douglas-fir stands harvested up to 30 years ago and all stands that will be harvested in the future, are assumed to grow according to managed stand volume estimates from TIPSY.

Volume estimation and prediction is subject to a fair amount of uncertainty due to uncertainty in inventories which form the basis for estimating site productivity, and to limited experience with second-growth in British Columbia. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on the timber volume estimates*, the current timber inventory on the timber harvesting land base is approximately 60 million cubic metres. About 48 million cubic metres, or 80%, of the total, are currently merchantable; that is, older than minimum harvestable age.

Volume estimate (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. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.*

2.3 Management practices

Timber supply depends directly 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 focus of the timber supply review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Chilliwack Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species.
- Forest health and unsalvaged losses* — average annual unsalvaged losses to natural forces such as insects, fire, wind, and disease are estimated to be 18 425 cubic metres per year for the entire 250 year analysis horizon, and have been subtracted from all harvest forecasts shown in this report.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Fraser TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (3 metres in height), before adjacent stands may be harvested. In addition, in the integrated resource management zones the area in the timber harvesting land base that is below green-up conditions cannot exceed 30%. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. The scale at which cutblock adjacency requirements were applied in the base case was revised after a map study was completed. The maps produced indicated that cutblock adjacency requirements should be applied to the areas of remaining mature timber independent from the areas of young second-growth in order to properly account for adjacency problems arising from the pattern of harvesting activities in the past.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. This can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (e.g., height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

- Maintenance of deer winter range — deer winter range requirements are met by ensuring that the amount and type of forest currently identified as deer winter range within each landscape unit is always maintained in stands that are more than 100 years old and of the same forest type (a large proportion are Douglas-fir stands).
- Maintenance of spotted owl habitat within special resource management zones — spotted owl habitat requirements are that a minimum of 67% of the forested area within each special resource management zone is always in forest stands that are more than 100 years old.
- Community watersheds — within designated community watersheds a maximum of 5% of the forest area may be harvested within a 5-year period, as suggested by the *Forest Practices Code Community Watershed Guidebook*.
- Management of scenic values — maintaining important scenic values requires that visible evidence of harvesting be kept within limits in some areas of the Fraser TSA. The proportion of each scenic area that may be covered by young stands that do meet "green-up" requirements varies depending upon forest characteristics and the visual quality objectives (VQO)* for each area, but generally vary between 5% and 20%.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set at the age at which stands reach a minimum volume and a minimum average stem diameter. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit*, requirements are placed on the proportion of area in the landscape unit that must be covered by stands with old-forest characteristics (defined as older than either 140 years or 250 years old depending on the type of forest).

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

Forest cover objectives
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 and Green-up period)****.*

Landscape-level biodiversity
Maintenance of biodiversity can occur at a variety of levels. The Forest Practices Code Biodiversity Guidebook *provides objectives for 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 landscape unit provides an appropriately sized (up to 100 000 hectares) planning unit for application of landscape level biodiversity objectives.

More detailed descriptions of these management practices and the assumptions used to assess their impacts on timber supply are included in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Figure 6 displays the proportion of the timber harvesting land base subject to each of the management emphases discussed above. Note that the entire area of the timber harvesting land base is represented in each bar chart. Often several management objectives are applied to the same area for example a visual quality area may also be managed for spotted owl objectives. Thus, each bar chart below shows the total area within each forest management emphasis.

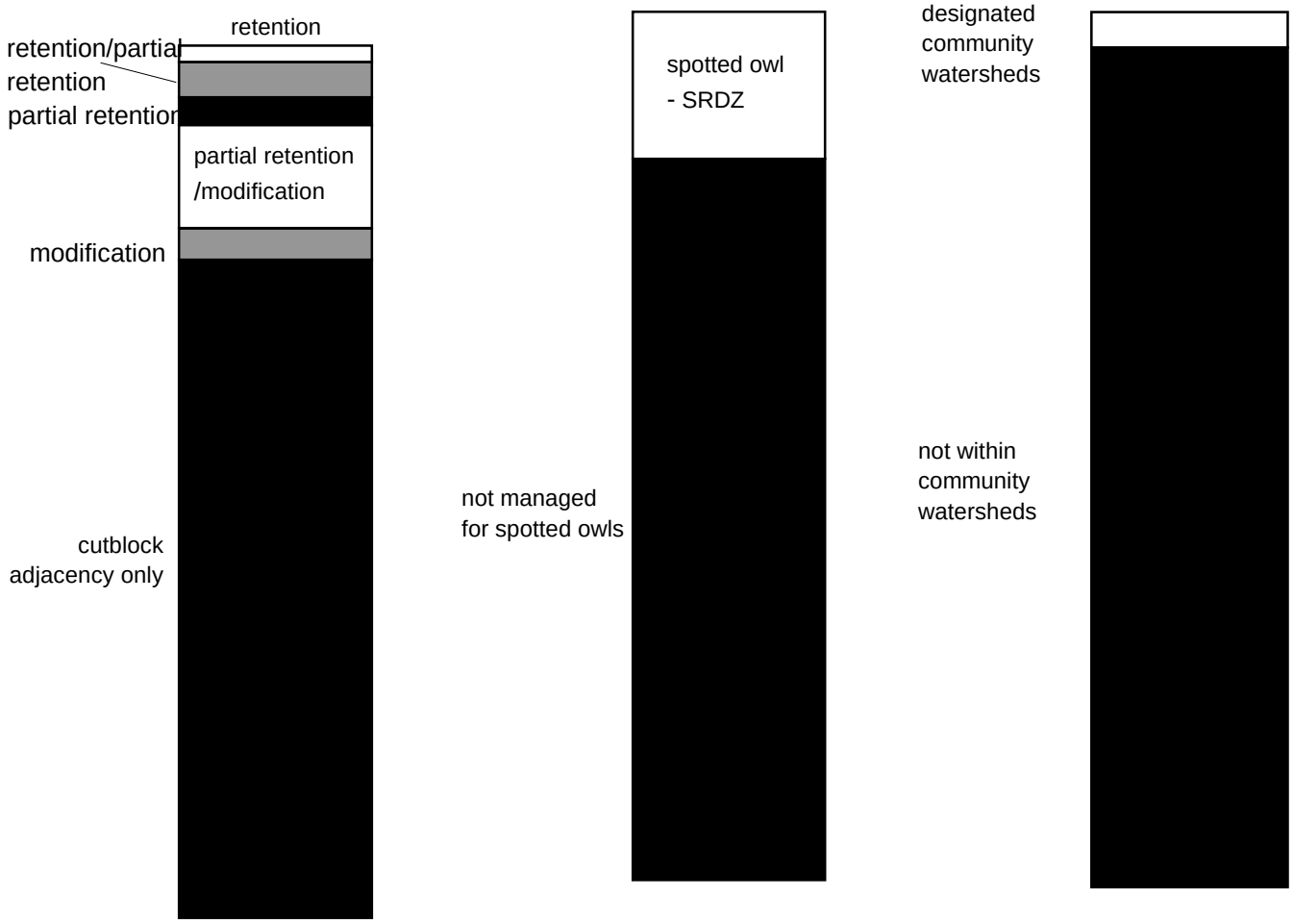


Figure 6. Forest area by management emphasis — Fraser TSA timber harvesting land base, 1998.

The total amount of area in the Fraser TSA that has visual quality objectives (VQOs) has remained constant since the last timber supply review at about 25% of the timber harvesting land base. However, the proportion of area under the more restrictive visual quality objectives (retention* and partial retention*) has decreased significantly. For example the area having a "retention" VQO (the most restrictive classification) has been reduced from about 16% to about 4% of the timber harvesting land base, in this analysis. This change represents current management and is the result of a review of all existing VQO areas in the Fraser TSA. This review was completed by the Chilliwack Forest District recreation staff in 1996 - 1997 and considered factors such as improved cutblock design, the level of use (viewer numbers) in an area, and the varying abilities of different scenic areas to "absorb" the visual effects of harvesting.

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

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

3 Timber Supply Analysis Methods

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

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

4 Results

This section presents results of the timber supply analysis for the Fraser 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 2, "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 5, "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 Fraser TSA, and should not be viewed in isolation of the sensitivity analysis.

4.1 Initial harvest forecast (before revisions used to produce the base case)

At the beginning of the timber supply review (TSR) process the Chilliwack Forest District staff identified an issue regarding operational problems with the adjacency requirements. Past harvesting practices had resulted in most of the remaining older timber being in a few concentrated areas. In order to address this issue an initial harvest forecast* was produced for the Fraser TSA based on the forest management assumptions and modelling methods outlined in the *Fraser TSA Timber Supply Analysis Data Package*. The results of this initial harvest forecast (Figure 7) indicate that the current allowable annual harvest level of 1 550 000 cubic metres cannot be maintained without causing large timber supply shortfalls in the future. Over the first 30 years of the forecast, the rate of harvest is projected to decline to a level of about 1.02 million cubic metres per year. If the rate of decline through this transition period is to be even and gradual, the rate of harvest must be immediately reduced to about 1.39 million cubic metres per year (10% lower than the current AAC) followed by further reductions of 10% in each of the next 3 decades. The steady long-term harvest level* is not reached until about 105 years from the present.

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

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

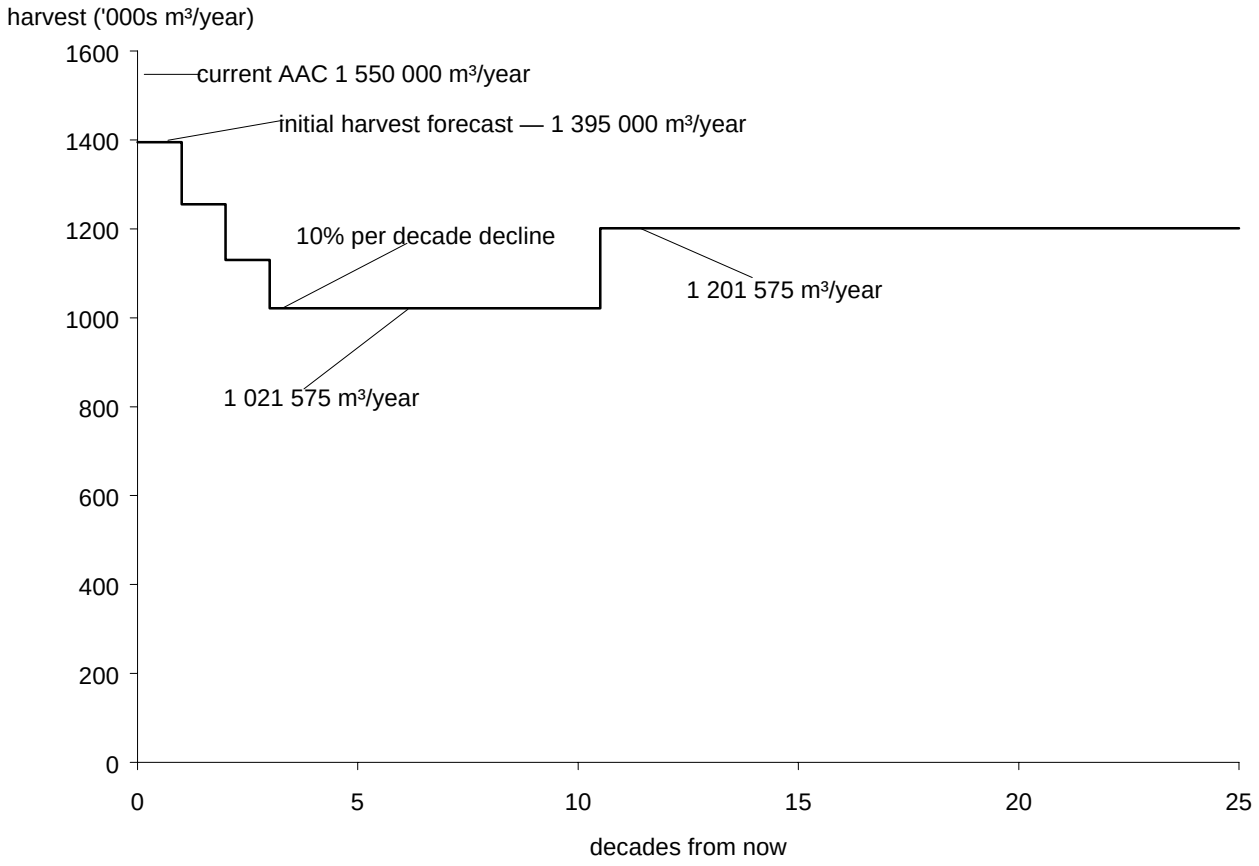


Figure 7. Initial harvest forecast for the Fraser TSA, before revising the method used to model cutblock adjacency requirements — Fraser TSA, 1998.

After completing this initial harvest forecast, the location and rate of harvest over the short term (first 25 years) was mapped to the landscape unit level and reviewed by the Chilliwack Forest District staff. This exercise indicated that in many landscape units where the remaining mature timber is concentrated in a few areas, the cutblock adjacency requirements as modelled in the initial forecast were not reflecting reality. For example, in the Pitt landscape unit (LU) there is only about 4200 hectares of remaining mature timber (of a total harvestable land base of about 17 500 hectares), most of which is located in a few relatively large patches. The rest of the harvestable forest area is mainly young second-growth stands, most of which are taller than the 3 metre green-up height required to satisfy cutblock adjacency concerns, but are not yet old enough to be harvested. As a result, the majority of

harvesting within the Pitt LU in the short term would have to be within the remaining old-growth stands. However, the way in which cutblock adjacency requirements were modelled in this forecast would allow all of the remaining mature timber in the Pitt LU to be harvested in the next 10 years without showing conflicts due to cutblock adjacency. Because most of the remaining mature timber is concentrated in relatively few large patches, rather than being evenly dispersed amongst the second-growth stands, the modelled rate of harvest would result in cutblock adjacency violations operationally. This problem was corrected by applying the cutblock adjacency requirements at a finer geographic scale, resulting in the base case harvest forecast which is discussed in Section 4.2, "Base case harvest forecast."

A significant amount of time was required to complete the above noted mapping exercise and subsequent review by the Chilliwack Forest District staff.

Therefore, the analysis was continued using the initial harvest forecast as a reference point from which to complete sensitivity analyses. As a result, all sensitivity analyses discussed in Section 5, "Timber Supply Sensitivity Analyses" use the initial harvest forecast, rather than the base case, as a starting point and a reference from which changes in the forecast are measured. However, the value of the sensitivity runs is not diminished. Sensitivity analyses are intended primarily to test the relative change (i.e., high versus low sensitivity) in the harvest forecast from changes in forest management assumptions and data. Forest management practices and modelling assumptions shown to have a significant impact on the harvest forecast will remain significant using either the "initial" or the "base case" harvest forecast as a reference.

4.2 Base case harvest forecast

Figure 8 shows the base case harvest forecast for the Fraser TSA which builds on the initial harvest forecast by using an improved method for modelling cutblock adjacency requirements over the short term.

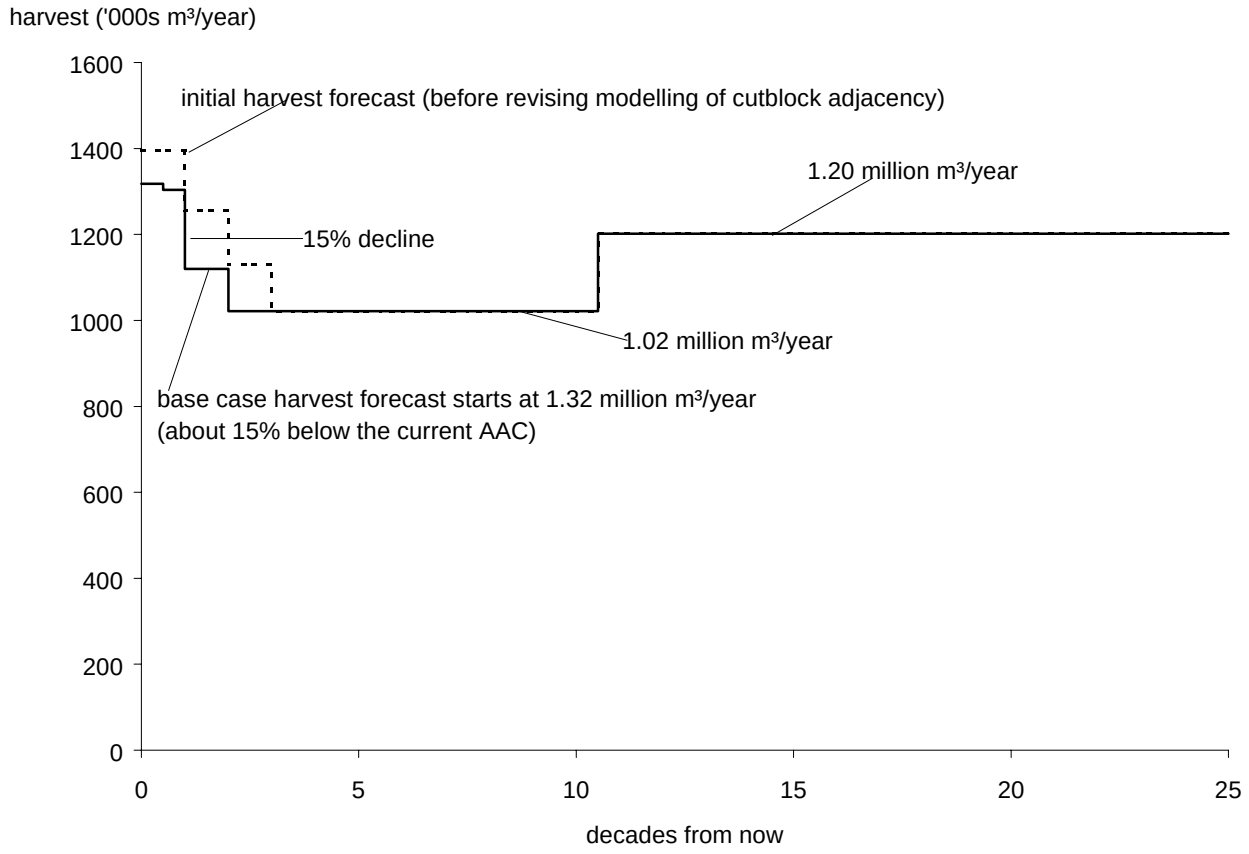


Figure 8. Base case harvest forecast for the Fraser TSA, 1998.

The results of this harvest forecast indicate that the starting harvest level must be reduced to about 1.32 million cubic metres per year in order to avoid large timber supply shortfalls in the future. This reduced rate of harvest is about 15% below the current AAC and about 5% lower than the starting harvest level in the initial harvest forecast. After the first decade, the harvest forecast declines by a further 15% and 9% per decade over the next two decades respectively to a level of about 1.02 million cubic metres per. The steady long-term harvest level is not reached until about 105 years from the present, at the

point when the harvest profile changes from harvesting mostly unmanaged stands (both existing old-growth stands and unmanaged second-growth stands) to harvesting

almost exclusively managed stands. The higher productivity of the second-growth managed stands (about 15% higher on average above the natural, unmanaged stands) allows the harvest to be increased in the long term to a steady rate of about 1.20 million cubic metres per year.

The starting harvest level and the rate of decline in the base case harvest forecast are more than previous analyses have shown. The most important factors contributing to the projected decline in the harvest forecast over the short term are:

- The transition from harvesting primarily older stands with high timber volumes (due to their old age) to younger second-growth stands with lower timber volumes.
- The significant changes in forest management that have occurred since the last analysis, including the creation of several large parks, completion of a spotted owl management plan, and implementation of Forest Practices Code guidelines.
- An inventory audit completed in 1997 indicated that the inventory information for the Fraser TSA overestimated the volume of timber in mature stands (60 years and older) by an average of 23%. The overestimate has been corrected for this analysis, which has resulted in a reduced volume of existing mature timber.

The rate of decline in the harvest forecast in the base case is moderated by the following changes that have occurred since the last timber supply review for the Fraser TSA:

- about 15 000 hectares of forest incorrectly excluded from the last timber supply review (existing plantations incorrectly labelled as low-site productivity) have been included in the timber harvesting land base;
- more stands of marginal timber quality and some areas that can be harvested with aerial systems have been included in the timber harvesting land base;
- the addition of deciduous stands to the timber harvesting land base;
- changes in visual quality objectives;
- reduced minimum harvestable ages for higher productivity stands; and
- the harvest flow policy used in this analysis attempts to equalize the rate of decline in both the short- and medium-term. A slower rate of decline would result in a larger reduction in the first decade.

Several criteria are used to define the harvest flow used in the base case harvest forecast. The first is to keep the initial rate of harvest as close to the current level as possible without causing substantial timber supply shortages in the future. Crucial time periods in the harvest forecast for the Fraser TSA are 10 to 20 years from the present and again in 80 to 100 years from the present (when the poorer than average stands that are harvested in the short term are harvested for a second time). In order to avoid timber supply shortfalls at these points in time the initial rate of harvest must be reduced and a portion of the existing stock of mature timber reserved for later harvest. The harvest flow used in the base case also assumes that any reductions made to the current rate of harvest should be about the same as the reductions that are projected to be required in future decades. The long-term harvest level is defined as the highest rate of harvest that can be maintained in perpetuity while maintaining the total timber growing stock* at a relatively even level (see Figure 9). These basic criteria were applied when generating all harvest forecasts in this report.

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

4 Results

About 10 000 hectares of the timber harvesting land base consists of alder and maple-leading stands. All of these stands that were included in the land base are estimated to have more than the required minimum volume per hectare. However, a significant proportion of these stands may have problems with poor tree form, or may have a high value for riparian or wildlife areas that would prevent harvesting. For these reasons, and because historically only a marginal amount of harvesting in deciduous stands has occurred in the Fraser TSA, there is concern that the actual amount of harvesting that will be carried out in these stands may be less than estimated in the base case. The sensitivity of the harvest forecast to varying the contribution from deciduous stands is examined in Section 5.14, "Sensitivity of the harvest forecast to the contribution of timber from deciduous-leading stands."

Figure 9 shows the projected level of growing stock over time for the base case harvest forecast. The total growing stock on the timber harvesting land base declines slightly from the present level (about 59 million cubic metres) over the first 40 years, as the existing mature stands are removed and replaced with younger managed stands. As the managed stands mature, the growing stock is projected to increase above the present level and stabilize at about 66 million cubic metres. A constant growing stock serves as an indicator that a particular harvest level can be sustained over the long term. Conversely, a declining growing stock would indicate that the long-term harvest level exceeds the productive capability of the land.

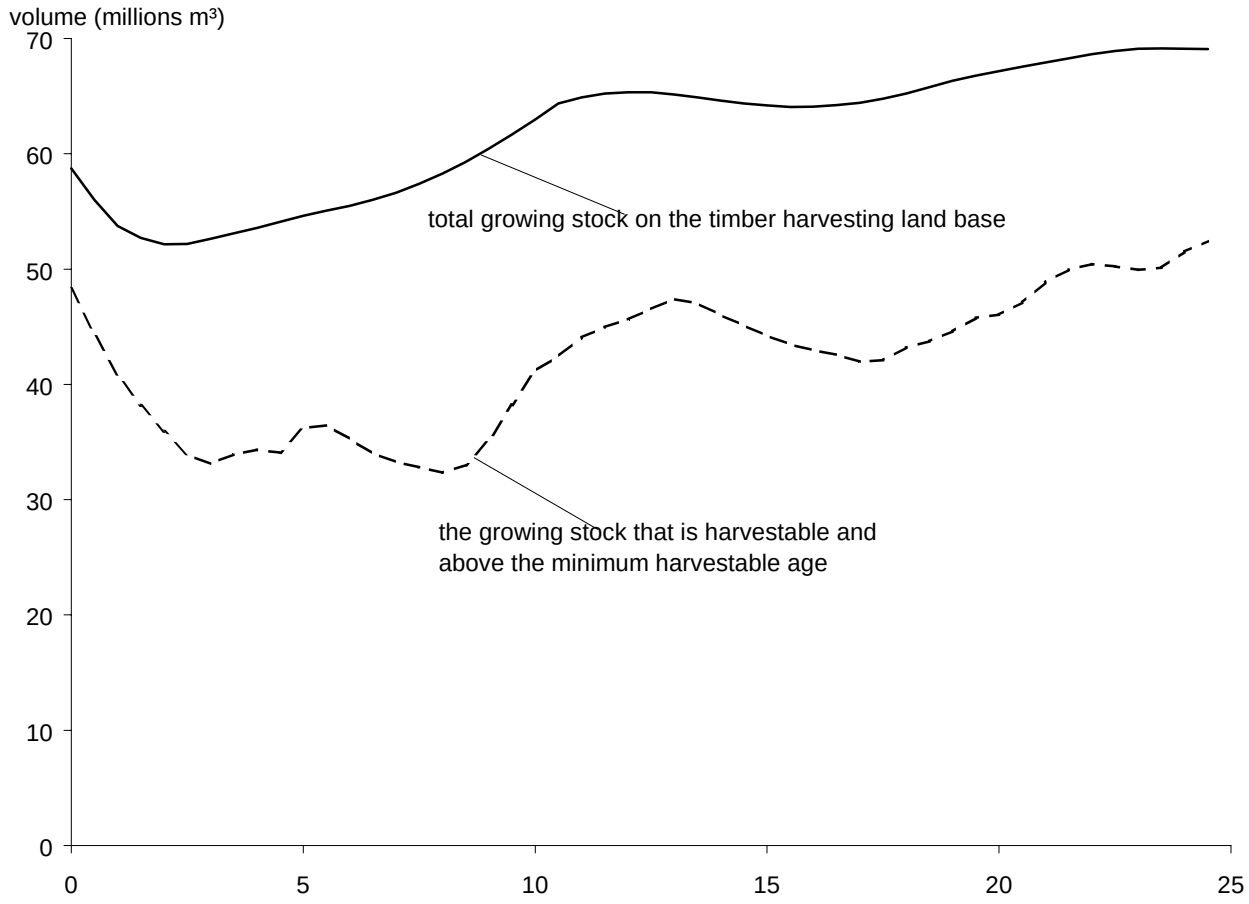


Figure 9. Changes in timber growing stock over time — Fraser TSA base case, 1998.

4.3 Area, average volume, and average age harvested

Figure 10 shows the annual area harvested over the next 250 years for the base case harvest. The average annual area harvested is relatively constant at just under 2500 hectares per year. Fluctuations around the average, which range from a maximum of about 3000 hectares per year in the short term to just over 2000 hectares per year in about 80 years are due to the declining rate of harvest in the short term and changes in the site productivity and ages of stands harvested over time.

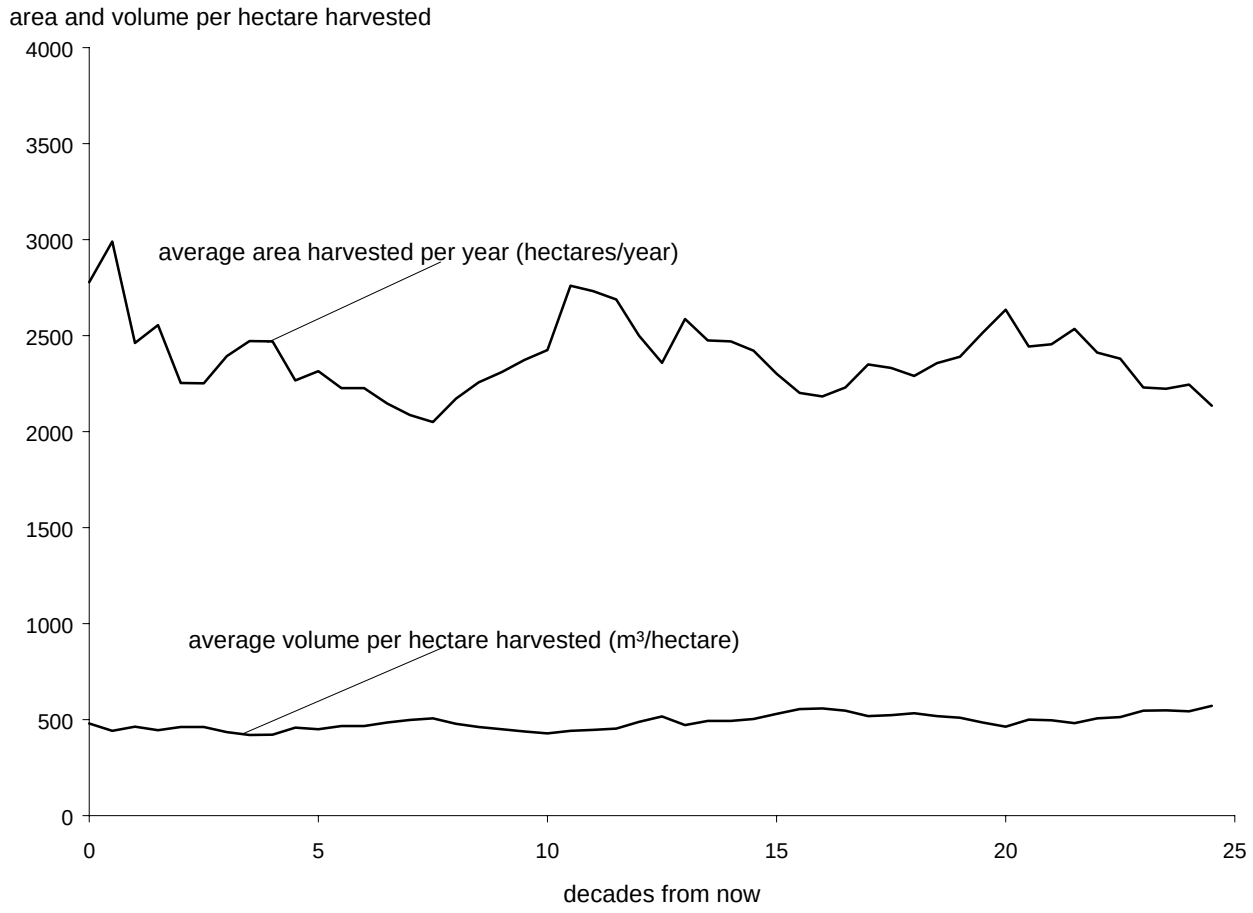


Figure 10. Average area harvested annually and average volume per hectare harvested over time — Fraser TSA base case, 1998.

Figure 10 also shows the average volume per hectare harvested over time. Historically, old-growth stands have yielded higher timber volumes per hectare than are expected from second-growth stands due to their age. However, the majority of the remaining mature timber in the Fraser TSA is on poorer than average growing sites. In the short term, the majority of the harvest comes from the remaining areas of mature timber that are lower than average in terms of productivity but, due to their older age have adequate timber volumes to make them economical for harvest. In the medium and long term younger stands will be harvested, but because of higher average site productivity will provide timber volumes similar to the remaining old growth. Thus the average timber volume per hectare harvested is not expected to change significantly over time.

4 Results

Figure 11 tracks the change in the average age at which stands are harvested under the base case harvest forecast. Average harvested ages decline rapidly over the first 30 to 40 years from an average of just under 300 years old to an average of about 100 years old. The rapid decline in the average age of harvested stands over the short term and the rapidly increasing dependence of the harvest forecast on second-growth harvesting is consistent with the second-growth management strategy being implemented by the Chilliwack Forest District. Over the long term, the average age of stands harvested remains fairly constant, fluctuating around an average of about 120 years old. The minimum harvestable ages used in the analysis are, on average, lower than 120 years old, however, stands are not always harvested at the minimum harvestable age due to a number of factors. When a large proportion of the timber harvesting land base is of a similar age, it cannot all be harvested when it reaches the minimum harvestable age if stability in the harvest forecast is to be maintained over time. Forest cover objectives applied to maintain biodiversity, provide wildlife habitat, protect water quality or protect scenic values also result in the actual harvest ages being extended.

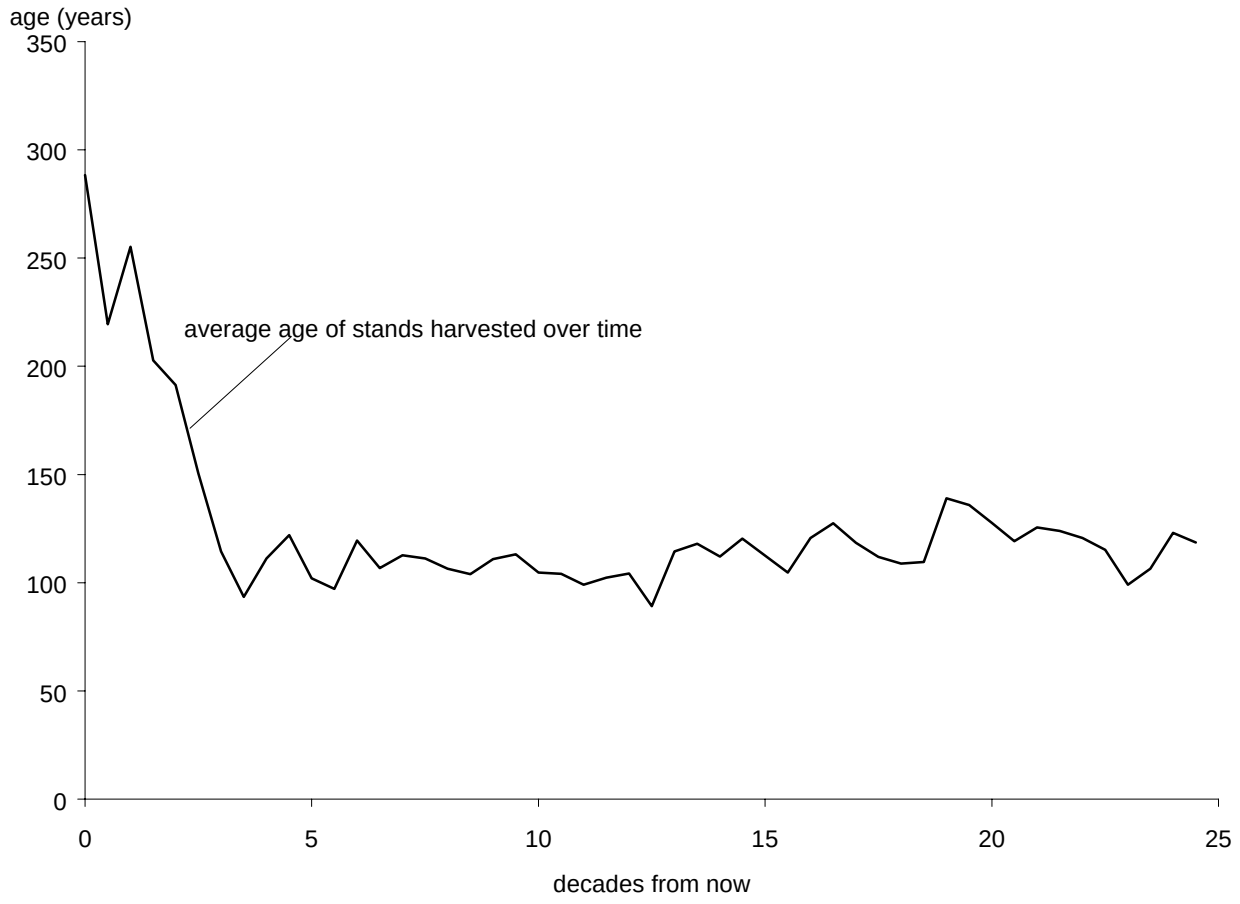


Figure 11. Average age of stands harvested over time — Fraser TSA base case, 1998.

4.4 Age class composition over time

The charts in Figure 12 show how the age composition of the productive forest within the Fraser TSA land base would change over the next 250 years under the base case harvest forecast.

The current age class distribution shows a relatively high proportion of young stands on the timber harvesting land base, due to the historical harvest levels in the Fraser TSA. The age class distribution is not well balanced, with large areas of second-growth timber concentrated in single age groups. Over the first 100 years as harvesting moves predominantly into the large areas of second growth, the age class distribution is projected to become more balanced with relatively even areas in stands up to 100 years old. In the long term, the portion of the timber harvesting land base that is more than 100 years old is predominantly poor-growing sites (with extended minimum harvestable ages) or areas with restrictive forest cover objectives (i.e., areas being maintained for biodiversity purposes, spotted owl habitat and visual quality areas).

Overall, about 21% of the total forested area in the Fraser TSA is currently in old-growth stands. About 15% of the timber harvesting land base is currently in old-growth stands. Over the first 50 years, the total area of old-growth forest is projected to increase to about 31% (assuming that excluded forest areas are not lost to natural events such as large fires). At all times, there is sufficient area of old growth to meet the Forest Practices Code biodiversity guidelines, both in terms of the amount of area required and the variety of ecosystems represented.

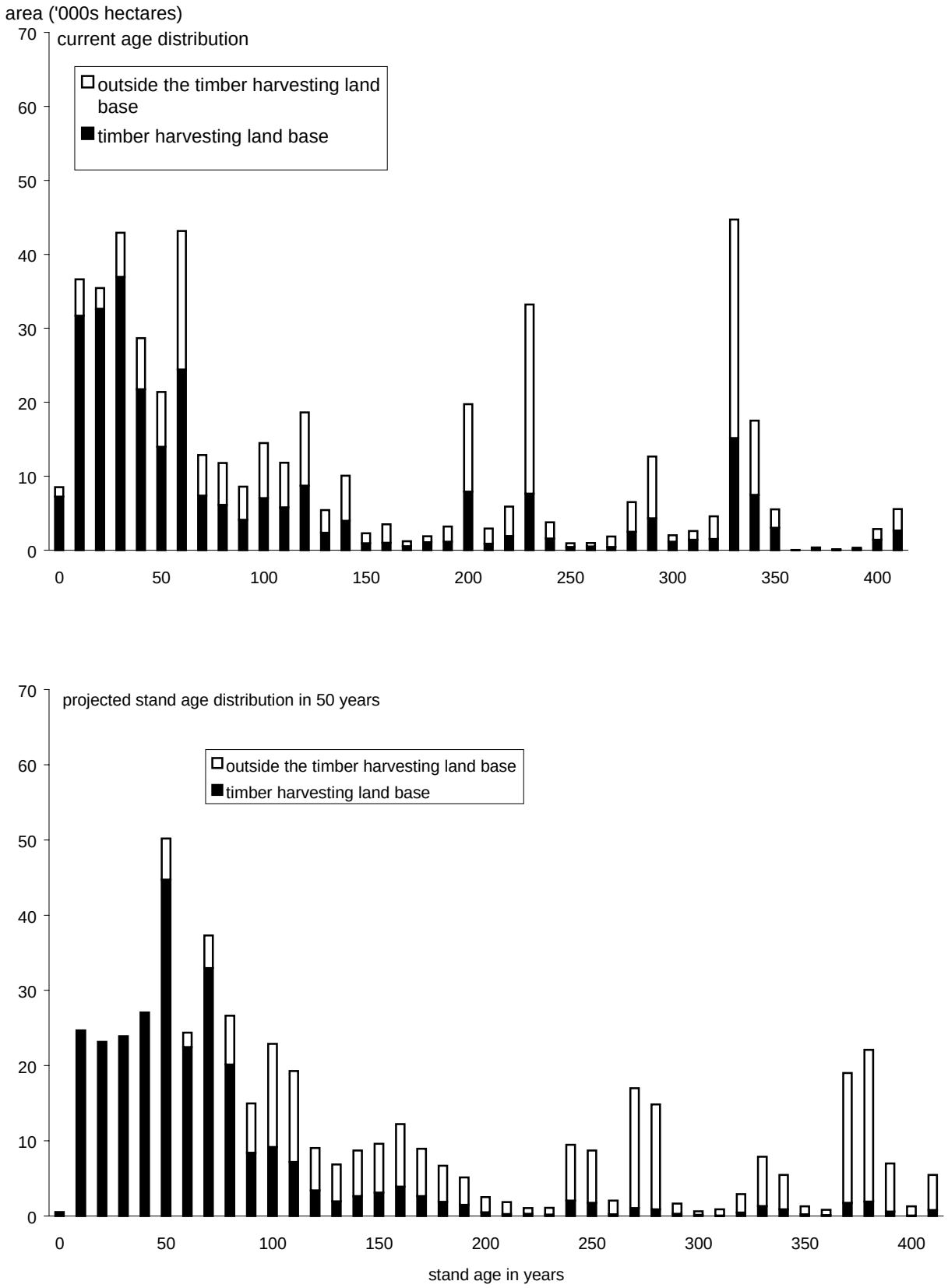


Figure 12. Changes in age composition on productive forest land base over time — Fraser TSA base case, 1998.

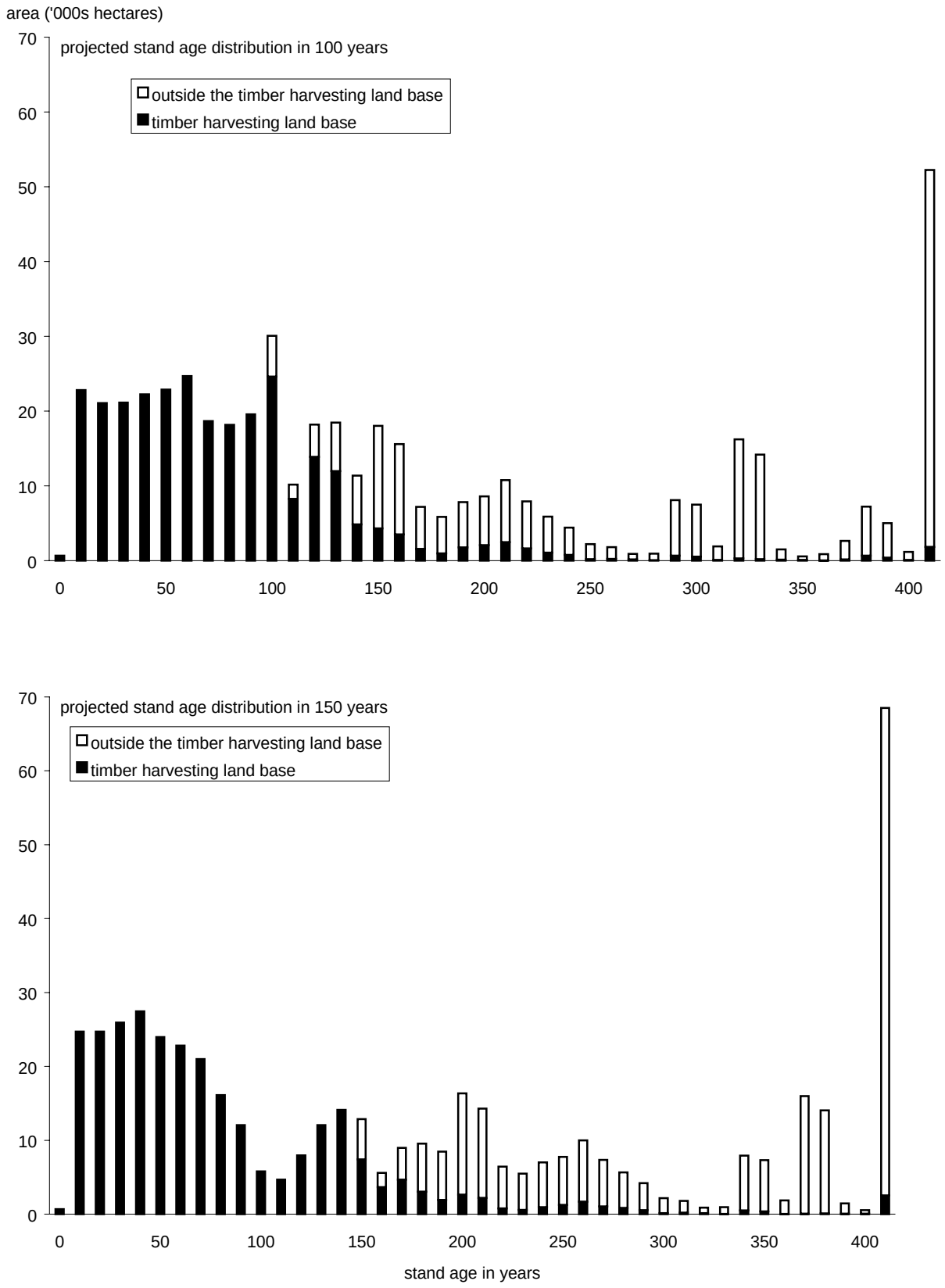


Figure 12. Changes in age composition on productive forest land base over time — Fraser TSA base case, 1998.

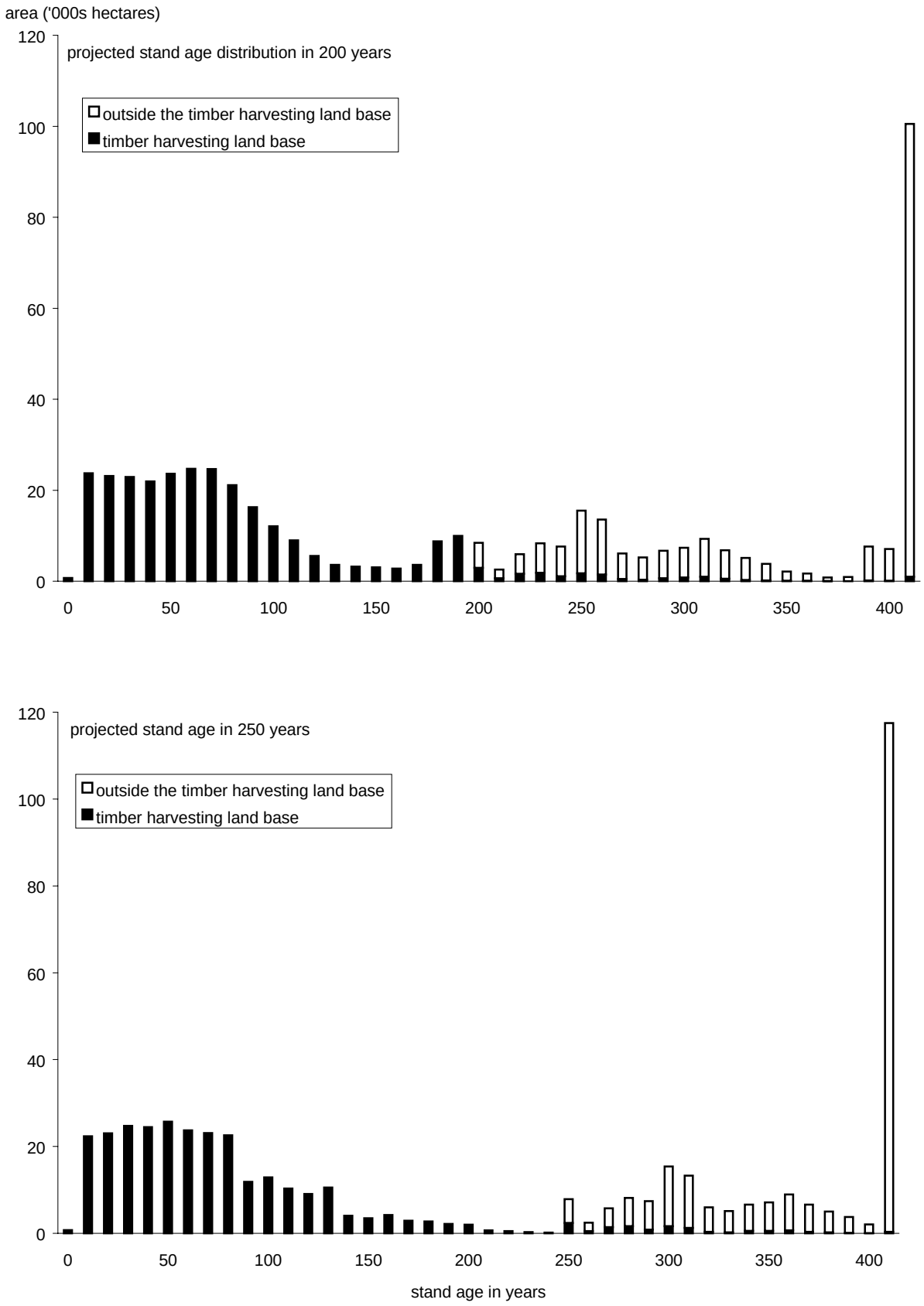


Figure 12. Changes in age composition on productive forest land base over time — Fraser TSA base case, 1998.

(please note scale change on this page)

5 Timber Supply Sensitivity Analyses

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

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

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

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

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

In this section, results of several sensitivity analyses are discussed. As discussed in Section 4.1, "Initial harvest forecast (before revisions used to produce the base case)" the initial harvest forecast differs from the base case in the scale at which cutblock adjacency guidelines were modelled. Because the need to change the scale at which the cutblock adjacency guidelines were modelled was discovered after the sensitivity analyses were complete, all sensitivity analyses (except for the alternative harvest flows) discussed in this section use the initial harvest forecast, rather than the base case, as a reference point from which changes in the forecast are

measured. However, the value of the sensitivity analyses is not diminished. Sensitivity analyses are intended primarily to test the relative change (i.e., high versus low sensitivity) in the harvest forecast from changes in forest management assumptions and data. For most of the sensitivity analyses shown, the per cent change in the harvest level from the initial harvest forecast would remain the same for a sensitivity that used the base case as a reference point. In other words if a sensitivity analysis showed a 10% increase or decrease in the starting harvest level using the initial harvest forecast as a reference point, there would also be a 10% change in the starting harvest level in the base case harvest forecast. Overall any forest management practices and modelling assumptions shown to have a significant impact on the harvest forecast will remain significant using either the "initial" or the "base case" harvest forecast as a reference.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows over time

The base case forecast was defined using criteria including managing the rate of decline in harvests from the current level, avoiding large and abrupt harvest shortfalls, and maintaining a fairly constant growing stock level over the long term. The last of these criteria is linked to maintaining the productivity of forest land, and is therefore an indicator of sustainability. The other criteria are attempts to avoid both excessive changes from decade to decade, and significant timber shortages in the future, either of which might limit future options. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short- and medium-term rates of harvest.

Figures 13 and 14 show harvest flow alternatives to the base case harvest forecast. It is not possible to start the harvest level higher than that in the base case. Figure 13 shows an alternative harvest flow that starts at the highest rate of harvest that can be achieved if no decreases in the timber supply are allowed at any time; this is commonly referred to as a non-declining forecast. The rate of harvest must be immediately reduced by about 30% if no declines are allowed in the forecast in the future. In producing this non-declining harvest forecast it was determined that even if the rate of harvest is set immediately at the steady long-term harvest level it cannot be maintained throughout the 250 year period modelled. Significant timber supply shortfalls occur during the transition period (time 0 to 100 years) when harvesting operations must change from primarily older stands to younger second-growth stands.

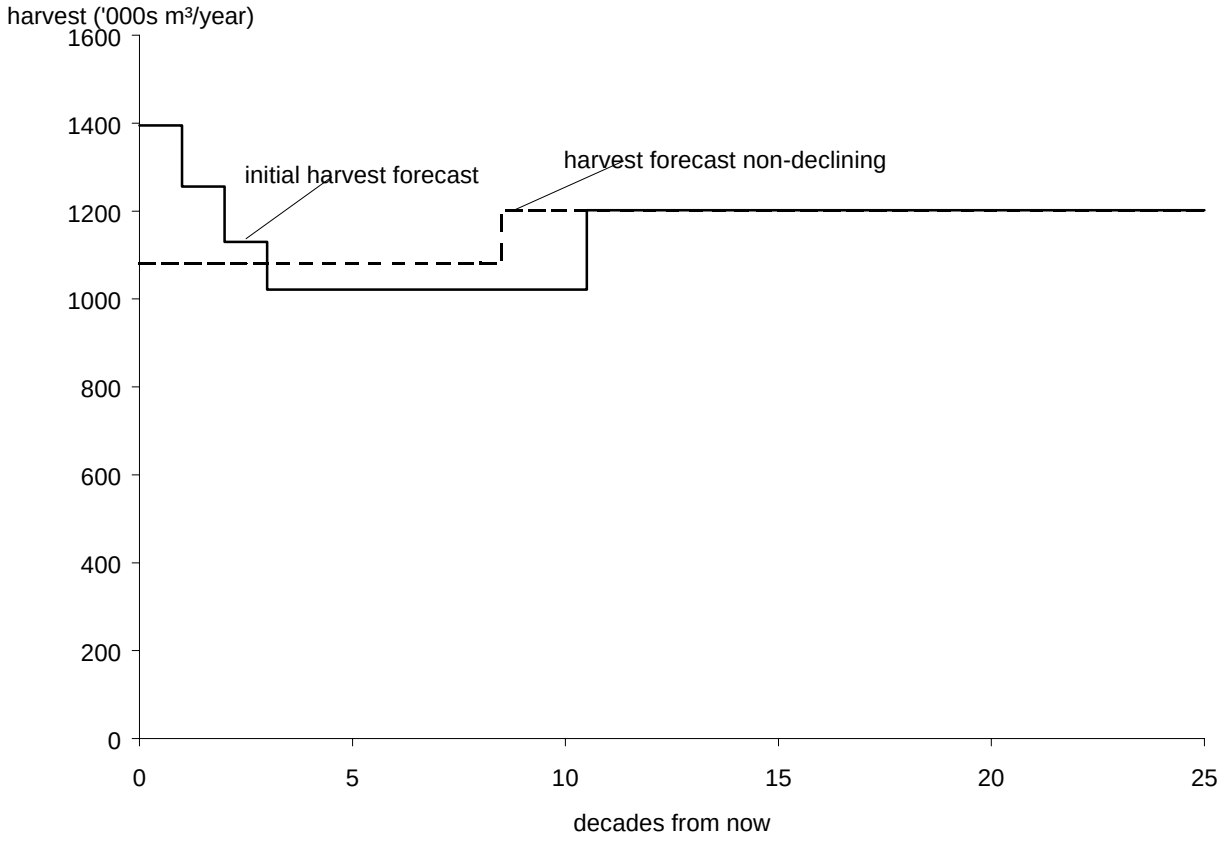


Figure 13. Harvest forecast using alternative short-term harvest flow policies — Fraser TSA, 1998.

Figure 14 shows the changes to the base case harvest forecast that result from attempting to increase the rate of harvest to the steady long-term level at an earlier point in time (80 years versus 105 years). Increasing the rate of harvest to the long-term level before there is a sufficient proportion of mature managed stands (of higher average productivity than the natural stands they replace) available for harvest results in a significant timber supply shortfall later in the forecast. The magnitude of the shortfall (represented by the area between the two lines between years 165 to about 185) is about equal to the amount of additional timber harvested earlier in the forecast (between years 80 to 105).

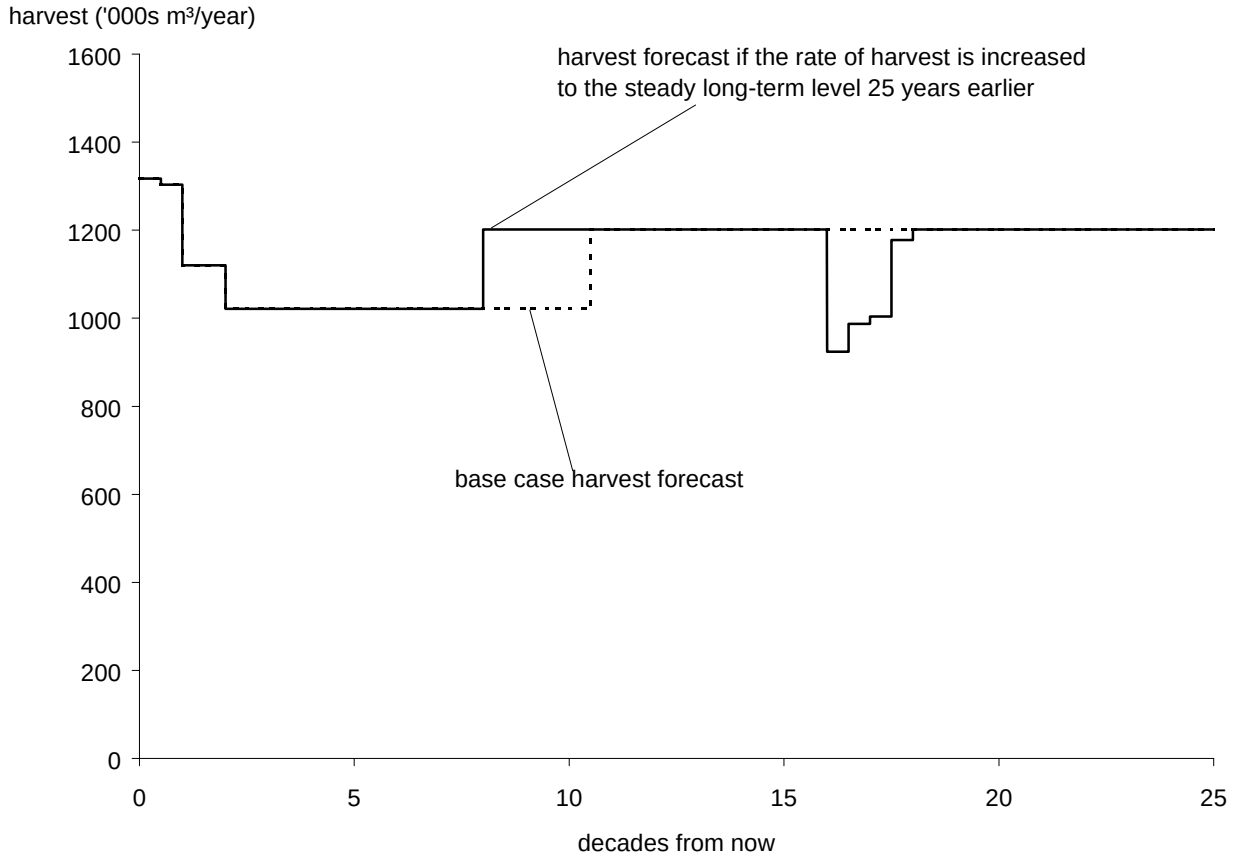


Figure 14. Harvest forecast if the term of the dip below the steady long-term harvest level is reduced — Fraser TSA, 1998.

Regardless of the harvest flow policy applied, the steady long-term harvest level is unchanged as it is determined by the size and estimated productivity of the timber harvesting land base and the management practices applied to that land base.

5.2 Uncertainty in the estimated area of the timber harvesting land base

Uncertainty in the estimated 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. Given that the Lower Mainland Protected Areas Strategy and the Spotted Owl Management Plan land use decisions have already been made for the Fraser TSA, future changes in the size of the timber harvesting land base are most likely to be due to fluctuations in timber prices (and therefore the value of marginal stands) and changes in harvesting/milling technology. The stands that would move into or out of the timber harvesting land base due to these changes would be predominantly poorer quality growing sites given that the better growing sites have already been proven to be harvestable. Figure 15 shows the effect on the harvest forecast of reducing the area of poor quality growing sites included in the timber harvesting land base by 30% this is equivalent to reducing the overall size of the timber harvesting land base by about 10%. The starting harvest level must be reduced by about 4% and the subsequent rate of decline increased by 4% from the rate used in the initial harvest forecast. The long-term harvest level is reduced by about 6%. In addition, there is a large shortfall of available timber between 70 and 80 years from now. Figure 15 also shows the effect on the harvest forecast of increasing the area of poor quality growing sites included in the timber harvesting land base by 30%. The initial rate of harvest can be increased by about 3%, and the rate of decline in the second and third decades of the forecast can be reduced by about 3%. The change in the estimated long-term rate of harvest is about 6%. Whether the land base is increased or decreased, the per cent effect on the harvest forecast is less than the percentage change in the timber harvesting land base. The main reason for this less than proportional effect is that the area being added or removed from the timber harvesting land base is less than average in terms of site productivity and, therefore, has a lower volume per hectare than the average stand in the timber harvesting land base.

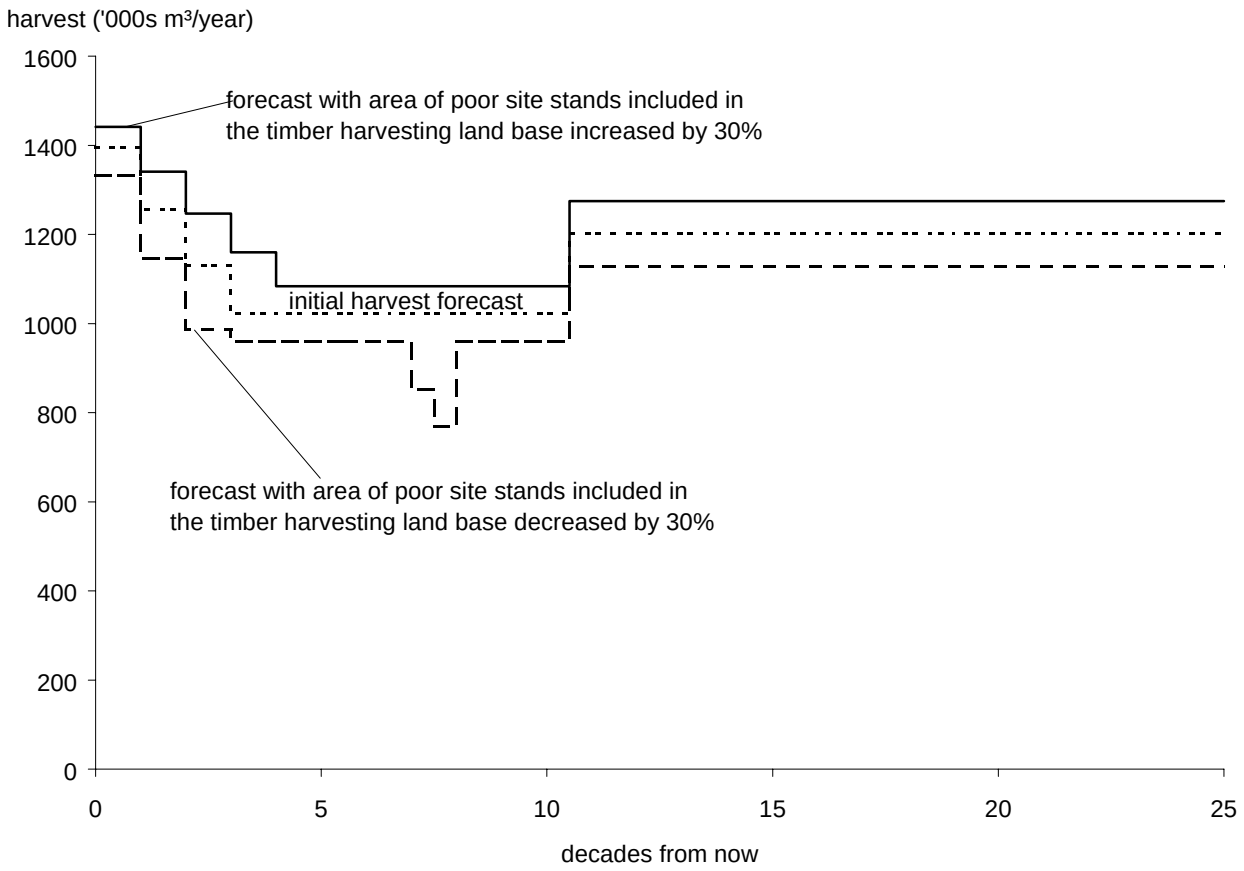


Figure 15. Harvest forecast if the area of poor productivity stands in the timber harvesting land base is increased or decreased by 30% — Fraser TSA, 1998.

5.3 Uncertainty in timber volume estimates for existing unmanaged stands

Timber volume estimates for existing unmanaged stands are subject to uncertainty due to factors such as the forest inventory information used to estimate timber volumes (i.e., estimated tree heights and stand ages) and the statistical process used to develop the equations used to predict forest growth and yield. The effect that uncertainty in timber volume estimates for unmanaged stands can have on the harvest forecast is shown in Figure 16.

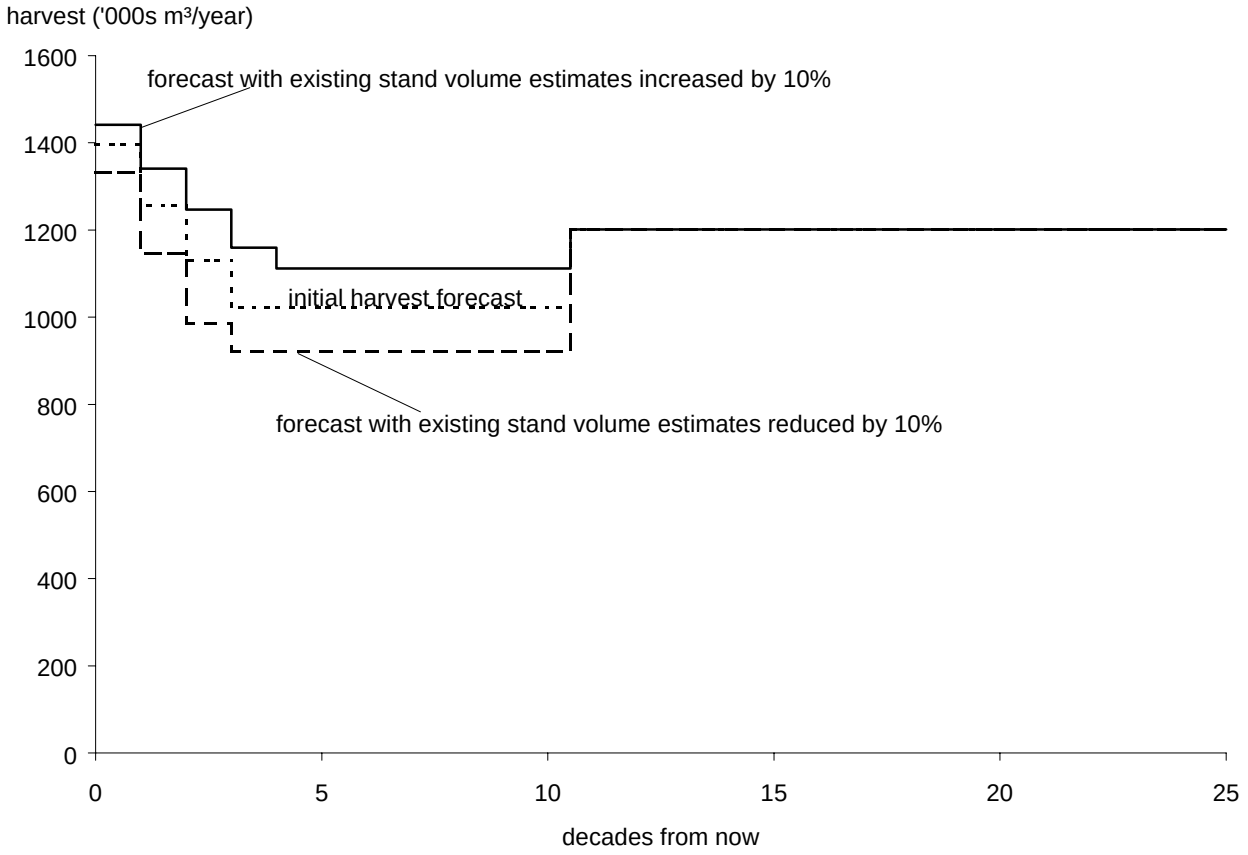


Figure 16. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands by 10% — Fraser TSA. 1998.

Figure 16 shows the effect on the harvest forecast of reducing the estimated timber volumes from unmanaged stands by 10%. The starting harvest level is reduced to about 4% below the starting harvest level in the initial harvest forecast and the rate of decline to the medium-term harvest level is 4% per decade higher. In the medium term, the rate of harvest is allowed to decline to a level that is 10% lower than the medium-term level in the initial harvest forecast. The reason for this is that the medium-term harvest level is for the most part dependent on harvesting existing unmanaged stands. In the long term, harvesting occurs almost exclusively in managed stands and is therefore not affected by changes in timber volume estimates for existing unmanaged stands.

Figure 16 also shows the effect on the harvest forecast of increasing the timber volume estimates for unmanaged stands by 10%. The starting harvest level is increased by about 3% from the starting harvest level in the initial harvest forecast and the rate of decline in the harvest forecast in decades 2 and 3 is about 3% lower. The rate of harvest in the medium term is increased by about 10% and the long-term harvest level remains unchanged.

5.4 Uncertainty in timber volume estimates for regenerated (managed) stands

Uncertainty in volume estimates for managed stands exists for all of the same reasons listed for existing unmanaged stands (inaccuracies in the forest inventory

and the growth and yield models), but also because of

the limited experience and data that is available for regenerated managed stands in B.C. There is also uncertainty around how the productivity of older stands may change after being harvested and regenerated as a managed stand. This issue is examined in Section 5.9, "Uncertainty in the estimated productivity of old-growth stands after being harvested and regenerated as managed stands." The following sensitivity analysis examines the effect of just changing the estimated timber volumes for regenerated stands.

The effect on the harvest forecast of reducing the estimated timber volume from regenerated stands by 20% is shown in Figure 17. This change has no effect on the harvest forecast in the short term, but the medium- and long-term harvest forecasts are significantly affected. In the medium term when the proportion of harvesting second-growth stands is increasing steadily, the rate of harvest is 8% lower than in the initial harvest forecast. In the long term, the steady long-term harvest level is about 20% lower than in the initial harvest forecast; the same per cent as the change in the estimated timber volume from regenerated stands.

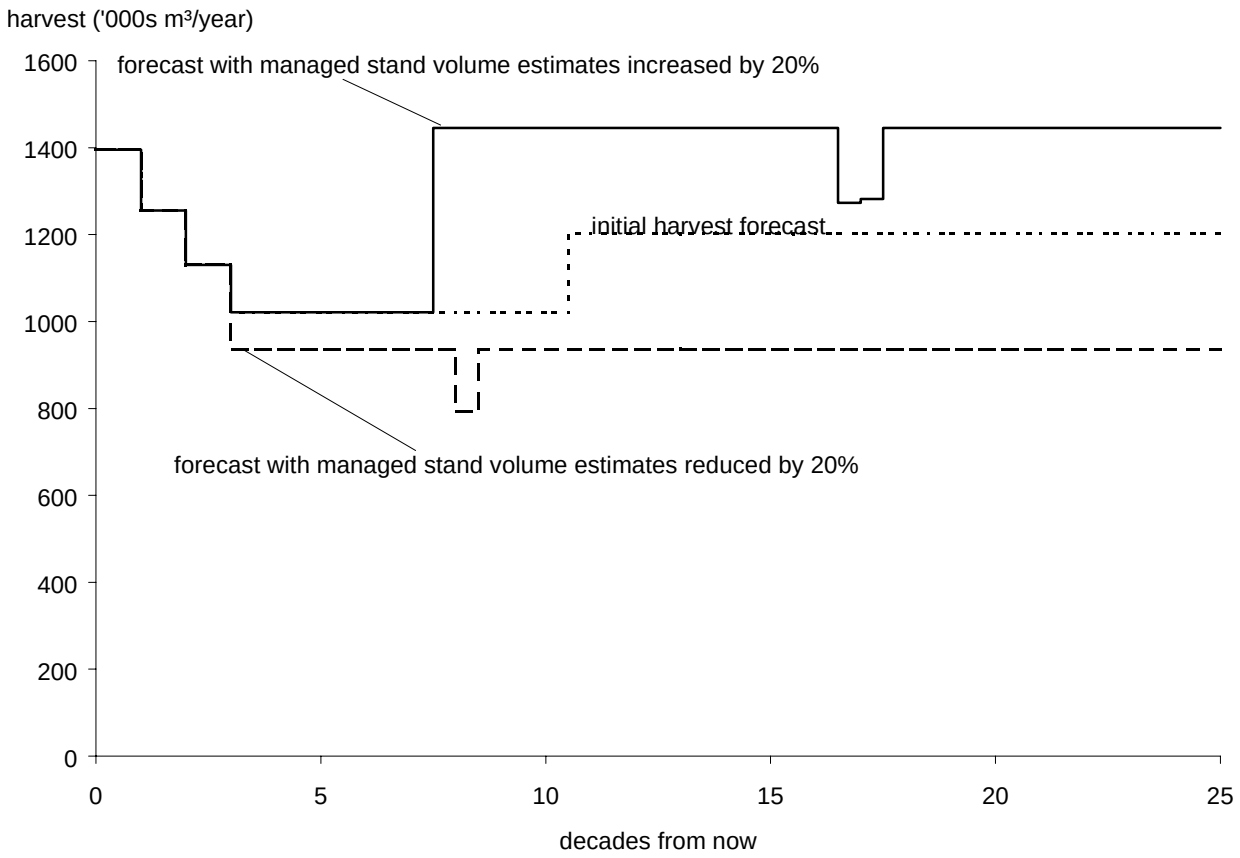


Figure 17. Harvest forecasts with regenerated stand timber volume estimates increased and decreased by 20% — Fraser TSA, 1998.

Figure 17 also shows the effect on the harvest forecast of increasing timber volume estimates for regenerated stands by 20%. Again, the short-term harvest level is unaffected by this change. In the medium term, the rate of harvest is able to increase to a steady long-term harvest level 30 years earlier than in the initial harvest forecast due to the increased timber volumes from the area of regenerated stands harvested at that point in time. In

the long term the rate of harvest is increased by about 20%.

5.5 Uncertainty in estimated minimum harvestable ages

Minimum harvestable ages assumed in this analysis range from 50 years for Douglas-fir stands on good-growing sites to 170 years for hemlock/balsam stands on poor-growing sites. In general, minimum harvestable ages used in this analysis are based upon the earliest age at which a stand is expected to achieve a timber volume of 350 cubic metres per hectare and an average stem diameter of 30 centimetres. Uncertainty in minimum harvestable ages can arise from uncertainty in the productivity of stands (which determines how soon the stand will achieve the required size and volume) or uncertainty in the required stand conditions (i.e., perhaps a lower timber volume or smaller average tree diameter could be used). The sensitivity of the harvest forecast to changes in minimum harvestable ages was tested by increasing and decreasing the minimum harvestable ages used in the initial harvest forecast by 10%. A per cent change in the minimum harvestable ages was used instead of an absolute change (i.e., plus/minus 10 years for all stands) because of the wide range of minimum harvestable ages used in the analysis. An absolute change that is insignificant to a minimum harvestable age of 170 years may be an unrealistically large change to a minimum harvestable age of 50 years.

The effect on the harvest forecast of increasing all minimum harvestable ages used in the analysis by 10% is shown in Figure 18. The starting harvest level is reduced to about 2% lower than the starting harvest level in the initial harvest forecast and the rate of decline to the medium term is increased by about 2% per decade. These changes in the short-term harvest forecast are due to the decreased availability of stands for harvesting in the short term, which also reduces flexibility for dealing with periodic timber supply shortfalls in the future. However, the long-term harvest level is not affected by the change in minimum harvestable ages. Over the long term the timber supply is more stable and harvesting down to the minimum harvestable age is not always necessary. In fact, the average age of stands harvested is often older than the minimum harvest due to factors such as forest cover objectives and the desire to have a stable flow of timber from the Fraser TSA over the long term. Figure 11 in Section 4, "Results", aids in the understanding of this point. The average age of stands harvested over time (shown in Figure 11) is relatively constant at about 120 years which is older than most of the minimum harvestable ages used in the analysis.

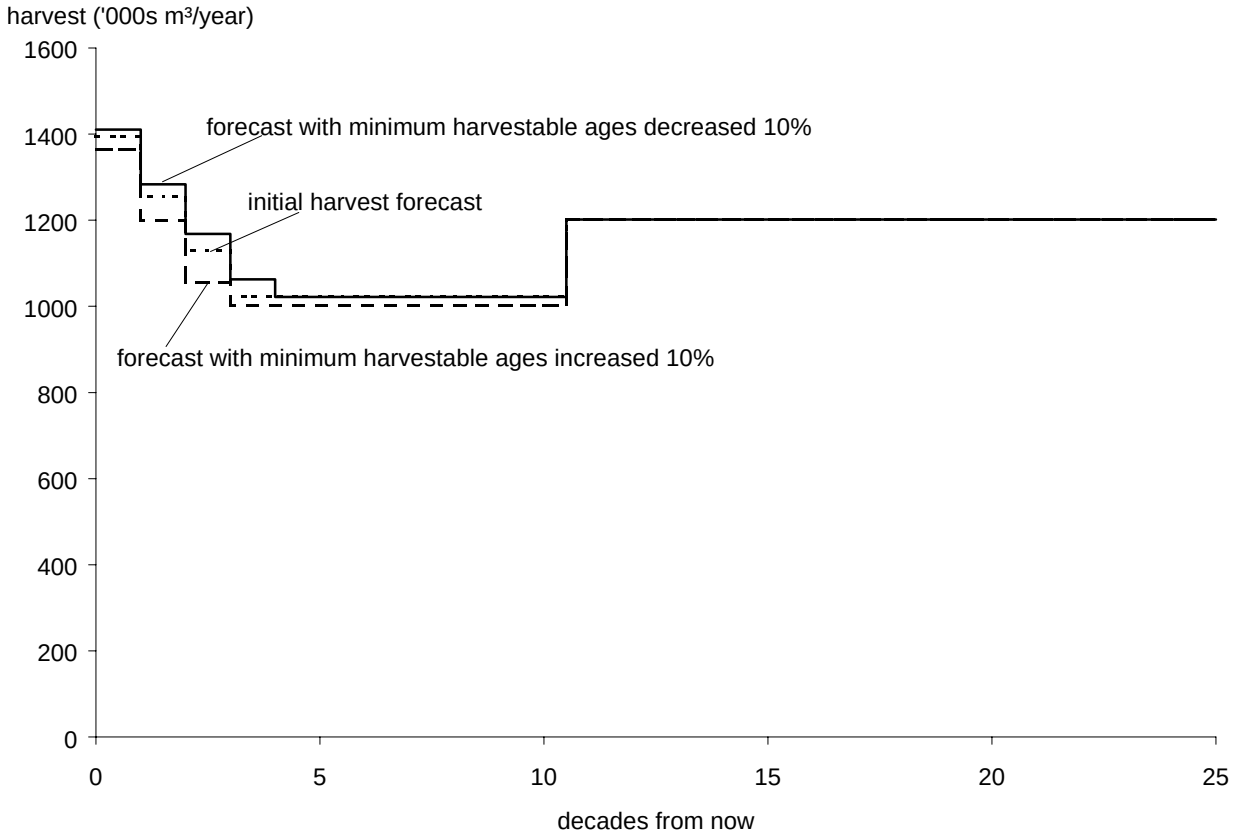


Figure 18. The effect on the harvest forecast of increasing and decreasing minimum harvestable ages by 10% — Fraser TSA, 1998.

The effect on the harvest forecast of decreasing all minimum harvestable ages by 10% is also shown in Figure 18. The starting harvest level is increased by only 1% and the rate of decline to the medium term is the same as in the initial harvest forecast. The slight increase in the starting harvest level is due to the increased availability of stands for harvesting in the short term and a reduction in the area of harvestable stands that must be reserved in order to avoid future shortfalls while ensuring a gradual rate of decline in the harvest.

5.6 Uncertainty in green–up ages

Forest cover requirements for visual quality and cutblock adjacency that were applied in this analysis involve estimates of when stands will reach green-up conditions, expressed as the desired height of a stand. Green-up age, the age at which a stand exhibits the desired condition, is determined using a growth and yield model. The green-up period includes both the green-up age and the regeneration delay*, or time taken to establish a stand after harvesting. Uncertainty about the green-up period arises because the desired green-up condition (i.e., tree height) may either exceed or fall short of actual needs, the period of stand establishment may vary, and uncertainties about growth and yield may mean that stands will reach the desired condition sooner or later than estimated.

Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

In the initial harvest forecast green-up requirements for cutblock adjacency are assumed to be met at a stand height of 3 metres, which is estimated to be achieved in about 12 years on average. Using the relatively broad landscape unit level modelling approach used in the initial harvest forecast, varying the required green-up height between 2 metres and 4.5 metres (or about 9 to 15 growing years) had no effect on the harvest forecast.

For visually sensitive areas, green-up requirements are assumed to be met at a stand height of about 5 metres, which is estimated to be achieved in about 16 years on average. Figure 19 shows the effect on the harvest forecast of increasing the green-up requirement to a stand height of about 6 metres. The starting harvest level is about 2% lower than in the initial harvest forecast and the rate of decline over the first 30 years is increased by about 2% from the rate of decline used in the initial harvest forecast. Figure 19 also shows the effect on the harvest forecast of reducing the green-up requirement to a stand height of about 4 metres. This change has little effect on the harvest forecast, resulting in a change in the starting harvest level of only 1% followed by a 1% slower rate of decline over the first 30 years of the forecast.

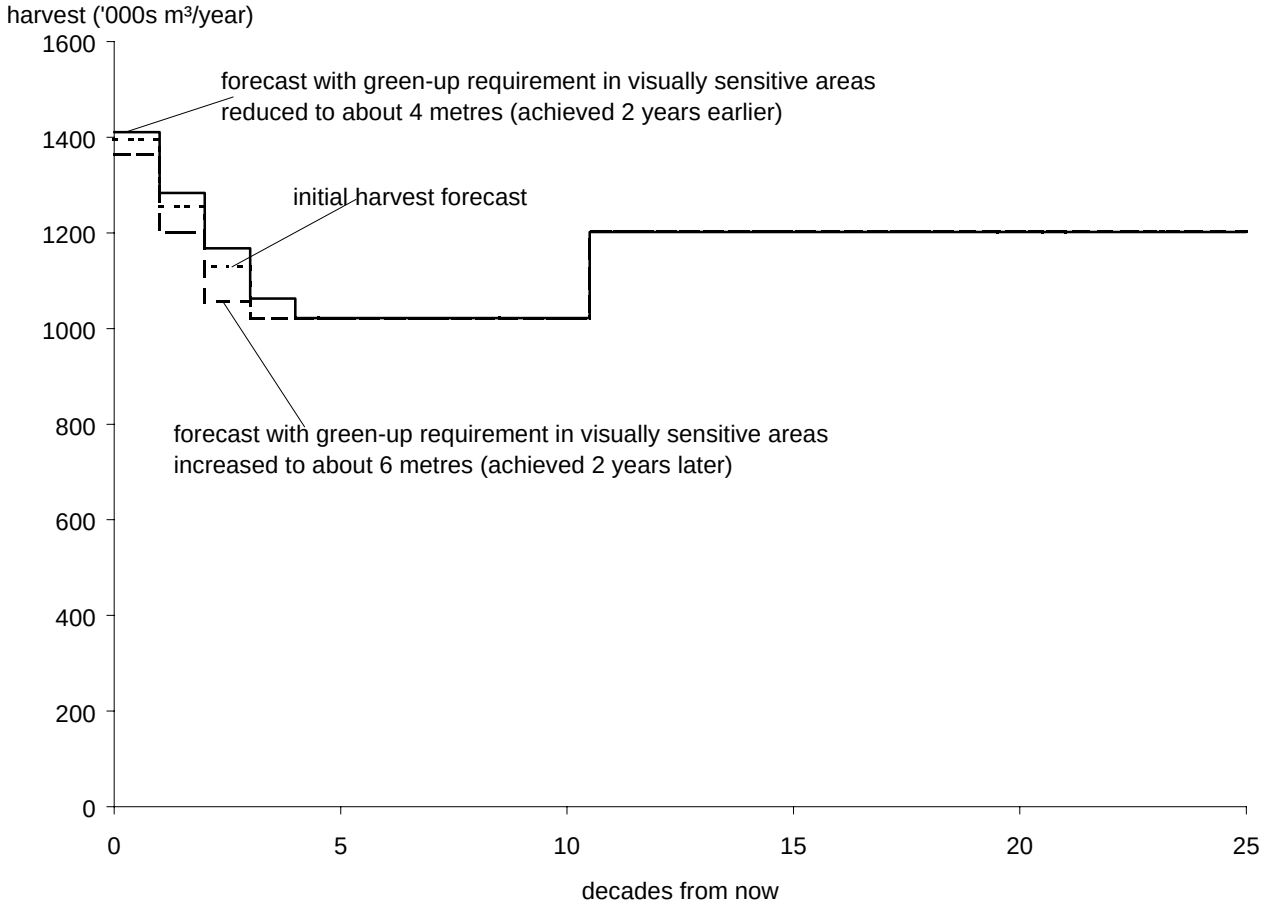


Figure 19. Harvest forecast if green-up requirements in visually sensitive areas are increased or decreased — Fraser TSA, 1998.

5.7 Uncertainty in cutblock adjacency objectives

To ensure that harvesting related disturbance does not become overly concentrated in an area the Forest Practices Code requires that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. To model this requirement, it was assumed that a maximum of 30% of the timber harvesting land base within each landscape unit could be covered by stands that have not met the green-up condition (minimum height of 3 metres). This requirement was applied to all areas within each landscape unit that were not already subject to more restrictive forest cover requirements (such as visually sensitive areas).

One area of uncertainty is around the maximum percentage of the forest that can be in stands less than the 3 metres green-up height required before adjacent blocks can be harvested.

Applied at the relatively broad landscape unit level as was done in the initial harvest forecast, no effect on the harvest forecast is noted until this maximum per cent area that does meet green-up is decreased to about 20% (shown in Figure 20). However, at the 20% level the starting harvest level must be decreased by 17% immediately.

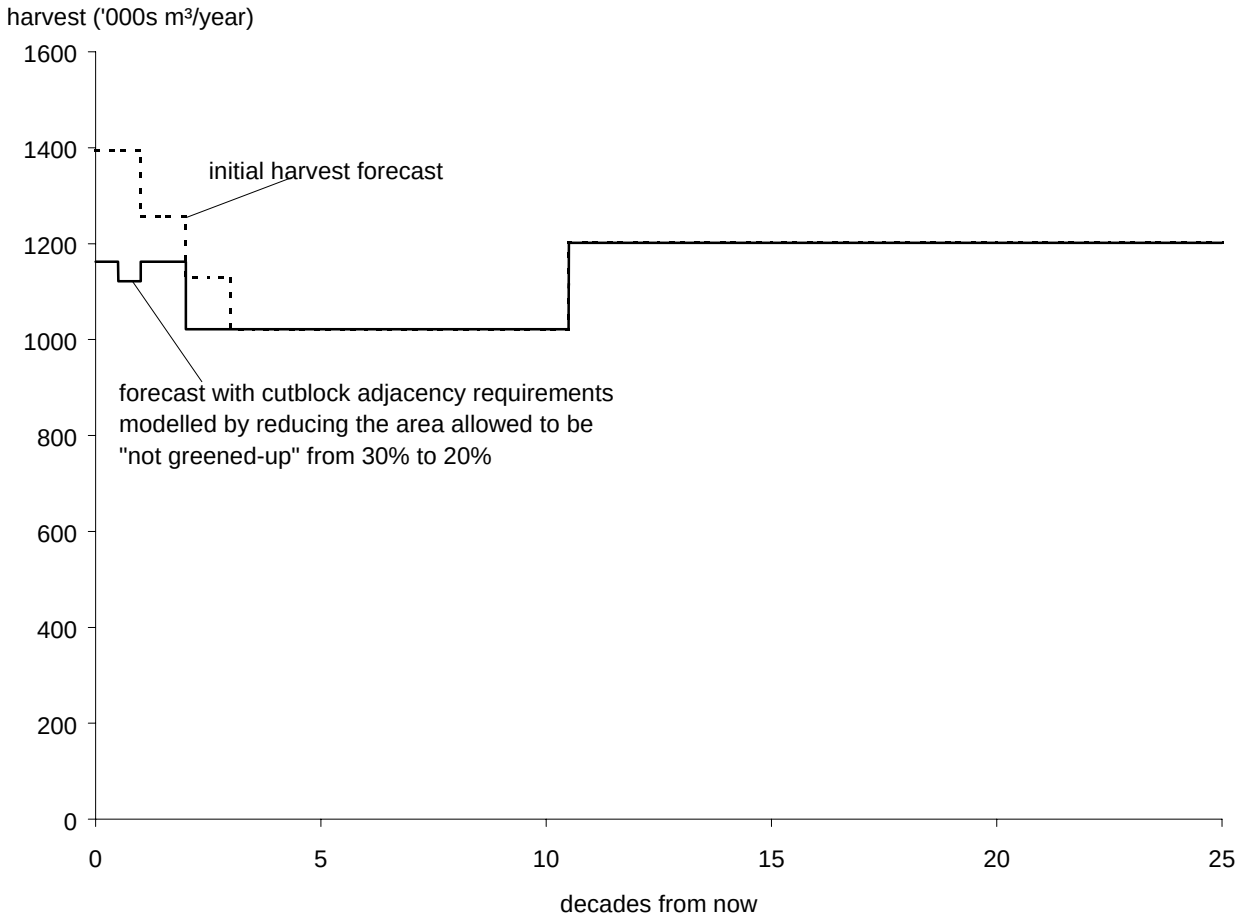


Figure 20. Sensitivity of the harvest forecast to changes in the maximum per cent area that does not meet green-up requirements used to model cutblock adjacency — Fraser TSA, 1998.

5.8 Uncertainty in the approach used to model biodiversity guidelines

Forest Practices Code guidelines for maintaining biodiversity specify a minimum percentage of the forest within each biogeoclimatic variant within each landscape unit that should be retained in old forest. The percentage that should be maintained depends on the biodiversity emphasis assigned to the landscape unit. Areas with a low-biodiversity emphasis require less old forest and allow a longer time period before the guideline must be met than in areas with a high biodiversity emphasis. A general target is to have the following proportions of the timber harvesting land base under each biodiversity emphasis: low biodiversity — 45%; intermediate biodiversity — 45%; high biodiversity — 10%. In the Fraser TSA, only draft-biodiversity emphases have been established for each landscape unit. Therefore, the modelling approach used in the initial harvest forecast was to calculate the average, area weighted proportion of old growth that would be retained across the Fraser TSA and apply the same average requirement to each landscape unit. However, it is possible that applying old-growth retention requirements individually to each landscape unit, depending on the biodiversity emphasis for each landscape unit, may have a different effect on the harvest forecast. The sensitivity of the harvest forecast to this issue was tested by applying old-growth requirements to each landscape unit individually, based on the draft-biodiversity emphasis assigned to each landscape unit. This change had no effect on the harvest forecast in either the short or long term. This result was not unexpected because the proportion of the timber harvesting land base under each draft-biodiversity emphasis falls fairly close to the target of 45% low, 45% medium and 10% high biodiversity.

5.9 Uncertainty in the estimated productivity of old-growth stands after being harvested and regenerated as managed stands

Estimating the future productivity of the existing mature forest is difficult in that 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 assessments 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, future site productivity estimates may be incorrect due to invalid tree height estimates due to top breakage or overestimated ages. In the Fraser TSA, only a small proportion of older stands remain due to the long harvesting history in the area. The results of recent research suggests that the estimated future productivity of these remaining old-growth stands may be significantly underestimated. This research has focused on comparing the measured productivity of existing young regenerated stands with the estimated future productivity of old-growth stands growing on ecologically identical sites. The measured productivity of the regenerated stands is generally higher than the estimated future productivity of the old-growth stands. The site productivity adjustments suggested by this recent research are based on the maximum potential site productivity that might be achieved under perfect conditions while, in the field, regeneration and subsequent growth does not always occur under perfect conditions due to competition from brush or overstocking. Therefore, many stands will not

reach the maximum potential productivity suggested by research. To test the sensitivity of the harvest forecast to this issue the estimated site indices* (an estimate of forest productivity) for all old-growth stands in the current forest inventory were increased to the maximum potential level. Timber supply analysis inputs affected by changes in estimated future forest productivity (managed stand volume estimates, green-up ages and minimum harvestable ages) were then recalculated based on the increased average site productivity. The overall change in site indices on the mature stands (greater than 140 years) is about seven metres. This results in regenerated stand volume estimates that are about 15% higher, the green-up age is reduced one year and the minimum harvestable ages change by a range of 0 to 80 years. The effect of this change on the harvest forecast is shown in Figure 21. The short-term harvest forecast is increased by 2% over the short-term harvest level shown for the initial harvest forecast.

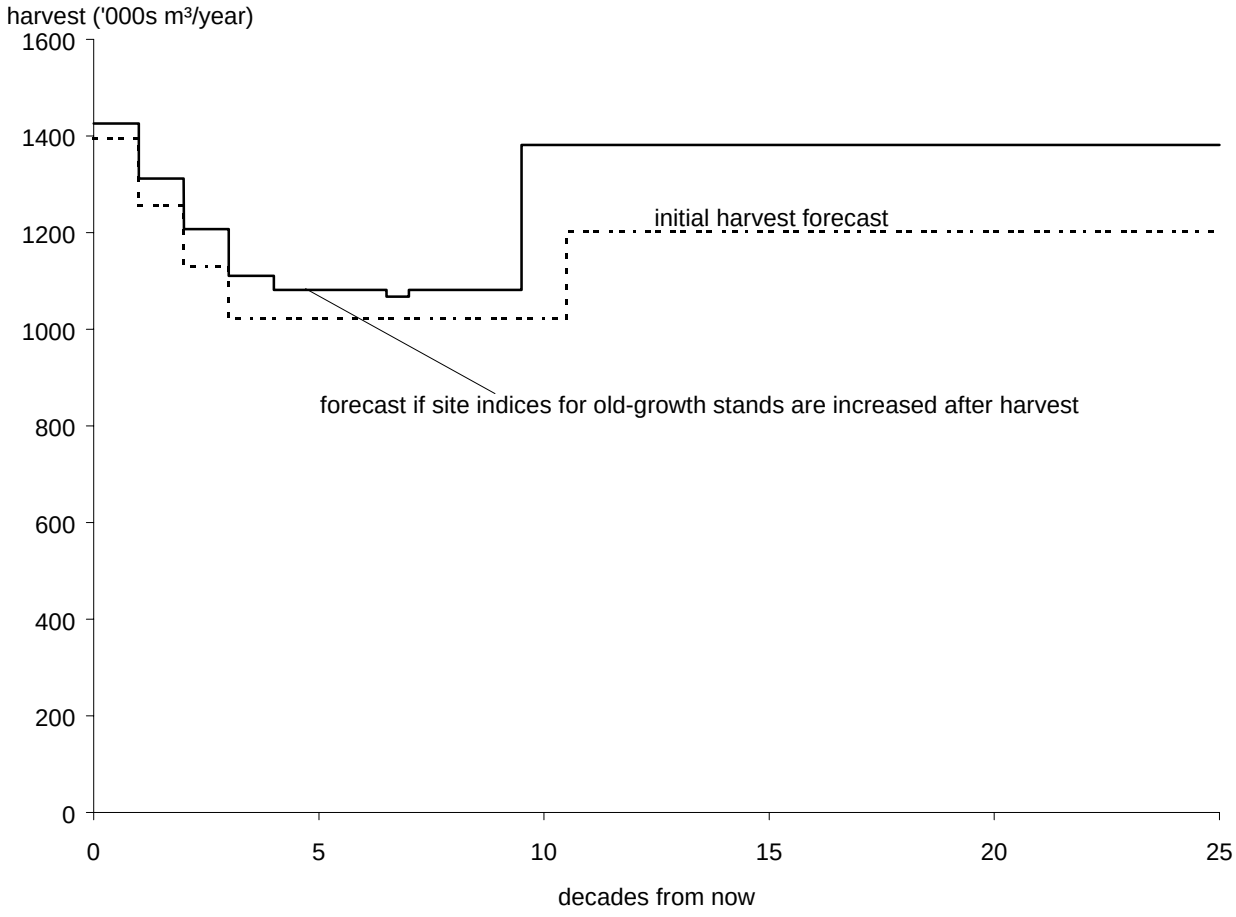


Figure 21. Harvest forecast if the future site productivity estimated for the remaining old-growth stands is increased to the maximum suggested by recent research — Fraser TSA, 1998.

Site index
A measure of site productivity. Site indices in British Columbia are based on heights of free-growing dominant trees of a given species at a reference age of 50 years above breast height. Site index curves have been developed for British Columbia's major commercial tree species.

This increase in the short-term harvest level is due to the earlier minimum harvestable ages and green-up ages, see Sections 5.6, "Uncertainty in green-up ages" and 5.5, "Uncertainty in estimated minimum harvestable ages." The steady long-term harvest level is increased by about 15% over the initial harvest forecast, due to the increased managed stand volumes.

The effect on the harvest forecast of the above changes must be viewed cautiously. As noted above, the research that has been done on the issue of future site productivity of older stands has thus far provided an estimate of the maximum potential productivity that we might achieve from the future forest. How well most regenerated stands are performing relative to this theoretical maximum is still unclear. To illustrate this issue, the forest inventory information for the Fraser TSA was divided into three species and age groupings — 0 to 40 years, 40 to 140 years and older than 140 years for each species. After adjusting the site productivity estimates for the stands older than 140 years, the average area weighted site productivity of each group was compared. The average estimated site productivity was found to be highest in the oldest group, after adjustment. Given that harvesting operations have historically targeted the higher productivity stands first, this result is counterintuitive and may mean that the adjustments applied to the older stands must be significantly reduced or that the future site productivity for stands of other age groups are also underestimated.

Overall, the harvest forecast in the Fraser TSA is not significantly affected in the short term by increases in the estimated future productivity of remaining older stands. The reason for this is, as noted above, the Fraser TSA has a relatively small component of older stands in the timber harvesting land base due to the long history of harvesting in the area.

5.10 Uncertainty in forest management prescriptions for deer winter range

In the initial harvest forecast, deer winter range estimates are based on currently mapped areas included in the forest inventory information for the Fraser TSA. The total area of deer winter range currently on the inventory file is about 29 000 hectares. Of this about 13 000 hectares is within the timber harvesting land base. Habitat requirements are assumed to be met as long as the same area of forest older than 100 years, of the same forest types as currently mapped within each landscape unit, are maintained over time. However, the Ministry of Environment, Lands and Parks is currently in the process of updating the inventory of deer winter range which may result in a change in the amount of area affected by forest cover requirements for deer winter range.

Figure 22 shows the effect on the harvest forecast if the area of deer winter range within each landscape unit is increased by 50%. The short-term harvest forecast is about 2% lower than the short-term harvest level in the initial harvest forecast. This short-term effect is due to the decreased availability of the existing older-stands for harvesting early in the harvest forecast. Later in the harvest forecast, a large proportion of the deer winter range requirements can be met by areas that are either, not part of the timber harvesting land base, areas within the timber harvesting land base that are already being maintained as older forest for other reasons such as, biodiversity requirements, spotted owl habitat, etc. or, have minimum harvestable ages that are older than 100 years.

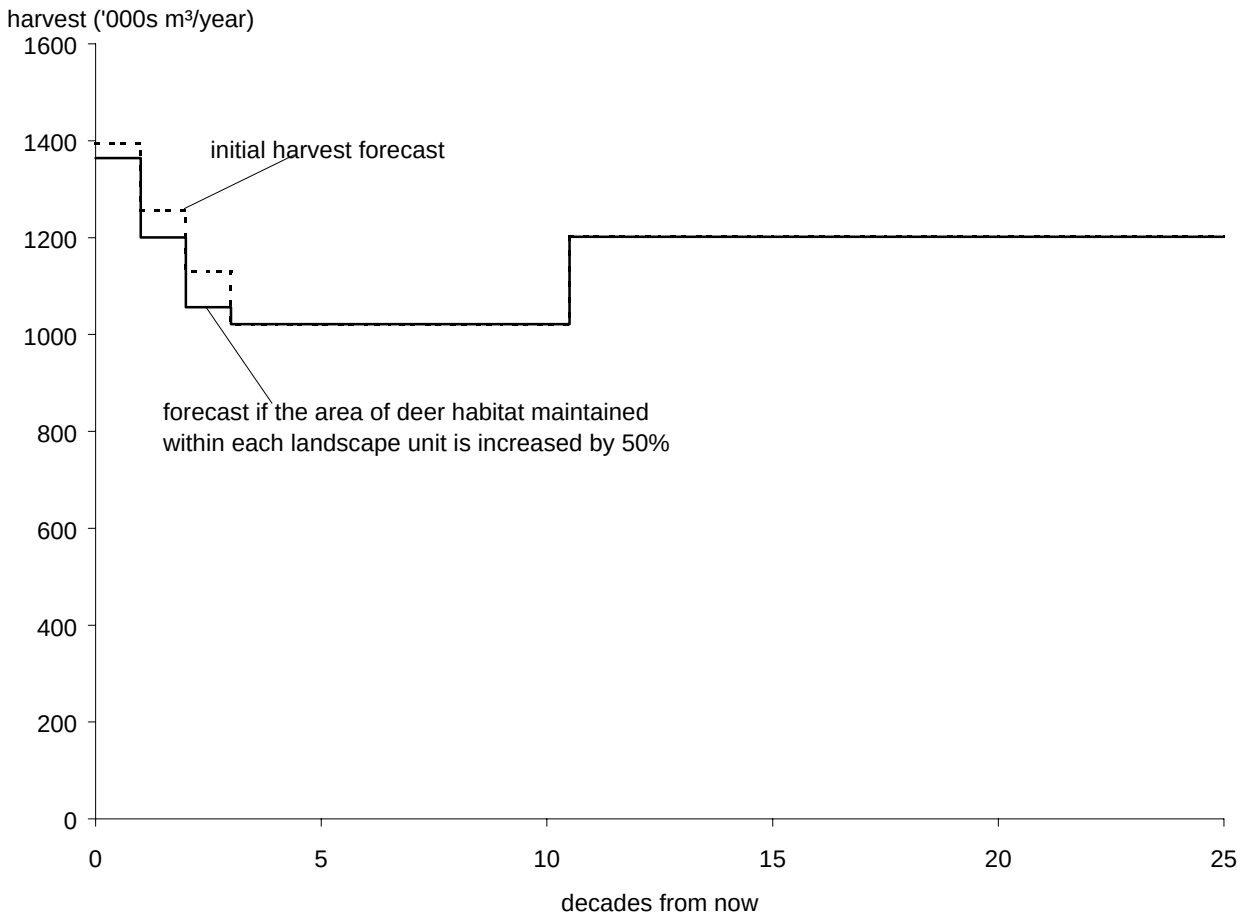


Figure 22. Harvest forecast if the area of deer winter range within each landscape unit is increased by 50% — Fraser TSA, 1998.

Decreasing the area of deer winter range by 50% did not have an effect on the harvest forecast. The short-term harvest level is not dependent on harvesting the maximum allowed area within the deer winter range. In the longer term, sufficient alternative areas of deer habitat are provided by areas that are not part of the timber harvesting land base, are already being maintained in older forest due to other forest cover requirements or, have minimum harvestable ages that are older than 100 years.

5.11 Uncertainty in forest management prescriptions in community watersheds

In the initial harvest forecast, forest management objectives within each of the 83 designated community watersheds in the Fraser TSA were represented by ensuring that a maximum of 5% of the forest area within a watershed could be harvested in a 5-year period. This general rule is drawn from the *Forest Practices Code Community Watershed Guidebook*. Uncertainty exists around this assumption, as in some community watersheds, the area that may be harvested may exceed 5% in a 5 year period while in others the rate of harvest may have to be lower than the general rule suggests.

Increasing the amount of each community watershed that can be harvested in a 5-year period to 7% of the total forest area did not result in any change to the initial harvest forecast. The short-term harvest forecast is unaffected because, at the TSA level, a relatively small portion of the timber harvesting land base (only about 4% or about 11 400 hectares) is in designated community watersheds and

less than one-half of this area is old enough for harvesting in the short term.

As discussed in Section 4.2, "Base case harvest forecast" the starting harvest level is strongly affected by the need to reserve some of the existing mature timber to avoid projected future shortfalls, thus the small potential increase in the volume that harvesting from community watersheds under relaxed guidelines should provide, cannot be utilized in the short term. Over the longer term, the community watersheds guidelines result in most of the forest being available for harvest at about 100 years of age which does not significantly constrain harvesting. Even in the absence of community watershed guidelines, harvest ages for many stands are older than 100 years due to other factors.

Figure 23 shows the effect on the harvest forecast of reducing the maximum area allowed to be harvested in a 5-year period to only 3% of the forest area within a community watershed. The starting harvest level is reduced by about 2% from the starting harvest level in the initial harvest forecast. Given that the community watershed requirements in the initial harvest forecast were not constraining on the rate of harvest (discussed above) this result indicates that a "threshold" is crossed in changing the maximum rate of harvest from 5% to 3% in a 5-year period. Therefore, if community watershed guidelines are on average more stringent than the general rule provided in the *Community Watershed Guidebook*, the short-term harvest forecast for the Fraser TSA will be reduced. In the medium and long term, the rate of harvest is reduced about 1% due to extending the average age stands become available for harvest to about 167 years.

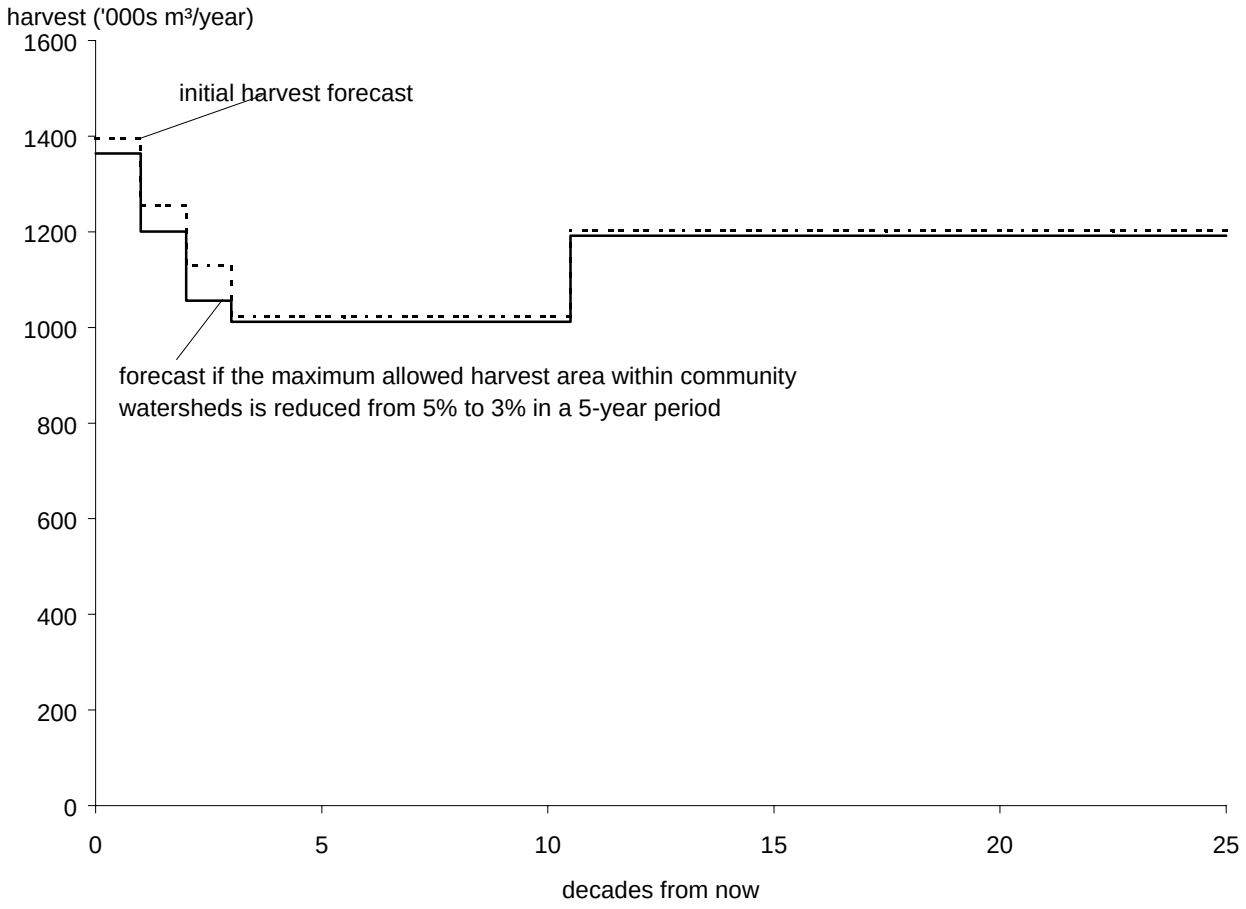


Figure 23. Harvest forecast if forest management objectives for the rate of harvest within each community watershed are made more constraining — Fraser TSA, 1998.

5.12 Uncertainty in the adjustments applied to the forest inventory information to account for a mature timber volume overestimate identified by the Fraser TSA inventory audit

As discussed in Section 2.2, "Timber growth and yield" an important factor affecting the initial harvest forecast is the adjustments that were made to the height, age and volume information for all stands older than 60 years based on the results of an inventory audit completed for the Fraser TSA. The audit results have been used in this analysis on the assumption that mature timber volumes on the forest inventory are overestimated by an average of about 23%. However, to be statistically correct, the audit results indicate that there is a 90% chance that the average overestimation of timber volumes in stands older than 60 years is between about 15% and 31% (plus/minus 8% from the 23% average). The following analysis tests the sensitivity of the harvest forecast of adjusting the estimated timber volumes in stands older than 60 years to either end of the range suggested by the audit, rather than the 23% average.

Figure 24 shows the effect on the harvest forecast of reducing the estimated volume of timber in stands older than 60 years by only 15%, which is the lower end of the range of adjustments suggested by the inventory audit. This is an 8% smaller adjustment than was used in the initial harvest forecast. The starting harvest level is about 2% higher than the starting harvest level in the initial harvest forecast and the subsequent rate of decline is slowed by 2% per decade. The medium- and long-term harvest levels are unaffected as they are dependent on the long-term productivity of the forest and forest management practices rather than the existing store of mature timber.

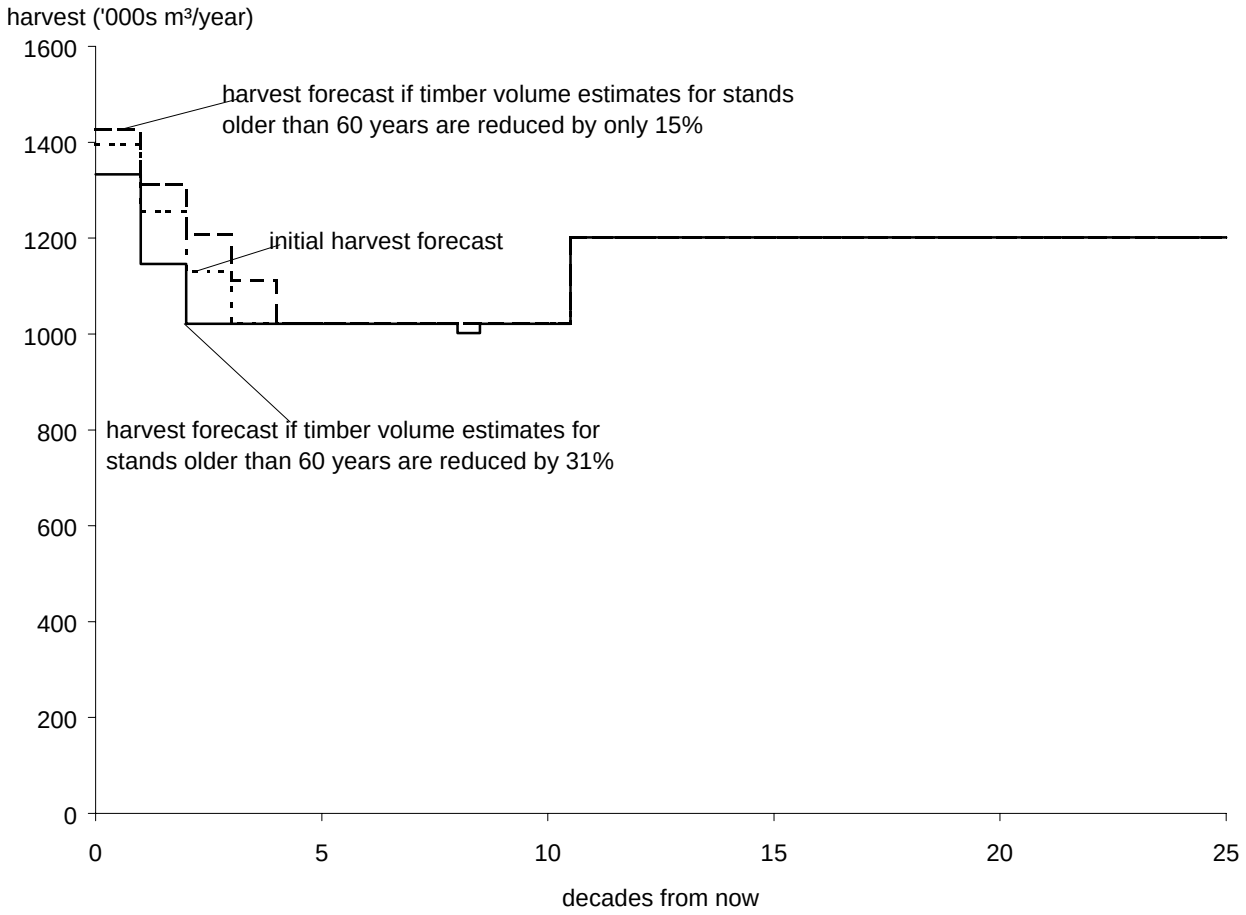


Figure 24. Harvest forecast if volume estimates for existing stands older than 60 years are changed to the upper and lower ends of the range indicated by the Fraser TSA inventory audit.

Figure 24 also shows the effect on the harvest forecast of reducing the estimated volume of timber in stands older than 60 years by 31% which is equal to the upper end of the range of adjustments suggested by the inventory audit and an 8% larger adjustment than was used in the initial harvest forecast. The starting harvest level is about 4% lower than the starting harvest level in the initial harvest forecast and the subsequent rate of decline is increased by about 4% per decade to about 19% per decade.

A 19% rate of decline is quite steep and it is important to note that if the harvest flow policy was changed, in either of the sensitivity runs discussed above, to maintain the same rate used in the initial harvest forecast (10% per decade), the short-timber supply impacts would be much greater from varying the inventory audit adjustments.

5.13 Sensitivity of the harvest forecast to applying the early seral and mature/old seral stage requirements outlined in the Forest Practices Code Biodiversity Guidebook

The Ministry of Forests and the Ministry of Environment, Lands and Parks have agreed on some assumptions as to how the *Forest Practices Code Biodiversity Guidebook* will be applied operationally. Two of the most important assumptions to timber supply, with respect to the application of landscape-level biodiversity guidelines are:

1) The late-seral (old growth) requirements are most important to achieving landscape-level biodiversity objectives and will be applied operationally in all landscape units.
2) Mature plus old requirements and early-seral requirements are less critical to achieving landscape-level biodiversity objectives, often have partial overlap with other forest management prescriptions (i.e., visual quality objectives or cutblock adjacency guidelines), have the potential to cause significant timber supply impacts and will not be applied operationally unless it can be shown in a timber supply analysis that the application of these seral-stage requirements will not have an impact on the timber supply forecast

The following sensitivity analyses show the effect on the harvest forecast of applying the early seral guidelines, the mature plus old seral guidelines and both sets of guidelines together. No attempt has been made to "smooth" the harvest flow in these forecasts by reducing starting harvest levels, increasing the rate of decline, etc. The purpose of these model runs is simply to show whether or not the harvest forecast is affected and, if so, the magnitude and timing of the impact.

Figure 25 shows the effect on the harvest forecast of applying the early seral guidelines as indicated in the *Forest Practices Code Biodiversity Guidebook*, note the late seral guidelines are also applied as they were already included in the initial harvest forecast. Although the early seral guidelines do not make any stands unavailable for harvest over the long term, they constrain the rate at which stands can be harvested from each landscape unit/biogeoclimatic variant combination over time, which causes significant shortfalls early in the harvest forecast.

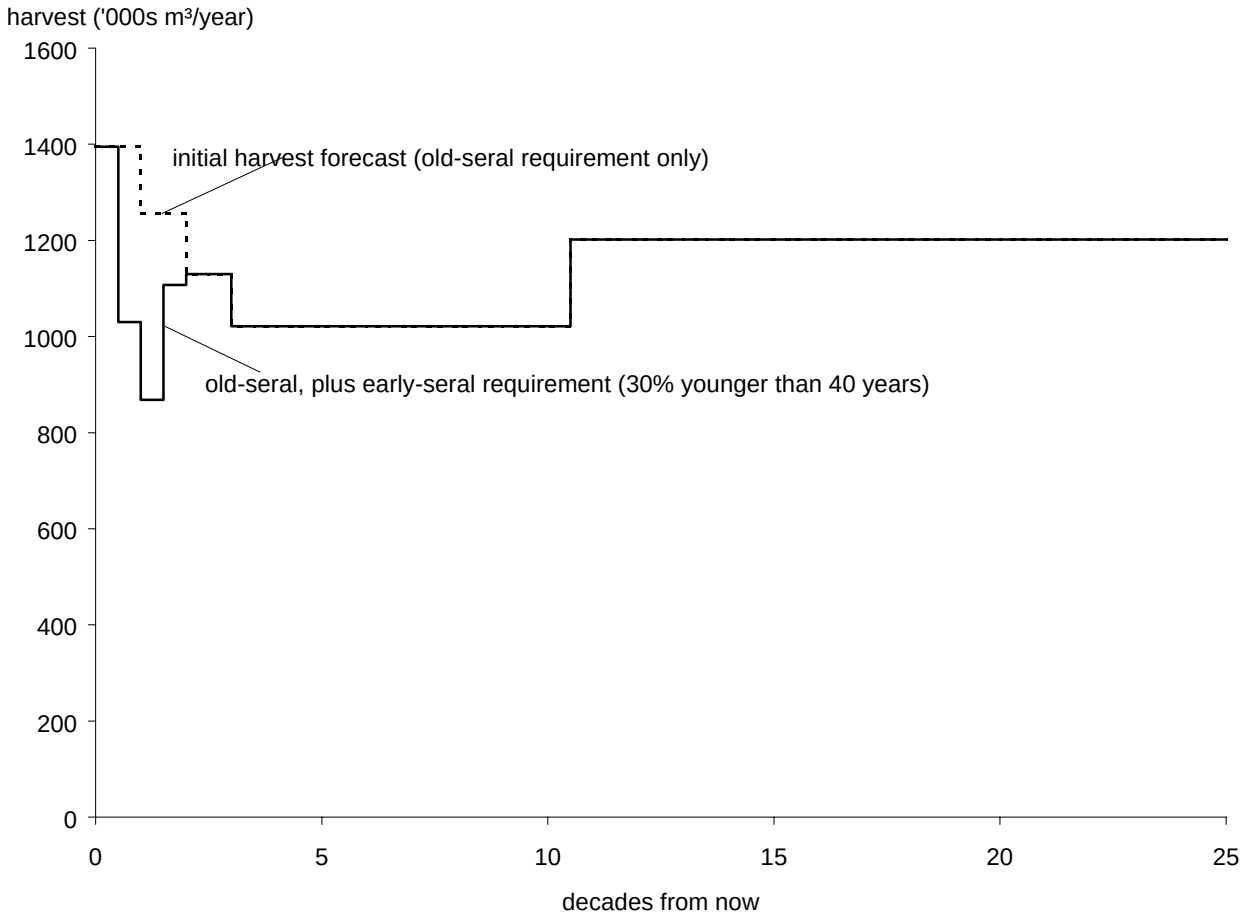


Figure 25. Harvest forecast if early seral stage guidelines from the Forest Practices Code Biodiversity Guidebook are applied — Fraser TSA, 1998.

Figure 26 shows the effect on the harvest forecast of applying the mature plus old seral stage requirements in addition to the late seral guidelines already included in the initial harvest forecast. Application of these requirements has an effect on the short-term timber supply by reducing the area of stands available for harvest. Stands that are available for harvest in the initial harvest forecast have to be retained to meet the mature plus old guidelines and a timber-supply shortfall occurs about 20 years into the harvest forecast.

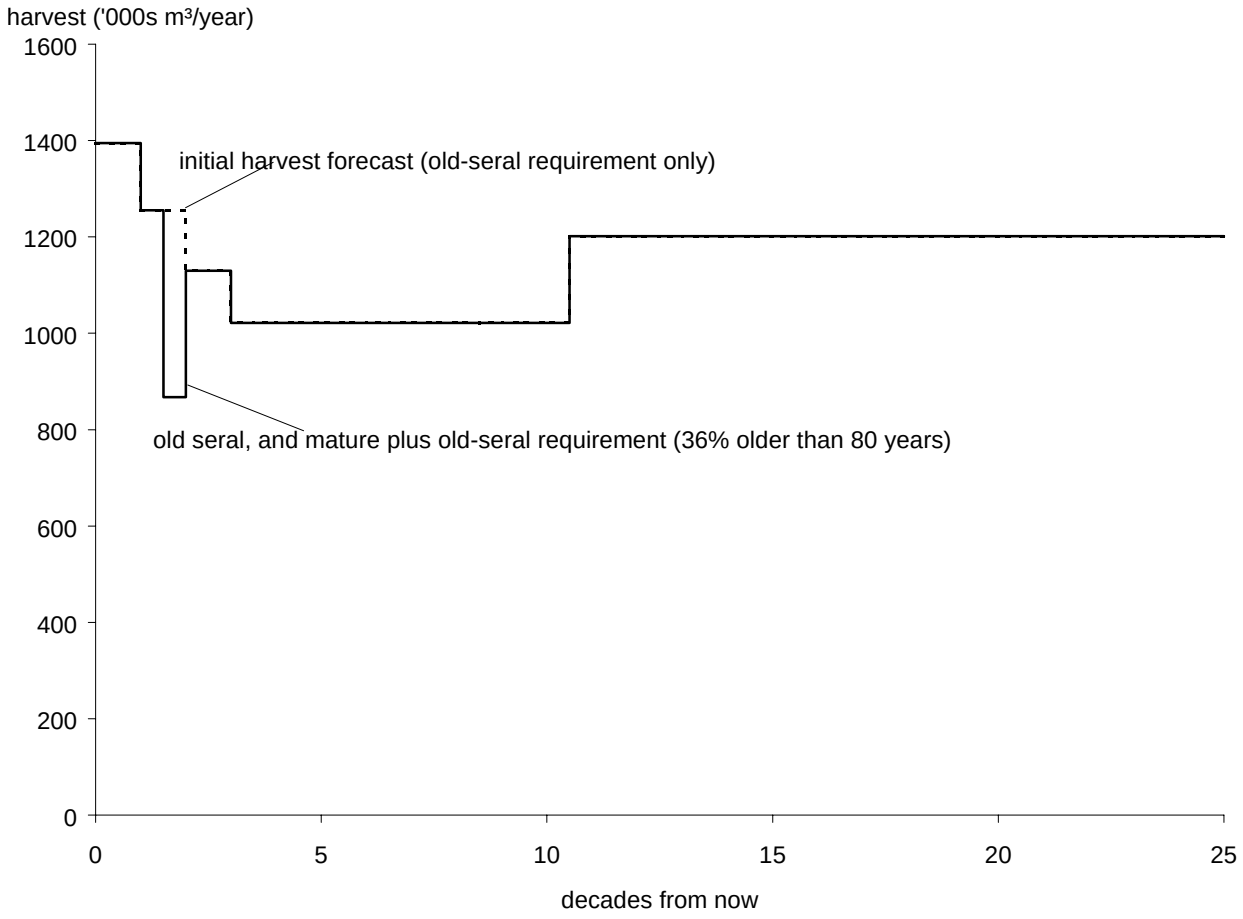


Figure 26. Harvest forecast if the mature plus old-seral stage guidelines from the Forest Practices Code Biodiversity Guidebook are applied — Fraser TSA, 1998.

Figure 27 shows the effect on the harvest forecast of applying both the early-seral and mature-old requirements in addition to the late-seral guidelines already included in the initial harvest forecast. Significant timber supply shortfalls occur within the first 20 years due to both the reduced availability of stands for harvesting (due to the mature plus old seral stage guidelines) and the reduced rate at which the available stands can be harvested (due to the early-seral stage guidelines).

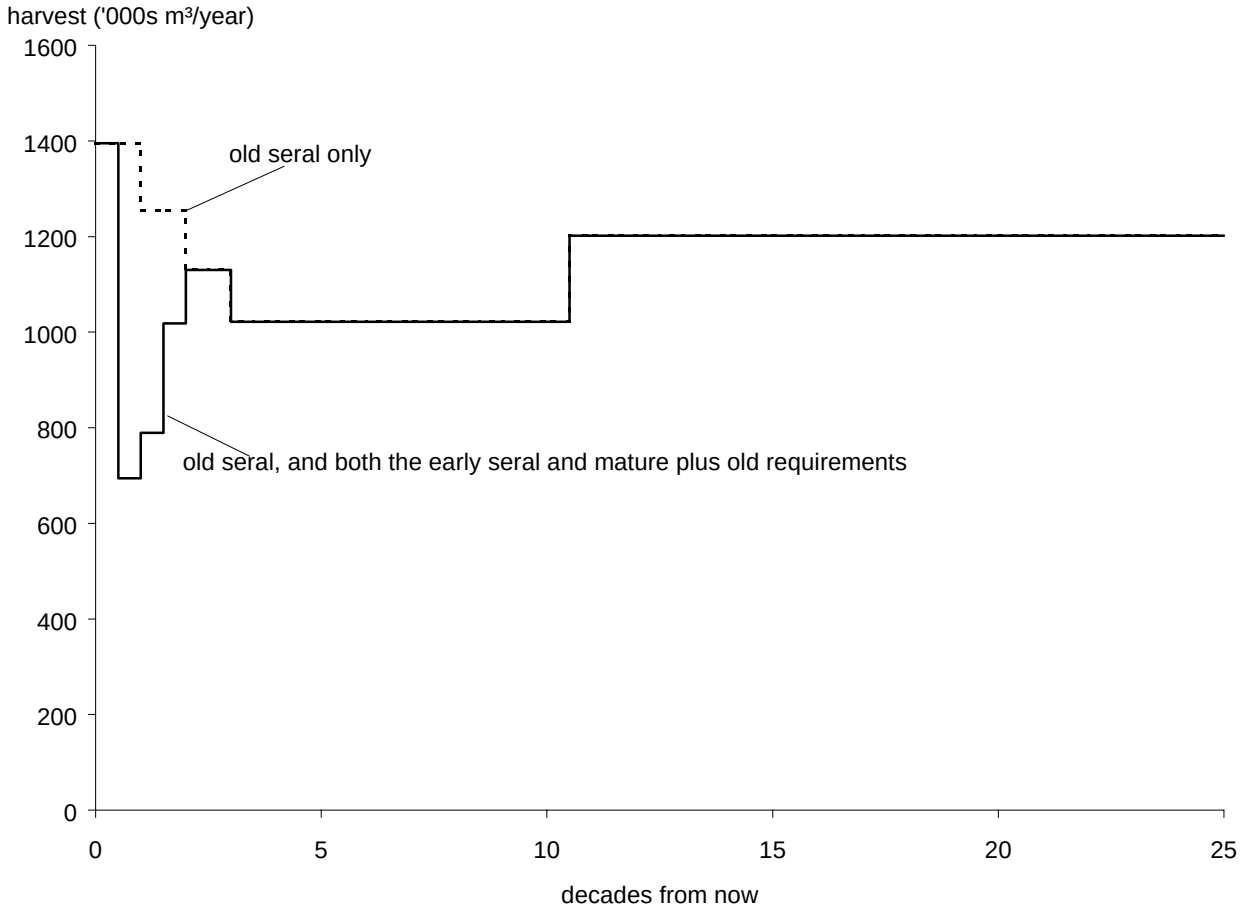


Figure 27. Harvest forecast if both the early-seral stage and mature plus old-seral stage guidelines from the Forest Practices Code Biodiversity Guidebook are applied — Fraser TSA, 1998.

5.14 Sensitivity of the harvest forecast to the contribution of timber from deciduous-leading stands

About 10 000 hectares of deciduous-leading stands are included in the timber harvesting land base in the initial harvest forecast. The management assumptions applied to these stands are that three-quarters of these stands will be converted to coniferous stands (Douglas-fir leading) following harvest while one-quarter will be managed as deciduous-leading stands in perpetuity. Uncertainty exists around the amount of harvesting that will actually be done in these stands because, although all of the 10 000 hectares meets the minimum volume per hectare assumed to be necessary for harvesting to occur, there are problems with the stem form and location of these stands. Many of these stands have poor stem form (crooked stems which make cutting a merchantable log difficult) or may have high value as riparian management zones or reserves.

Figure 28 shows the effect on the harvest forecast of assuming that harvesting will not

occur in the deciduous-leading stands. Without the volume contribution from deciduous-leading stands, the starting harvest level must be reduced about 2% from the starting harvest level in the initial harvest forecast. In the medium and long term, the effect on the harvest forecast is larger. Because it is assumed

that three-quarters of the deciduous-leading stands would be regenerated as coniferous-leading stands which would produce higher timber volumes, the contribution to the harvest forecast from these stands is higher in the long term than the short term. Without the contribution from these stands both the medium- and long-term rates of harvest are about 4% lower than in the initial harvest forecast.

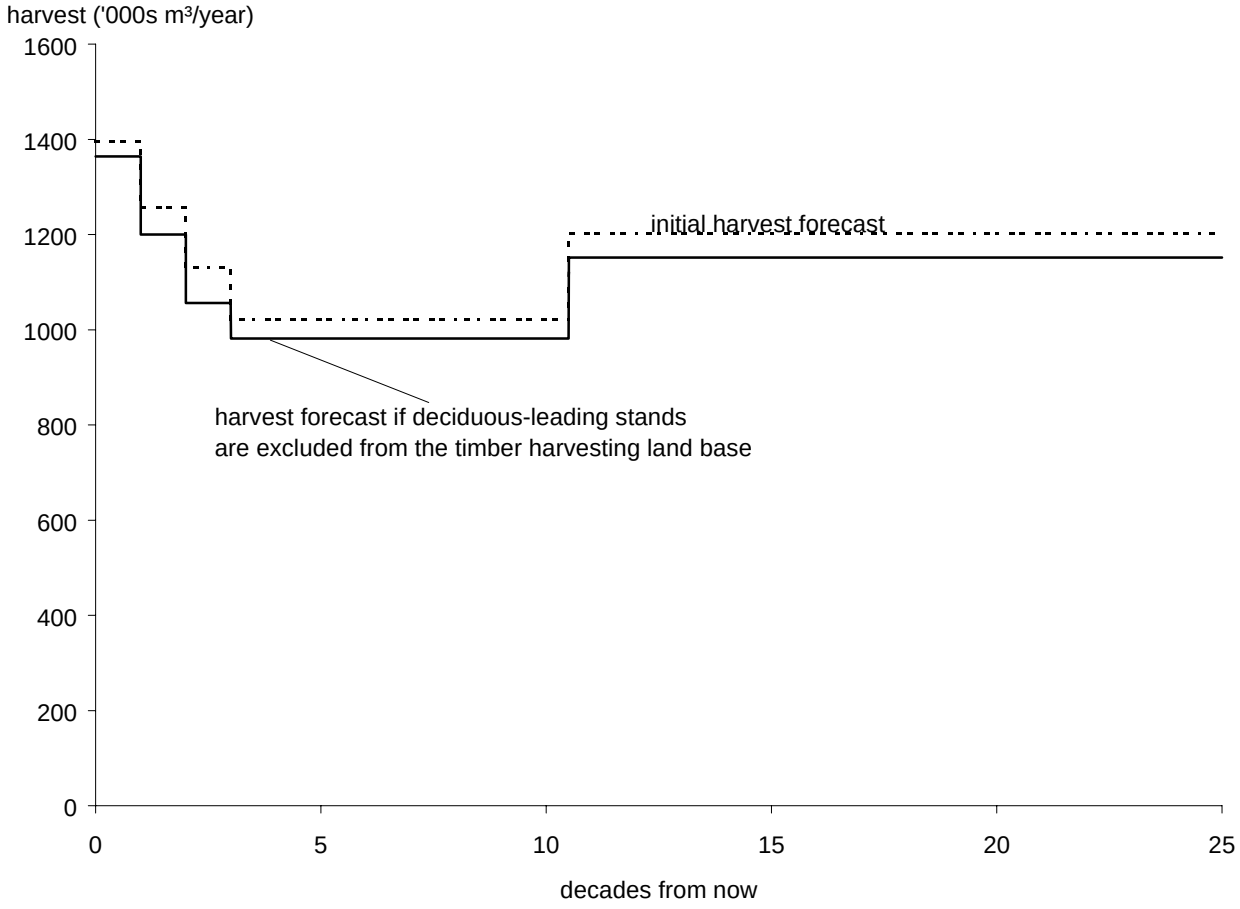


Figure 28. Harvest forecast if deciduous-leading stands are not included as part of the timber harvesting land base — Fraser TSA, 1998.

6 Summary and Conclusions of the Timber Supply Analysis

Based on current forest inventory information and forest management assumptions in the Fraser TSA, the results of this analysis indicate that the current AAC of 1 550 000 cubic metres per year cannot be maintained. The base case harvest forecast shows that if the decline in the rate of harvest over time is to be gradual and of a constant rate, the current rate of harvest must be reduced by 15% to about 1.32 million cubic metres per year, followed by further reductions of 15% and 9% in each of the next two decades to 1.02 million cubic metres per year. In the long term (about 100 years into the future) when harvesting is occurring almost exclusively in second-growth managed stands, the rate of harvest may be increased to a steady long-term harvest level of about 1.2 million cubic metres per year. Without the contribution of volume from deciduous-leading stands, the current rate of harvest must be reduced by a further 2%, or about 26 000 cubic metres per year.

The timber supply forecast for the Fraser TSA is driven by several important factors, some of which reduce the timber supply and others that increase the supply. Due to the long harvesting history in the Fraser TSA, the forest inventory contains predominantly younger stands that are of higher average productivity (generally managed and on better growing sites) but at harvest will have lower average timber volumes because of their much younger age. Thus, the decline seen in the harvest forecast in this analysis is partly due to the planned transition from harvesting older stands with high timber volumes to harvesting younger second-growth stands with lower timber volumes.

Since the last timber supply analysis completed for the Fraser TSA, several land use and forest management initiatives have been implemented including the creation of several new parks, completion of a spotted owl management plan, and full implementation of the *Forest Practices Code Guidelines*. All of these initiatives have had an effect of reducing the available timber supply in the Fraser TSA.

The inventory audit completed in 1997 indicated that the inventory information for the Fraser TSA overestimated the volume of timber in mature stands (60 years and older) by an average of 23%. Correction of this overestimate has resulted in a reduced volume of existing mature timber and a reduction in the timber supply forecast.

A comprehensive review of the way in which scenic areas will be managed was completed in 1997. In general, harvesting opportunities have been increased within scenic areas by accounting for factors such as improved harvesting design, the differing ability of areas to "absorb" the visual effects of harvesting, and the level of recreational use in an area. This change in management of scenic areas increases the available timber supply and partially offsets the reductions in the timber supply caused by other factors.

A review of the criteria used to determine whether forest stands are economically feasible to harvest has resulted in more area of "marginal" stands on low-productivity growing sites being included in the timber harvesting land base. This change in the definition of the timber harvesting land base also increases the available timber supply and serves to offset some of the reductions in the timber supply caused by other factors.

Uncertainty in any of several factors could affect the harvest forecast in the Fraser TSA. In the short term (first 20 years) the harvest forecast is most strongly affected by uncertainty in:

- existing stand timber volume estimates;
- the estimated area of the timber harvesting land base;
- the scale in which cutblock adjacency guidelines were applied in the analysis.

The steady long-term harvest level is strongly affected by several factors including changes to regenerated stand timber volume estimates, changes in the future site productivity estimated for existing old-growth stands and the estimated area of the timber harvesting land base.

The way in which cutblock adjacency was modelled in the base case was decided following a map-based review. This review of the rate and location of harvest by landscape unit over time indicated the need to specifically account for the geographic concentration of harvesting activities in the past. This problem was addressed by applying the cutblock adjacency requirements at a finer scale than was initially planned. Unfortunately this review was time consuming and in the mean time the analysis was completed using the original information regarding scale of adjacency requirements. As a result, the sensitivity analyses discussed in Section 5, "Timber

Supply Sensitivity Analyses" use the initial harvest forecast, rather than the base case, as a starting point and a reference from which changes in the forecast are measured.

The socio-economic analysis shows that the current Fraser TSA AAC of 1.55 million cubic metres per year can support approximately 1,953 direct and a further 2,300 indirect and induced person-years of employment across the province. A harvest level of 1.32 million cubic metres as indicated by the timber supply analysis would support 1,659 direct and 1,954 indirect and induced person-years of employment in the province. Recent harvest levels have been somewhat below the current AAC, subsequently the impacts may be somewhat less.

In conclusion, this analysis indicates that, based on current inventory, growth and yield information, and current forest management practices, the current rate of harvest in the Fraser TSA cannot be maintained without causing larger timber supply shortfalls in the future.

7 Socio-Economic Analysis

The socio-economic analysis examines the socio-economic implications of changing harvest levels in the Fraser TSA. It compares the level of forest industry activity currently supported by timber harvested from the Fraser TSA with the level of activity that could be supported by the Fraser TSA as the timber supply moves towards the long-term harvest level. The analysis uses the base case harvest forecast as an indication of future harvest levels.

The socio-economic analysis is divided into three sections:

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

7.1 Socio-economic setting

7.1.1 Current population and demographic trends

The Fraser TSA includes the communities within the Vancouver Lower Mainland and Fraser Valley, and smaller communities and rural areas of the Fraser Canyon. Over half of the population of British Columbia lives in the area. In 1996, the Fraser TSA's population was approximately 2.05 million people: a 14.8% increase since 1991.[1] Table 4 provides population statistics for several communities, the Fraser TSA, and the Greater Vancouver and Fraser Valley Regional Districts.

Table 4. Fraser timber supply area population statistics, 1991 – 2001

Community	1991	1996	2001 (projection)	% change 1991-1996	% change 1996-2001
Vancouver	471,844	514,008	N/A	8.9	—
Abbotsford	86,928	105,403	N/A	21.1	—
Chilliwack	49,531	60,186	N/A	21.5	—
Mission	26,202	30,519	N/A	16.5	—
Hope	5,728	6,247	N/A	9.1	—
Boston Bar[a]	433	329	N/A	- 24.0	—
Fraser Valley Regional District	186,163	222,397	258,384	19.5	16.2
Greater Vancouver Regional District	1,602,590	1,831,665	2,068,067	14.3	12.9
Fraser Timber Supply Area	1,787,288	2,052,672	N/A	14.8	—
British Columbia	3,281,910	3,724,500	4,249,075	13.5	14.1

Source: Census, 1991, 1996, BC Stats Population Section.

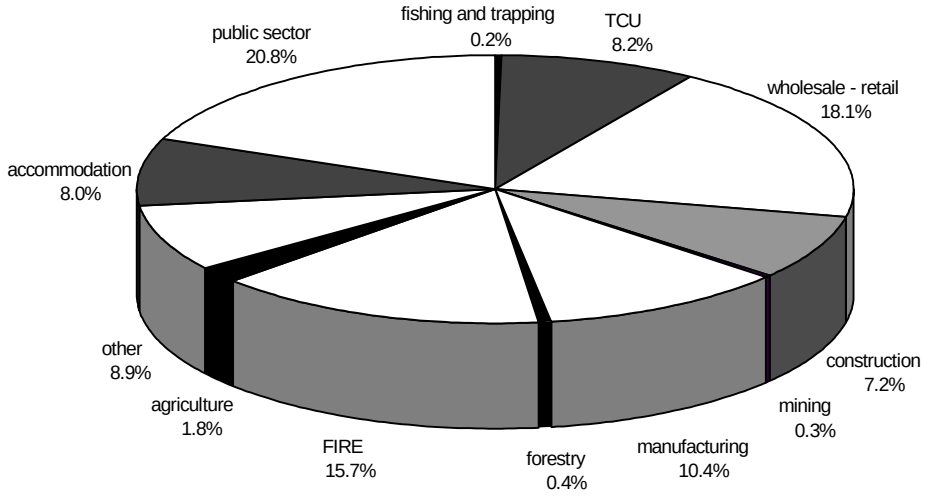
(a) Figures for Boston Bar include the town of Boston Bar and some rural areas to the south.

(1) B.C. Stats. Population Section. Government of B.C.

From 1996 to 2001, the population of the Greater Vancouver Regional District is expected to grow by approximately 2.5% annually.[2] The Fraser Valley Regional District's population is forecast to grow by an estimated 3.2% annually over the same period.

7.1.2 Economic profile

The Fraser TSA has three distinct economic regions: Greater Vancouver, the Fraser Valley, and the Fraser Canyon. Figure 30 illustrates employment by industry sector for the Fraser TSA. The unemployment rate for the mainland southwest portion of the province averaged 8.5% in 1997: an increase of 0.1% from 1996.[3]



Source: 1996 Census of Canada — data is for the Greater Vancouver and Fraser Valley Regional Districts.

Note: Forestry consists of harvesting related activity, but does not include processing. Processing is included in the manufacturing sector. Forestry headquarters employment is captured in business services of the FIRE category. FIRE consists of finance, insurance and real estate, and other business services. TCU consists of transportation, communications and utilities. Public Sector consists of local and provincial government services, health and education.

Figure 29. Fraser timber supply area employment by industry sector, 1996.

(2) B.C. Stats. Population Section. Government of B.C.

(3) B.C. Stats. The Mainland Southwest Economic Region encompasses the Fraser TSA, Soo TSA and portions of the Sunshine Coast TSA.

7 Socio-Economic Analysis

The Fraser TSA's economy is well diversified, especially in Greater Vancouver. While no single sector dominates the economy, the business and consumer services sectors, including finance, insurance and real estate (FIRE), transportation, communications and utilities (TCU), wholesale and retail trade, accommodation, and government services, account for about 70% of the region's employment. Many forest companies who operate in the province have corporate headquarters in Vancouver and are included in the business sector.

Although forestry does not dominate the Greater Vancouver economy, it gains importance east of metropolitan Vancouver and especially in the upper Fraser Valley and Fraser Canyon where the forest industry supports at least 15% of the total labour force.

Tourism is included in components of accommodation, retail, transportation and other sectors in Figure 30. It is a leading-growth sector throughout the Fraser TSA. In 1991, tourism supported almost 5% of the Fraser TSA's employment.[4] Greater Vancouver attracts the majority of visitors and in 1996 over 7.6 million people visited the area and spent approximately $2.45 billion — a 43% increase from 1991.[5] Tourism in Greater Vancouver has increased steadily over the past decade and growth is expected to continue. From 1986 to 1996, the number of visitors to Greater Vancouver increased by 31%.

Outdoor recreation draws numerous residents and visitors to the region's parks and trails. The B.C. Forest Service operates 46 recreation sites with camping and other outdoor opportunities, and 20 recreation trails offering day hikes, wildlife viewing and other activities.

Additional trail systems and parks are operated by the regional districts and municipalities, however, increasing population and tourism will continue to put substantial pressure on these facilities.

Agriculture supports approximately 2% of the labour force in the Fraser TSA; however, the eastern Fraser Valley portion relies on agriculture more than the western, more urban portion. In the Chilliwack, Kent-Harrison and Matsqui-Abbotsford areas agriculture accounts for up to 7% of employment.[6]

Employment income is another indicator of a sector's contribution to the economy. Sectors with high income levels tend to support more supply and service activity than those with lower income levels. For example, using basic sector* income and employment Table 5 indicates that although the forest sector supports less basic employment than tourism, its higher basic income level will have a greater impact on the local economy.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy.
Basic income and employment are *indicators used to describe the size of a basic sector.*

(4) The Revised Forest District Tables, March 1996, Ministry of Finance and Corporate Relations.

(5) Tourism Vancouver.

(6) Source: Ministry of Finance and Corporate Relations.

Table 5. Comparison of basic sector indicators, Fraser TSA

Basic sector	Per cent (%) basic employment	Per cent (%) basic income	Employment multiplier
Forestry	4.9	5.8	1.74 — 2.10
Mining and mineral processing	3.5	4.1	1.65 — 1.78
Fishing and trapping	1.2	1.2	N/A
Agriculture and food	4.7	3.7	1.42
Tourism	6.1	3.3	1.20
Public sector	33.0	34.1	1.40
Construction	13.2	13.9	1.70

Source: The revised forest district tables, Ministry of Finance and Corporate Relations.

Note: The employment percentages in Table 5 will not exactly match those in Figure 30 as they are derived from a different data set and include direct and indirect employment.

A regional impact or multiplier* analysis provides another perspective of forestry's role in the economy. For every 100 direct forestry jobs in the Fraser TSA another 74 to 110 indirect and induced jobs* are supported, depending on the type of forest industry activity (wood manufacturing, logging, or pulp and paper) and the associated level of wages and salaries. In contrast, for every 100 public sector jobs another 40 positions are supported, while every 100 tourism jobs support 20 further jobs. Only mining (rock quarries for example) and construction fall into the range of forestry, with 78 and 70 associated positions respectively per 100 jobs. All jobs are assumed to be full time in this illustration.

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.

Indirect and induced jobs
Indirect jobs are supported by direct businesses purchasing goods and services; induced jobs are supported by employees spending their incomes on things such as groceries, automobiles, restaurant dinners and haircuts.

7.2 Fraser TSA forest industry

Forestry was first recognized as a valuable resource in the region over 150 years ago. With the first sawmills at New Westminster, Fort Langley and Burrard Inlet, the forest industry began its role in the area's economy. Today, harvesting, silviculture and processing employment, combined with corporate activity and an extensive log transportation and handling system, distribute 10 to 13 million cubic metres of timber annually to numerous mills in southwestern British Columbia. Timber harvested from the Fraser TSA accounts for about 10% – 12% of the timber moved and processed within the Fraser TSA and approximately 2.3% of the total provincial allowable annual cut.

This section will profile in more detail the forest industry in the Fraser TSA and will present information necessary to estimate industry activity at various timber supply levels associated with the base case harvest forecast.

7.2.1 Current allowable annual cut

The current allowable annual cut (AAC) for the Fraser TSA is 1 550 000 cubic metres which came into effect in 1995. From 1985 to 1995, the AAC was 1 765 000 cubic metres. The current AAC is apportioned to various tenure types, as outlined in Table 6. Seven companies have replaceable forest licences in the Fraser TSA accounting for 1 131 365 cubic metres, or 73% of the total AAC. The remainder is divided among several other forms of tenure including timber sale licences and small business forest enterprise program (SBFEP) sales.

Table 6. Fraser TSA allowable annual cut apportionment, by licence type (1997)

	AAC	Per cent (%)
Forest licences — replaceable	1 131 365	73.0
Timber sale licence (TSL) > 10 000 cubic metres	16 322	1.1
Timber sale licence (TSL) < 10 000 cubic metres	16 368	1.1
Small business forest enterprise program (SBFEP)	296 199	19.1
Forest service reserve	45 047	2.9
Woodlot licences	19 268	1.2
Forest licences — non-replaceable	25 431	1.6
Total	1 550 000	100.0

Source: Ministry of Forests.

7.2.2 Fraser TSA harvest history

The Fraser TSA is the largest source of timber in the Chilliwack Forest District accounting for an average of 78% of the total forest district harvest from 1993 to 1997. Other sources in the region include Tree Farm Licences, Timber Licences, private lands, and Indian Reserves. There are two Tree Farm Licences in the Chilliwack Forest District with a combined AAC of 89 640 cubic metres. From 1993 to 1997 the TFL harvest averaged 34 070 cubic metres. During the same period, the average annual harvest level from private lands was 286 612 cubic metres, from Timber Licences was 59 275 cubic metres, and a total of 42 267 cubic metres was harvested annually from municipal, regional, district and Indian Reserve lands.

Table 7 indicates a decline in the Fraser TSA's harvest levels between 1993 and 1997. On average, however, individual licensee's harvests generally fall within 10% of the AAC over a five-year cut control period.[7]

Table 7. Fraser timber supply area volumes billed, by licence type, 1993 – 1997

	Cubic metres					
Tenure	1993	1994	1995	1996	1997	Average 1993-1997
Forest licences	1 457 566	1 216 700	1 112 740	961 585	954 000	1 140 518
Small business enterprise program (SBFEP)	394 105	227 257	259 610	147 116	399 741	285 566
Timber sale licence (TSL)	24 237	25 305	14 406	52 220	32 630	29 760
Woodlots	9 745	24 897	10 968	4 308	13 903	12 764
Other[a]	16 385	25 765	32 005	4 784	11 782	18 144
Total harvest	1 902 039	1 519 924	1 429 728	1 170 013	1 412 056	1 486 752
AAC	1 765 000	1 765 000	1 550 000	1 550 000	1 550 000	

Source: Ministry of Forests.

(a) Other consists of cutting permits such as rights-of-way, road permits and other small temporary permits.

(7) Over a five-year cut control period the harvest may range within 10% of the AAC, and may be within 50% and 150% in any one year.

The actual annual harvest rate is an important indicator of forest industry activity. A review of recent harvest volumes in the Fraser TSA provides two important pieces of information. First, while the AAC sets the maximum permissible harvest level, the actual volume of trees harvested indicates the amount of economic activity for any particular year. Second, harvest levels can indicate a shortfall between the actual harvest and the allowable cut. Frequent shortfalls in the harvest may mean that employment could increase if the AAC was fully harvested. This could influence the potential short-term impacts of a change in the AAC.

7.2.3 Fraser TSA major licensees

J.S. Jones Holdings Ltd. has a replaceable forest licence to harvest 422 406 cubic metres per year in the Fraser TSA. J.S. Jones also has a forest licence in the adjoining Lillooet timber supply area for 88 510 cubic metres per year. Table 8 outlines J.S. Jones' recent harvest activity and 1994 – 1996 employment levels in person-years* for its Fraser TSA operations.

Table 8. J.S. Jones harvest and employment statistics

Allowable annual cut	422 406 cubic metres
1997 harvest	447 943 cubic metres
1993 -1997 average harvest	464 138 cubic metres
Employment (1994 -1996 person-years):	
Harvesting and administration	300 - 295
Transport, road building and maintenance	115 - 135
Silviculture	19 - 19
Processing	308 - 290
Total	742 - 739

Note: The employment figures relate to the 1994 -1996 volumes of 481 139 - 452 670 cubic metres harvested from the Fraser TSA land base only and processed in British Columbia. Employment is reported in person-years.

Person-year(s)
A full-time full-year job of at least 200 days per year. A part-time job lasting 100 days per year equals 0.5 of a person-year.

J.S. Jones' operations in the Fraser TSA include two lumber mills — J.S. Jones Timber in Boston Bar and Stag Timber in Surrey, and one shake and shingle mill — Teal Cedar Products in Surrey. In 1997 these mills processed over 730 000 cubic metres of timber and employed about 550 individuals for 220 to 235 days per year. The majority of the wood harvested by J.S. Jones is processed at either its Boston Bar or Surrey facilities. The remainder is sold or traded as pulplogs, poles and houselogs to various Vancouver Lower Mainland processors. Timber harvested from the Fraser TSA accounts for approximately 69% of J.S. Jones' total timber requirement.

International Forest Products Ltd. (Interfor) has a replaceable forest licence in the Fraser TSA for 202 526 cubic metres per year. Interfor has numerous other tenures throughout the province totalling 3.5 million cubic metres. Table 9 summarizes Interfor's harvest activity in the Fraser TSA and associated 1994–1996 employment.

Table 9. Interfor harvest and employment statistics

Allowable annual cut	202 526 cubic metres
1997 harvest	152 083 cubic metres
1993 - 1997 average harvest	199 872 cubic metres
Employment (1994 - 1996 person-years):	
Harvesting and administration	42 - 36
Transport, road building and maintenance	19 - 10
Silviculture	5 - 6
Processing	133 - 84
Total	199 - 136

Note: The employment figures relate to the 1994 - 1996 volumes of 208 289 - 130 815 cubic metres harvested from the Fraser TSA land base only and processed in British Columbia. Employment is reported in person-years.

Interfor operates several mills in the province, five of which are located in the Fraser TSA: Fraser Mills at Coquitlam, Mackenzie Seizai at Surrey, Hammond Mills at Maple Ridge, McDonald Cedar at Fort Langley and Western Whitewood at New Westminster. In 1997, Interfor opened a small log sawmill at the site of the Flavelle Cedar mill which closed in 1996. Interfor's Bay Lumber mill at Whonnock also closed in 1996; no plans have yet been announced for the Bay Lumber property. In 1997, Interfor's mills in the Fraser TSA processed approximately 2.2 million cubic metres of timber and supported approximately 1,375 direct processing jobs. Approximately 85% of the timber harvested under Interfor's Fraser TSA licence remains in the TSA and is processed at Interfor mills. The Fraser TSA supplies approximately 6.5%

of the total volume of timber processed at Interfor's Fraser TSA mills.

Canadian Forest Products Ltd. (Canfor) has a replaceable forest licence in the Fraser TSA for 70 473 cubic metres per year. Canfor has numerous other licences throughout the province totalling 4.8 million cubic metres. Table 10 outlines Canfor's recent harvest activity in the Fraser TSA and associated 1994 – 1996 employment.

7 Socio-Economic Analysis

Table 10. Canfor harvest and employment statistics

Allowable annual cut	70 473 cubic metres
1997 harvest	50 721 cubic metres
1993 - 1997 average harvest	68 688 cubic metres
Employment (1994 - 1996 person-years):	
Harvesting and administration	32 - 35
Transport, road building and maintenance	N/A
Silviculture	N/A
Processing	46 - 49
Total	78 - 84

Note: The employment figures relate to the 1994 - 1996 volume of 71 745 - 76 915 cubic metres harvested from the Fraser TSA land base only and processed in British Columbia. Employment is reported in person-years. Employment figures are based on average Fraser TSA direct employment coefficients as no company data was provided.

In 1997, Canfor operated solely or jointly a number of primary processing facilities in British Columbia. Three of these were located in the Fraser TSA: Canfor's Eburne and WestCoast Cellufibre sawmills, and a panel mill in New Westminster. Canfor is also involved in a combined finger-joint and laminating plant in Vancouver. Canfor closed the Eburne mill in March 1998, citing declining coastal timber supplies. There is concern that the closure of this mill may affect Canfor's coastal timber apportionment. In 1997, the two Fraser TSA sawmills processed approximately 730 000 cubic metres of timber and employed approximately 360 people. Canfor's Fraser TSA licence accounts for an estimated 10% of the timber supply for these mills.

In December 1997, Pacfor's Crown tenures and milling facilities were acquired by Doman Industries Ltd. The replaceable Pacfor forest licence in the Fraser TSA permits a harvest of 40 690 cubic metres per year. Doman has several other tenures in the province which, including Pacfor's volumes, total over 4 million cubic metres. Table 11 outlines Pacfor's pre-Doman harvest activity in the Fraser TSA and associated 1994 – 1996 employment.

7 Socio-Economic Analysis

Table 11. Doman-Western harvest and employment statistics

Allowable annual cut	40 690 cubic metres
1997 harvest	23 365 cubic metres
1993 - 1997 average harvest	37 138 cubic metres
Employment (1994 - 1996 person-years):	
Harvesting and administration	30 - 23
Transport, road building and maintenance	9 - 8
Silviculture	1 - 2
Processing	30 - 20
Total	70 - 53

Note: The employment figures relate to the 1994 - 1996 volumes of 46 943 - 30 951 cubic metres harvested from the Fraser TSA land base only and processed in British Columbia. Employment is reported in person-years.

Prior to the Doman purchase, Pacfor operated three sawmills on Vancouver Island. In 1997, the three mills processed 1.3 million cubic metres and employed 572 people. Approximately 47% of Pacfor's Fraser TSA harvest is shipped to Vancouver Island sawmills and the Avenor pulp mill in Gold River. The Fraser TSA contributes approximately 1% of the timber processed at these mills.

The remainder of Pacfor's harvest passes through the Vancouver log market and is eventually processed into a variety of products. These timber flows may change due to the licence transfer. Also as a result of the transfer, 5% of the licence volume will be transferred to the Small Business Forest Enterprise Program (SBFEP).

Cattermole Timber, Pretty's Timber Co. Ltd. and Tamihi Logging Co. Ltd. have forest licences with a combined AAC apportionment of 395 271 cubic metres (155 534 cubic metres, 168 641 cubic metres and 71 096 cubic metres, respectively). These companies do not operate processing facilities and are known as market loggers. In 1997, they harvested approximately 265 000 cubic metres of timber from the Fraser TSA which was processed at facilities producing a range of products. Table 12 outlines their combined harvest activity in the Fraser TSA and associated 1994 – 1996 employment levels.

Table 12. Combined harvest and employment statistics

Allowable annual cut	395 271 cubic metres
1997 harvest	264 752 cubic metres
1993 - 1997 average harvest	362 731 cubic metres
Employment (1994 - 1996 person-years):	
Harvesting and administration	169 - 119
Transport, road building and maintenance	39 - 34
Silviculture	12 - 9
Processing	262 - 163
Total	482 - 325

Note: The employment figures relate to the 1994 -1996 volumes of 408 571 - 254 668 cubic metres harvested from the Fraser TSA land base only and processed in British Columbia. Employment is reported in person-years.

Other licences in the Fraser TSA include various timber sale licences with a total AAC of 32 690 cubic metres and the small business forest enterprise program with an AAC apportionment of 296 199 cubic metres. From 1993 to 1997, timber sale licences and small business forest enterprise program harvests averaged 29 760 cubic metres and 285 566 cubic metres, respectively. These harvests have annually supported approximately 380 direct harvesting, silviculture and processing person-years since 1995.

7.2.4 Forest sector employment and income summary

The employment, income and harvest information is used to estimate employment and income coefficients* that will be used to project future employment and income levels at various harvest rates. To complete this analysis the forest sector has been divided into three sub-sectors:

1) harvesting and other woodlands related employment such as falling, labouring, log salvage, log scaling and planning;
2) silviculture employment, including all planting and other basic and enhanced operations; and
3) primary processing facility employment.

Employment and income coefficients
The number of person-years supported by each 1000 cubic metres of timber harvested, for example, a ***coefficient*** *of 1.0 indicates that each 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.*

Harvesting and silviculture employment

In the Fraser TSA, clearcut is the predominant harvesting system using conventional tower and longline systems and increasingly, helicopter yarding. Horse logging is also used for thinning and salvage work.

Silviculture activity is either basic or 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 Fraser TSA, licensees are responsible for basic silviculture on areas harvested under major licences; the provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land.

The *1994 Fraser TSA Socio-Economic Assessment* (SEA) identified approximately 920 harvesting and silviculture related person-years associated with the previous AAC of 1.76 million cubic metres. The survey completed for this timber supply review compiled information for 1994 through 1996 and indicates that harvesting employment has declined as expected, given the lower harvest level. From 1994 to 1996, harvesting and silviculture operations in the Fraser TSA supported an average of 837 direct person-years in the province. Eighty-five to ninety per cent of the harvesting workforce resides in the Chilliwack–Mission and Hope-Boston Bar areas of the Fraser TSA.

Processing employment

Over 100 primary processing facilities are located within the Fraser TSA, although not all of them process timber harvested from the Fraser TSA. The majority of the facilities are lumber mills, however, numerous shake and shingle mills, veneer/plywood or panel mills, log home mills, and pole mills are also in operation. Pulp and paper from both new and recycled fibre is also produced within the Fraser TSA. In addition, more than 100 secondary or "value-added" mills operate in the Fraser TSA. In 1994, these value added operations employed approximately 6,000 people in the manufacture of engineered wood products such as trusses, and other products such as cabinets, furniture, flooring, doors, and door and window frames, among many other products.

Primary processing employment fluctuated from 1990 to 1997, declining in some years and increasing in others (see Table 13). However, the trend since 1994 appears to be declining employment, which follows a decline in volumes processed in the Fraser TSA. In 1997, processing employment in the Fraser TSA was approximately 12% lower than in 1990. The largest absolute fluctuations were in the production of lumber, veneer/plywood and chips. However, while both employment and the volume of logs processed are declining, the number of jobs per 1000 cubic metres processed is rising. In 1990, processing facilities in the Fraser TSA supported 0.73 jobs per 1000 cubic metres processed.[8] Since then, the ratio has increased steadily and in 1997 was 0.80 jobs per 1000 cubic metres processed.

(8) 0.73 is a simple average, thus not weighted by the volume processed by each processing facility type.

7 Socio-Economic Analysis

Table 13. Fraser TSA timber processing employment, by mill type, 1990 – 1997

	Number of jobs							
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Lumber	5,409	4,937	4,860	5,112	5,349	5,386	5,085	4,876
Pulp and paper	1,466	1,094	1,128	1,185	984	1,143	1,479	1,443
Shake and shingle	1,181	1,380	1,362	1,118	1,158	1,170	1,270	992
Plywood/veneer/panel	1,177	1,422	1,526	1,494	1,528	1,545	882	877
Log homes	66	87	80	94	85	133	144	150
Pole and post	106	27	26	80	72	64	67	60
Chip mills	263	61	58	56	62	53	63	62
Total	9,668	9,008	9,040	9,139	9,238	9,494	8,990	8,460

Source: Ministry of Forests.

In 1997, mills in the Fraser TSA processed just over 10.5 million cubic metres of timber, with the Fraser TSA contributing approximately 10% of this total. Approximately 80% of the timber harvested in the Fraser TSA remained in the TSA for processing — some of this volume was sold and distributed through the Vancouver log market and processed into numerous products. Of the total harvest from the Fraser TSA, approximately 80% went to sawmills, 13% to pulp and/or chip mills, and the remainder to shake and shingle, pole and post, log home, and veneer/plywood mills.

The *1994 Fraser TSA Socio-Economic Assessment* indicated that the allowable annual cut of 1.76 million cubic metres supported approximately 1,140 direct processing person-years in the province. Based on the survey completed for this timber supply review, the average 1994 – 1996 annual harvest of 1.36 million cubic metres supported approximately 865 direct processing person-years in the province.[9] Processing the full AAC of 1.55 million cubic metres could support closer to 990 person-years of employment in the province.

(9) Differences in processing employment figures not only reflect lower harvests and production levels, but also differences associated with data sources and methods of estimation between the two analyses.

7 Socio-Economic Analysis

Fraser TSA forestry employment and employment coefficient summary

Employment coefficients have been estimated for use in forecasting the employment impacts of harvest level changes. Table 14 summarizes the average 1994 – 1996 employment supported by the current Fraser TSA's AAC, and the corresponding employment coefficients. The employment coefficients presented here are average employment/harvest ratios (person-years per '000s cubic metres) for the years 1994 – 1996. Since the actual average annual harvest level from 1994 – 1996 was 1.36 million cubic metres and 1.34 million cubic metres from 1995 – 1997, the current AAC of 1.55 million cubic metres could potentially support more jobs, or at least more full-time jobs or a longer work year, and subsequently higher incomes, if fully harvested.

The employment and coefficients are separated into two groups:

1) Fraser TSA employment and employment coefficients, which only includes jobs of those who reside within the Fraser TSA; and

2) provincial employment and employment coefficients, which includes jobs across the province, including the Fraser TSA.

Provincial figures include Fraser TSA employment, employment supported by Fraser TSA timber processed outside the TSA, and employment supported by Fraser TSA timber harvested by individuals living outside TSA boundaries. Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. More detailed information on employment estimates and coefficients can be found in Appendix B, "Socio-Economic Analysis Background Information."

Table 14. Fraser TSA employment and employment coefficients[10], average 1994 – 1996

Forest industry activity	Fraser TSA employment (person-years)	Fraser TSA coefficients (person-years/'000s cubic metres)	Provincial employment (person-years)	Provincial coefficients (person-years/'000s cubic metres)
Harvesting	646	0.47	662	0.49
Silviculture	83	0.06	175	0.13
Processing	741	0.54	865	0.64
Total direct	1,470	1.07	1,702	1.26
Indirect + induced	1,255	0.93	2,035	1.50
Total employment	2,725	2.00	3,737	2.76

Note: Employment estimates are reported in person-years based on average 1994 -1996 employment levels and the average 1994 -1996 harvest of 1.36 million cubic metres (excluding woodlot licences). Wood products transport, and road building and maintenance are included in indirect estimates.

(10) Other employment coefficients may be found in other documents for the same or similar areas. A difference in ratios can occur for several reasons, such as using different sources of employment data and rounding of estimates, dividing employment by a different harvest level, using a different definition of a full-time position, and changing the definition of forestry sub-sectors. However, the magnitude of impacts associated with a timber supply change should illustrate similar effects.

Fraser TSA employment income

The average income for direct forest sector employees in 1996 was about $46,950[11] and indirect and induced average incomes were about $32,500. Consequently, the current level of employment supported by the harvesting and processing of timber from the Fraser TSA generates $79.9 million in direct wages and salaries and $66.1 million in indirect and induced wages and salaries (see Table 15).

A comparison of other average provincial income levels indicates that, on average, forestry is one of the highest paying sectors and a major contributor to local economies. Only mining has average incomes higher than forestry. In 1997, average weekly earnings in the forest sector were approximately $903, compared to mining's average weekly earnings of about $1,050.[12] In comparison, the average weekly income for the construction industry was approximately $709; the average weekly income for other goods-producing industries was $791; the average weekly income for the accommodation, food and beverage service industry was $266, and the average public administration job earned a weekly income of $785.

Table 15. Average provincial direct and indirect/induced incomes and total employment income, 1994 – 1996

	Average wage (1996 dollar value)	Total income ($millions)	Total income ($ per '000s cubic metres)
Direct	46,950	79.9	58,779
Indirect / induced	32,500	66.1	48,634
Total income		146.0	107,413

(11) Price Waterhouse, The Forest Industry in British Columbia, 1996.

(12) Statistics Canada, survey of employment, payroll and hours.

7.2.5 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties and rents to the provincial government for the rights to timber and its use, and other industry operating taxes such as corporate income, property, and sales taxes. The provincial and federal governments also receive revenues from forestry and related employees through income and sales taxes. Table 16 presents the various average provincial government revenues.

Table 16. Average provincial government revenues, 1994 – 1996

	Average revenue 1994-1996 ($1996 millions)	Revenue ($ per '000s cubic metre)
Stumpage, rents and royalties	21.2	16,653
Industry taxes	11.0	8,664
Provincial income tax	11.8	8,720
Total government revenues	44.0	34,037

Source: Ministry of Forests, Price Waterhouse.

7.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast suggests that the current AAC should be reduced immediately by 15% to 1.32 million cubic metres, followed by further declines of 15% and 9% in years 10 and 20, respectively. The socio-economic analysis focuses on changes in the short- to medium-term of about 25 years.

The potential socio-economic impacts are presented in four sections:

- the short- and long-term implications of alternative harvest levels for both the Fraser TSA and the province;
- the nature, production capabilities, and timber requirements of processing facilities;
- community level impacts; and
- regional timber supply issues.

The socio-economic analysis considers average levels of forest industry activity that the base case harvest forecast could support, assuming British Columbia's role in the forest sector continues and labour productivity does not change. The analysis assumes that the proportions of harvesting, processing and silviculture employment remain the same and does not attempt to predict how types of products or the production mix may change in the future. The analysis provides an indication of the magnitude of impacts to expect, within a constantly changing socio-economic environment. For more detailed information on the methods used to estimate economic impacts please refer to Appendix B, "Socio-Economic Analysis Background Information."

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

Fraser TSA employment and income impacts

Table 17 indicates the levels of employment and income the current AAC supports and the levels that could be supported by the timber supply suggested in the base case

harvest forecast. The current AAC of 1.55 million cubic metres could support an average of approximately 1,659 direct forestry person-years and 1,446 indirect and induced person-years in the Fraser TSA, if it is fully harvested.

The base case harvest forecast's initial harvest level of 1.32 million cubic metres could support an average of 1,409 direct forestry person-years and a further 1,228 indirect and induced person-years, which is a reduction of 250 direct person-years and between 175 to 218 indirect and induced person-years from current levels.[13] Total income would decline from current levels by approximately $15.8 to $18.8 million (1996 dollar value).

After two decades, the harvest level of 1.02 million cubic metres per year would support approximately 1,091 direct and 951 indirect and induced person-years: a reduction from current levels of about 568 direct person-years and about 285 to 495 indirect and induced person-years. Total employment income would decline from current levels by between $35.9 and $42.8 million.

Approximately 85% of the direct forestry employment associated with the Fraser TSA consists of persons who reside within the TSA. More specifically, 85% – 95% of the people employed in harvesting reside in the Chilliwack–Mission and Hope-Boston Bar areas of the Fraser TSA. As a result, a reduction in harvesting employment is likely to be concentrated in these regions.

The location of processing employment impacts is much harder to pinpoint, however, as a result of the Fraser TSA's processing facilities' dependence on numerous sources of timber from throughout the Vancouver Forest Region. Generally, processing employment job loss will have more to do with trends in the regional timber supply (i.e., timber from outside the Fraser TSA), than in a change to one timber supply source, such as the Fraser TSA. Actual vulnerability to lower harvest levels can be very different for each mill.

Since the harvest has been at a cyclical low recently, the employment impacts associated with an initial reduction in the AAC to 1.32 million cubic metres may not be as severe for those workers currently employed in the woods. However, the forestry workforce consists of individuals currently working full-time, working part-time, and those waiting to go back to work. In each case, the individuals rely on the forest industry for all or some of their livelihood. Reducing the AAC will impact these forest dependent workers, as suggested in Table 17.

Provincial employment and income impacts

Provincial employment and income includes employment and income of residents of the Fraser TSA, employment and income supported by processing Fraser TSA timber in other areas such as Vancouver Island, and employment and income of those who reside outside the Fraser TSA, but work within the TSA in harvesting and silviculture related activities.

Assuming all of the current AAC of 1.55 million cubic metres is harvested, the Fraser TSA can support approximately 1,950 person-years of direct forestry employment and a further 2,300 indirect and induced person-years across the province. Lowering the AAC to 1.32 million cubic metres would lower provincial direct employment by 294 person-years, and indirect and induced employment by between 261 to 346 person-years. After 20 years, the forecasted harvest level of 1.02 million cubic metres per year would support approximately 1,285 direct and 1,513 indirect and induced person-years. Provincially, this reflects a decline of 668 direct person-years and between 593 to 787 indirect and induced person-years from current full utilization levels.

Annual total employment income would decline in the first decade by $22.3-25.0 million (1996 dollar value). After 20 years, annual total employment income would decline from current levels by between $50 and $57 million.

As stated, the forestry workforce consists of those working full-time, part-time, and those waiting to be called back to work, therefore, the number of employees actively at work depends on the harvest level. Subsequently, the potential loss of active jobs as a result of a reduction in the AAC

depends on the harvest level at the time of the reduction. In any case, however, reducing the AAC will affect all forest dependent workers.

---

(13) The employment range accounts for employment insurance and other social assistance payments that provide short-term income to displaced workers and will lessen the short-term induced employment impacts.

Table 17. Socio-economic impacts of the Fraser TSA base case harvest forecast

		Base case harvest forecast		
	Current[a]	**Years 0-10**	**Years 11-20**	**Years 20+**
Timber supply ('000s m^3)	1,550	1,317	1,119	1,021
Total change from current		- 233	- 431	- 529
Fraser timber supply area impacts				
Employment		(person-years)		
Direct	1,659	1,409	1,197	1,091
Indirect/induced	1,446	1,228	1,044	951
Total	3,105	2,637	2,241	2,042
Range of employment loss[b] (total change from current)		375 to 468	694 to 864	853 to 1,063
Employment income		($millions, in 1996 dollars)		
Direct	77.9	66.2	56.2	51.2
Indirect/induced	47.0	39.9	33.9	30.9
Total	124.9	106.1	90.1	82.1
Range of income loss (total change from current)		15.8 to 18.8	29.2 to 34.8	35.9 to 42.8
Provincial impacts[c]				
Employment		(person-years)		
Direct	1,953	1,659	1,410	1,285
Indirect/induced	2,300	1,954	1,660	1,513
Total	4,253	3,613	3,070	2,798
Range of employment loss (total change from current)		555 to 640	1,026 to 1,183	1,261 to 1,455
Employment income		($millions, in 1996 dollars)		
Direct	91.7	77.9	66.2	60.3
Indirect/induced	74.7	63.5	54.0	49.2
Total	166.4	141.4	120.2	109.5
Range of income loss (total change from current)		22.3 to 25.0	41.2 to 46.4	50.6 to 56.9
Provincial government revenue impacts		($millions, in 1996 dollars)		
Provincial income tax	14.0	11.9	10.1	9.2
Stumpage and rent	25.8	21.9	18.6	17.0
Other forest industry taxes	13.4	11.4	9.7	8.8
Total all government revenues	53.2	45.2	38.4	35.0
Reduction in total revenue		8.0	14.8	18.2

(a) The estimates for current employment differ from those in Table 14 as the figures above are based on the current AAC of 1.55 million cubic metres and Table 14 uses the average 1994-1996 volume of 1.36 million cubic metres.

(b) The ranges provided for employment and income loss account for employment insurance and other social assistance programs that provide short-term income to displaced workers. The range's upper end assumes that all those laid-off will leave the area and will no longer spend any income locally. The lower end assumes that employment insurance and other social assistance payments will partially replace lost incomes, thus reducing induced impacts. Impacts are likely to fall

within the range. Please see Appendix B, "Socio-Economic Analysis Background Information" for more detailed information.

(c) Provincial employment and income estimates include TSA employment and income.

Provincial government revenues

Provincial government revenues from the forest industry include stumpage, royalties and rent payments, other taxes such as logging, corporate income, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees. Under the existing tax and stumpage regimes, the current AAC of 1.55 million cubic metres provides approximately $53.2 million annually to the provincial government (1996 dollar value).

Assuming tax, stumpage, royalty and rent rates do not change, each timber supply reduction would lower annual provincial revenues by approximately $8 million initially, $7 million after the first decade, and 3 million after the second decade. After 20 years, if the harvest level was reduced to 1.02 million cubic metres per year, the provincial government would receive about $18 million less per year than it does now. Table 17 lists the provincial government revenues associated with each timber supply level of the base case harvest forecast.

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

Approximately 80% of the timber harvested in the Fraser TSA is processed within the TSA, with the remainder flowing to other areas of the province such as Vancouver Island. The Fraser TSA currently supplies approximately 8% – 10% of the Vancouver Lower Mainland's total annual requirement of 10 – 11 million cubic metres. Subsequently, the initial change outlined in the base case harvest forecast should not significantly impact the overall Fraser TSA's mill production and employment.

Assuming that a reduction in the harvest level is spread evenly among all tenures, an initial 15% reduction in the timber supply may have a minor effect on some operators. For example, the Fraser TSA supplies one licensee's mills with approximately 6.5% of their requirements. A reduction of 15% in the Fraser TSA harvest would reduce this licensee's mill supply by less than 1%.

A 15% reduction could have more severe consequences for other licensees that rely on Fraser TSA timber for a major portion of their mill's supply. Any reduction in timber supply has the potential of reducing a mill's timber supply to a threshold level* where a reduction in the number of shifts or mill shutdown is necessary.

While the short term (i.e., 10 years) processing impacts may not be severe for the Fraser TSA as a whole, in the medium- to long-term, the timber supply situation will become more acute for processors. After 20 to 25 years, the Fraser TSA's timber harvest could be as much as 34% lower than its current level. This is equivalent to a reduction of 430 000 to 530 000 cubic metres which is a sufficient annual volume to supply a large lumber mill producing 120 to 130 million board feet of timber and employing 200 direct mill workers.

7.3.3 Community level impacts

The socio-economic impacts outlined would occur within a diverse and growing region. The more diversified and expanding the region, the less the whole economy would be negatively impacted by marginal changes in any one sector. For less diversified and more remote communities, however, any reduction to the available timber supply may lead to job loss, population declines, and subsequently alter the area's socio-economic environment (for example, the population, size of the labour force, employment sectors, economic development opportunities and local services).

Threshold level
A mill's timber supply level which, when reached, will cause a mill to reduce the number of shifts or to stop production.

Considering the contribution of the Fraser TSA's timber related activity to the overall economy of the Vancouver Lower Mainland (5.8% of basic income), the area's wide economic diversity and recent population growth rates, changes to the Fraser TSA's harvest level should not significantly influence the overall economic trends of the TSA. However, since the Fraser TSA is comprised of very distinct economic regions with varying degrees of dependence on forestry, this regional perspective should not minimize the potential effects on communities and displaced individuals in more forestry-dependent parts of the Fraser TSA. Over the long term and given regional and provincial trends in timber supply, income from the harvesting and primary products components of the forestry industry could continue to decline in both absolute terms and relative to other sectors.

The parts of the Fraser timber supply area most dependent on the forest sector are the Chilliwack–Mission area, and the Hope-Fraser Canyon area where forestry accounts for 15% of total basic income. A declining timber supply may have a more adverse effect on communities in this area of the Fraser TSA. The lack of significant population growth in the Fraser Canyon, coupled with forestry's dominance as a source of income, makes this area the most vulnerable to harvest reductions. Population migration from the area and a loss of local industrial operations could also affect local communities through a reduction in municipal tax revenues, and potential loss of locally, provincially and federally funded services.

Individuals from the communities of the Fraser TSA who lose their jobs are not only subject to economic concerns, but also physical and emotional difficulty while in transition to another job or profession. Physical and emotional effects on individual workers vary depending on age, education, future job opportunities, and various existing physical and emotional characteristics. Lee[14] notes that unemployment has been associated with a number of physical and emotional, or stress-related symptoms. However, the loss of one's job is only one of many factors associated with illness, although job loss often precipitates physical and/or mental breakdown. A 1996 discussion paper by the Canadian Public Health Association[15] found that the literature examining the health impact of unemployment indicates a strong relationship between unemployment and ill health. This highlights the importance of a quick transition to new opportunities for displaced workers.

7.3.4 Regional timber supply issues

The future timber supply of the Vancouver Forest Region is ultimately the most important issue for primary milling operations in the Fraser TSA. The timber supply feeding mills in the Fraser TSA comes from areas throughout the province, including the Fraser TSA, Vancouver Island, and the coast stretching as far north as the North Coast Forest District and the Queen Charlotte Islands.

The future of the timber supply in the Vancouver Forest Region is a key indicator of the ability or inability of existing operators to maintain production capacity at its current level. From 1994-1996, lumber mills located in the Fraser TSA operated between 81% and 85% of capacity. Lumber mills account for about 80% of the total volume of timber processed by primary mills in the Fraser TSA.

In the Vancouver Forest Region, the previous timber supply review led to a reduction of 9.3% in the coniferous portion of the AAC, or a reduction in the annual harvest of about 2 million cubic metres. Two decades from now, the annual timber supply from Vancouver Forest Region TSAs and tree farm licences could decline by as much 18%, or an additional 3.5 million cubic metres, assuming a continuation of current management practices and land-use priorities.

(14) Lee, Robert, 1993. "Effects of Federal Timber Sales Reductions on Workers, Families, Communities, and Social Services," in *Building Toward a Balances Solution: Position Papers on Northwest Forestry Issues,* compiled by the Northwest Forestry Research Council

(15) Canadian Public Health Assoc. (1996) *1996 Discussion Paper on the health impact of unemployment*

The existing primary milling capacity could not be supported after reductions of this magnitude. For example, a timber supply of 3.5 million cubic metres from the Vancouver Forest Region is comprised of roughly 75% sawlogs. A sawlog supply of 2.6 million cubic metres could support between four and seven large sawmills, based on a mill processing 350 000 to 600 000 cubic metres per year. It is impossible to predict, however, which mills, product types, and communities will be most affected, or if new "value added" operations will offset some of these changes. It is also important to note that changes of this magnitude are over two decades away and would likely occur gradually as industry adjusts to anticipated harvest levels. Regardless, change to the forest industry will likely be substantial.

7.4 Summary

The forest sector remains an important source of income for the Fraser TSA. In addition to primary forestry and manufacturing activity in the TSA, there are many forest company head offices, forestry suppliers, value-added facilities and other forestry related services in Greater Vancouver. The Fraser TSA has the largest concentration of processing facilities in the province and draws on timber supplies from numerous sources in the province. The timber harvested from the Fraser TSA is one of those sources, providing up to 10% of the Fraser TSA's milling requirements.

The current Fraser TSA allowable annual cut is 1.55 million cubic metres and can support an average of approximately 1,950 person-years of direct employment across the province. Approximately 85% of the employees are residents of the Fraser TSA. This direct activity supports a further 2,300 indirect and induced person-years.

Immediately reducing the harvest to 1.32 million cubic metres per year as indicated in the base case harvest forecast would reduce direct provincial employment by as much as 294 person-years, and indirect and induced provincial employment by about a further 261 to 346 person-years.

If the harvest were to continue to decline over the medium-term as suggested in the base case harvest forecast, after 20 years, the Fraser timber supply area harvest would average approximately 1.02 million cubic metres per year and would support approximately 1,285 direct person-years and 1,513 indirect and induced person-years across the province: a reduction of about 668 direct person-years and 593 to 787 indirect and induced person-years. Employment income would be approximately $50 to $57 million less than current levels.

The harvest has been at a cyclical low recently and the initial employment impacts may not be as severe for those workers currently employed in the woods. However, the forestry workforce consists of individuals working full-time, part-time, and those waiting to go back to work. These individuals rely on the forest industry for all or some of their livelihood. Reducing the AAC will impact these forest dependent workers by shortening the work year, the number of full-time jobs, or the overall number of opportunities supported by the forest industry.

Provincial government revenues would also decline. Based on the assumption that rates would remain the same as today, after the second decade the province would collect approximately $18 million less per year from forest industry activity related to the timber harvested from the Fraser TSA.

While the Vancouver Lower Mainland economy is widely diversified and the projected changes to the forest sector as a result of the Fraser TSA timber supply could be overshadowed by general regional economic growth and stability, individual communities, especially in the Hope-Fraser Canyon area are still vulnerable to forest sector changes. Individuals who lose their jobs often have difficulty financially and emotionally, and the specialized skills acquired in forestry jobs are often not easily transferable to other sectors. Actual effects on individuals will

likely depend on the availability of employment options. The gradual reduction in the harvest provides ample time to ensure that any displaced workers have alternative opportunities. However, the context in which these changes will occur also include timber supply reductions in various other areas of the province which may also affect Vancouver Lower Mainland forest products producers.

8 References

B.C. Ministry of Forests, Recreation Branch. 1993. Procedures for factoring recreation resources in timber supply analyses. Victoria, B.C. 10pp.

Canadian Public Health Association. 1996. 1996 Discussion paper on the health impact of unemployment. Canadian Public Health Association: Ottawa.

Horne, Garry, Charlotte Powell. 1996. The revised forest district tables, Ministry of Finance and Corporate Relations.

Horne, Garry, R. Riley, L. Ransom, S. Kosempel. 1996. A provincial impact estimation procedure for the British Columbia forest sector. Ministry of Finance and Corporate Relations.

Lee, Robert. 1993. Effects of federal timber sales reductions on workers, families, communities, and social services, building toward a balances solution: position papers on northwest forestry issues, compiled by the Northwest Forestry Research Council.

9 Glossary

Allowable annual cut (AAC)	The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with Section 8 of the Forest Act.
Basic income and employment	Indicators used to describe the size of a basic sector.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy.
Biodiversity	The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Cutblock adjacency	The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. This can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Employment coefficient	The number of person-years supported by each 1000 cubic metres of timber harvested, for example, a coefficient of 1.0 indicates that each 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	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	Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

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

9 Glossary

Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct businesses purchasing goods and services; induced jobs are supported by employees spending their incomes on things such as groceries, automobiles, restaurant dinners, and haircuts.
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.
Landscape level biodiversity	Maintenance of biodiversity can occur at a variety of levels. The *Forest Practices Code Biodiversity Guidebook* provides objectives for 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 landscape unit provides an appropriately sized (up to 100 000 hectares) planning unit 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 includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
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.

Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

9 Glossary

Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective).
Person-year(s)	A full-time full-year job of at least 200 days per year. A part-time job lasting 100 days per year equals 0.5 of a person-years.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see Visual quality objective).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Site index	A measure of site productivity. Site indices in British Columbia are based on heights of free-growing dominant trees of a given species at a reference age of 50 years above breast height. Site index curves have been developed for British Columbia's major commercial tree species.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Threshold level	A mill's timber supply level which, when reached, will cause a mill to reduce the number of shifts or to stop production.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by separating non-contributing areas from the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with Section 7 of the Forest Act.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimate (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. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

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

A.1 Inventory Information

The inventory information used in this analysis combines the Ministry of Forests forest cover inventory for the Fraser TSA (updated to 1997) with non-standard overlays added to provide information on:

- visual quality objectives;
- operability;
- landscape-unit boundaries;
- biogeoclimatic variants;
- spotted owl special resource management zones (SRMZ); and
- designated community watersheds.

A.2 Zone and Analysis Unit Definition

A.2.1 Management zones and tracking of multiple objectives (grouping)

For the purpose of modelling current forest management, several resource emphasis groupings were defined for this analysis based on common forest management objectives such as forest cover requirements and/or geographic location.

1. Landscape unit/bioegeoclimatic variants;
2. Community watersheds;
3. Spotted owl special resource management zones;
4. Deer winter range; and
5. Visual quality objectives by landscape unit.

Land considered unavailable for timber harvesting was included in the timber supply model and contributed to the attainment of both green-up forest cover objectives and the attainment of old-forest cover objectives.

In visually sensitive areas, adjustments are applied to forest cover requirements to account for the level to which areas excluded from the timber harvesting land base are intermixed with harvestable areas and where late seral forest cover objectives are required, excluded forest must consist of the required biogeoclimatic variant in order to contribute.

Table A-1 shows the inventory variables used to define the various model groupings used in this analysis.

A.2 Zone and Analysis Unit Definition

Table A-1. Groupings created to model forest cover requirements and facilitate modelling of second-growth harvest.

Objectives	Inventory definition
Level 1 grouping — VQOs and cutblock adjacency	
Cutblock adjacency only	No VQO assigned, modelled independently by landscape unit. Divided further by stand age (greater than or less than 100 years old).
VQO = Retention	VQO code = R, requirements modelled independently by landscape unit.
VQO = Retention/partial retention	VQO code = RR, requirements modelled independently by landscape unit.
VQO = Partial retention	VQO code = PR, requirements modelled independently by landscape unit.
VQO = Partial retention/modification	VQO code = PM, requirements modelled independently by landscape unit.
VQO = Modification	VQO code = M, requirements modelled independently by landscape unit.
Level 2 groupings	
Spotted owl SRMZs	SRMZ number, as indicated on spotted owl SRMZ mapping. Requirements for each area modelled independently.
Community watersheds	Community watershed numbers indicated on mapping.
Level 3 groupings	
Deer winter range/draft landscape units (LU)	Each analysis unit/landscape unit combination that falls within areas currently identified on the inventory file by W1 on the ESA field and 'D' in the wildlife modifier field.
Level 4 groupings	
Landscape unit/biogeoclimatic variant	Each LU/variant combination is assigned a unique group number to facilitate modelling of landscape level biodiversity guidelines.

A.2.2 Analysis unit characteristics

To facilitate modelling of stand growth and silvicultural treatments, individual forest stands were grouped according to dominant tree species (inventory type group) and timber growing capability (site index).

A.2 Zone and Analysis Unit Definition

Table A-2. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-20. for existing natural stands and Table A-21. for existing and future managed stands). The analysis units are not management-zone specific; that is, an analysis unit can be in one or more management zones described in Section A.2.1, "Management zone characteristics."

Table A-2. Definition of analysis units

Analysis unit	Criteria	
	Inventory type groups	Site index range[a] (metres)
1 Fir, good site	1 - 8	> 27
2 Fir, medium site	1 - 8	20 through 27
3 Fir, poor site	1 - 8	< 20
4 Cedar, good site	9 – 11	> 25
5 Cedar, medium site	9 – 11	19 through 25
6 Cedar, poor site	9 – 11	< 19
7 Hemlock/balsam, good site	12 – 20	> 21
8 Hemlock/balsam, medium site	12 – 20	14 through 21
9 Hemlock/balsam, poor site	12 – 20	< 14
10 Spruce, good site	21 – 26	>20
11 Spruce, medium site	21 – 26	15 through 20
12 Spruce, poor site	21 – 26	< 15
13 Pine/larch, good site	27 – 31 (inc. Pw)	> 19
14 Pine/larch, medium site	27 – 31 (inc. Pw)	16 through 19
15 Pine/larch, poor site	27 – 31 (inc. Pw)	< 16.
16 Alder	37 –- 38	All sites
17 Maple	39	All sites

(a) Reference age 50 years.

A.2 Zone and Analysis Unit Definition

The site index ranges used to separate stands of each leading tree species into good, medium and poor site analysis units were determined by natural breaks in the distribution of area by site index for each species, summarized from the current forest inventory file.

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Fraser TSA area. One of the first steps in this timber supply analysis was to define the timber harvesting land base. This land base was derived by identifying certain types of land and forest where timber harvesting is not likely to occur under current management. The characteristics of each of these types are discussed below in the order in which they were performed.

A.3.1 Land not managed by the B.C. Forest Service

The ownership (OWNER and OWNR_CH) codes on the inventory file were used to determine which areas are not managed by the B.C. Forest Service. This category may include areas such as parks, ecological reserves, private land and various special use permit areas. Forest in ownerships 62 C (forest management unit) 69 C (forest reserves) and 70 N (timber licences) contributes to timber harvesting within the TSA. Areas with any other ownership codes are excluded from the timber harvesting land base.

A.3.2 Non-forest land

Non-forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) areas do not contribute to timber harvesting. These categories include areas covered by such things as sparse alpine forest, ice, swamps, water, and rock.

A.3.3 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5), were not included in the timber harvesting land base.

A.3.4 Environmentally sensitive areas (ESAs)

Table A-3. shows the criteria used to account for environmentally sensitive areas in which harvesting is not expected to occur.

Table A-3. Description of environmentally sensitive areas

ESA category	ESA description	Reduction per cent (%)
S1	Highly sensitive soils	90
A1	Avalanche hazard	100
P1	Severe regeneration problems	100

The removal of S2 areas (moderately sensitive soils) was also considered. However, exclusions for other factors (low site productivity, inoperable areas etc.) already exclude almost all of the S2 area. Given that some timber harvesting does occur on S2 areas, a decision was made to retain the remaining S2 areas as part of the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

A.3.5 Areas with high recreation values

Recreation areas such as campgrounds, trails and lookout sites are identified in the inventory file through the recreation feature significance and recreation management code variables. Recreation management codes are more current and are used instead of ESA designations for the purpose of excluding areas with high recreation value. Areas with a recreation management class code of '0' are those areas such as established campsites that have very high, identified recreation values.

Table A-4. Description of areas with high recreation values

Recreation management class code	Recreation value description	Reduction per cent (%)
0	High recreation value	100

Data source and comments:

Areas with a recreation management class code of '1' are predominantly visually sensitive areas in which harvesting is expected to occur. These areas are dealt with in the analysis by applying forest cover requirements rather than excluding the areas from the timber harvesting land base

A.3.6 Areas considered Inoperable

Operability codes are generally used to describe the presence of physical barriers or limitations to harvesting, logging methods (e.g., cable), and the merchantability of stands. Areas labelled inoperable on the operability mapping are excluded from the timber harvesting land base.

Table A-5. Description of inoperable areas

Inventory description	Code	Reduction per cent (%)
Inoperable	I	100

Revised operability mapping resulting from a recent review of the operability lines were digitized and added to the current forest inventory file.

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Sites with low timber growing potential

Stands that do not currently have high enough timber volumes to make harvesting feasible and are not likely to achieve a harvestable volume over time (based on estimated site productivity) are excluded from the timber harvesting land base. Table A-6. shows the minimum volume and site productivity criteria used to define stands with low timber growing potential.

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

Species	Characteristics	Reduction per cent (%)
Fir	Existing volume less than 350 m³/hectare and SIBHA50 less than 16 metres (projected not to produce 350 m³/hectare by age 150 years). In heli-log areas (operability = 'H') volume and SI criteria will be based on achieving 400 m³/hectare.	100
Cedar	Existing volume less than 350 m³/hectare and SIBHA50 less than 13 metres (projected not to produce 350 m³/hectare by age 150 years). In heli-log areas (operability = 'H') volume and SI criteria will be based on achieving 400 m³/hectare.	100
Hemlock/balsam	Existing volume less than 350 m³/hectare and SIBHA50 less than 11 metres (projected not to produce 350 m³/hectare by age 150 years). In heli-log areas (operability = 'H') volume and SI criteria will be based on achieving 400 m³/hectare.	100
White spruce (FIZ D)	Existing volume less than 300 m³/hectare and SIBHA50 less than 11 metres (projected not to produce 300 m³/hectare by age 150 years).	100
Sitka spruce (FIZ A, B, C)	Existing volume less than 350 m³/hectare and SIBHA50 less than 6 metres (projected not to produce 350 m³/hectare by age 150 years). In heli-log areas (operability = 'H') volume and SI criteria will be based on achieving 400 m³/hectare.	100
Pine	Existing volume less than 300 m³/hectare and SIBHA50 less than 13 metres (projected not to produce 300 m³/hectare by age 120 years).	100
Alder	Existing volume less than 150 m³/hectare.	100
Maple (used for sensitivity analysis only)	Existing volume less than 150 m³/hectare.	100

A.3 Definition of the Timber Harvesting Land Base

All areas with an activity code of 'L' (logging history) or those stands that currently have more than the required existing volume (indicated in the above table by leading species type) will be retained in the timber harvesting land base regardless of site index. Volumes and site indices used for the purpose of this exclusion will be values calculated after correcting the age, height and volume figures on the inventory file, as recommended through the Fraser TSA inventory audit process. No age criteria is applied to alder and maple stands. Historically, these stands have only been harvested through temporary tenures of relatively short duration. Unless a stand of these types has an existing timber volume that is high enough to be harvested in the short term, it is excluded from the timber harvesting land base.

A.3.8 Problem forest types

Problem forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. These types are wholly or partially excluded from the timber harvesting land base.

Table A-7. Problem forest types criteria

Leading species	Inventory type group	Reduction per cent (%)
Cottonwood	35, 36	100
Aspen, birch	40, 41, 42	100

Cottonwood, birch and aspen leading stands are not currently utilized in the Fraser TSA.

A.3.9 Roads, trails and landings

Separate estimates are made to reflect the loss in productive forest land due to existing and future roads, trails and landings (RTL). Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting and future RTL reductions are applied after stands are harvested for the first time in the simulation model.

Table A-8. Estimates for existing and future roads, trails, and landings

Location	Age class	Road length (kilometres)	Road width (metres)	Reduction area (hectares) or per cent
Existing RTLs				
Roads	1 to 6	7500	15	11 250 hectares
Trails, landings	1 to 6			3 400 hectares
Future RTLs				
Roads, trails, landings	7 – 9			1%

Existing roads reductions are based on an estimated length of road (Forest Service, road permit, and non-status roads) in the Fraser TSA of 7500 kilometres and an average right of way width of 15 metres, for a total estimated road area of 11 250 hectares. The estimated length of forest road in the Fraser TSA was derived by the Chilliwack Forest District staff from road lengths shown on current forest inventory maps. An additional 3400 hectares is added to the estimate to account for existing landings and trails not shown on the inventory maps.

Due to the long history of timber harvesting in the area, the Fraser TSA is almost completely roaded (estimated at about 96.5% by the Chilliwack Forest District staff). If the per cent reduction for existing roads is applied to the 3.5% (approximately) of the Fraser TSA that is not roaded, the total additional reduction from the timber harvesting land base for future roads is 1% of the older age classes.

A.3.10 Riparian reserve zones

In order to account for riparian reserve zones the timber harvesting land base is reduced by 4.8%. This figure is based on coastal average figures for stream length by stream class, estimated in a 1994 study completed by Wild Stone Resources and the riparian reserve width specifications for each stream class found in the Riparian Management Area Guidebook. The per cent area excluded from the timber harvesting land base is calculated by multiplying the specified reserve width for each stream class by the lengths of stream of each class found on the cutblocks sampled (92 coastal cutblocks), then dividing by the total area of cutblocks sampled. The information to be used in the analysis to capture the effect on timber supply from the riparian management zone is dealt with in Section A.4.3, "Forest cover requirements."

A.3 Definition of the Timber Harvesting Land Base

A.3.11 Exclusion of specific, geographically defined areas

The purpose of this section is to specify the location and total area to be excluded from the timber harvesting land base to account for any area exclusions that are a part of current forest management but which have not already been accounted for in the inventory file.

Table A-9. Exclusion of specific, geographically defined areas

Identifying inventory variables (location descriptors)	Excluded area (hectares)
Mehatl Creek Protected Area (PA) (on new PAS mapping)	All
Liumchen PA (on new PAS mapping)	All
Chilliwack Lake PA (on new PAS mapping)	All
Mystic Lake PA (on new PAS mapping)	All
Nahatlatch PA (on new PAS mapping)	All
Sumas Mountain PA (on new PAS mapping)	All
Yale/Garry Oak PA (on new PAS mapping)	All

Pinecone-Burke Mountain and Indian Arm Parks are already accounted for on the forest inventory and are excluded from the timber harvesting land base by the ownership code criteria shown in Section A.2.1 "Land not managed by the B.C. Forest Service."

A.3.12 Timber licence reversions

Timber licences are old-tenure arrangements that give a licensee exclusive rights to harvest merchantable timber within the licence area and do not contribute to the TSA allowable annual cut. Once these areas have been harvested, regenerated and attain free-growing status, the timber licence area reverts to the B.C. Forest Service jurisdiction. Accordingly, these areas are included in the timber harvesting land base after the first harvest and contribute to the Fraser TSA harvests in medium- to long-term timber supply.

A.3 Definition of the Timber Harvesting Land Base

Table A-10. Timber licence reversion schedule

Area of timber licences (TL) harvested (hectares) (year of harvest)		
1997-2001	**2002-2006**	**2007-2011**
1/3 of unharvested TL area	1/3 of unharvested TL area	1/3 of unharvested TL area

One-third of the area of the timber harvesting land base that is in currently unharvested timber licences (defined as age class 7, 8 and 9 stands that are ownership code 70N on the inventory file) is assumed to revert to the TSA in each of the five-year periods identified in the above table. Timber licence areas that are younger than age class 7 are assumed to have already been harvested and reverted for the purpose of this analysis.

Timber licence areas are initially assigned to "groups" and analysis units in the same way as the rest of the land base. When a timber licence area reverts it will remain in the same groups and analysis units that it is initially assigned to.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization level defines the maximum allowable stump height, and the diameters at breast height (1.3 metres) and at the top of the tree used to calculate merchantable timber volumes.

Table A-11. reflects current regional utilization standards, licence requirements and current performance.

Table A-11. Utilization levels

	Utilization		
Leading species	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Pine/larch	12.5	30	10
Interior spruce	12.5	30	10
All others	17.5	30	10

A.4.2 Minimum harvestable age by analysis unit

Minimum harvestable ages are, as the term implies, the minimum age at which harvesting is expected to be feasible. While harvesting may occur in stands at the minimum requirements in order to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large inter-decadal changes in harvest levels), most stands will be not be harvested until past the minimum timber production ages because management of other resource values take precedence (e.g., requirements for the retention of older forest).

A.4 Forest Management Assumptions

Table A-12. Minimum harvestable age criteria

Analysis unit	Estimated age to reach required average stand volume		Estimated age for 250 biggest stems to reach 30 cm	Estimated minimum harvestable age (years)	MAI (m^3/hectare/year) and age (years) at culmination (regen. stands)
	Age (years)	Minimum volume (m^3/hectare)			
1 Fir, good site	50	350	40	50	9.0 @ age 75
2 Fir, medium site	70	350	55	70	5.7 @ age 80
3 Fir, poor site	140	350	90	140	2.6 @ age 110
4 Cedar, good site	N/A	N/A	N/A	70	12.5 @ age 100
5 Cedar, medium site	N/A	N/A	N/A	80	7.4 @ age 120
6 Cedar, poor site	N/A	N/A	N/A	110	3.4 @ age 130
7 Hemlock/balsam, good site	55	350	50	55	8.2 @ age 100
8 Hemlock/balsam, medium site	100	350	90	100	3.8 @ age 140
9 Hemlock/balsam, poor site	170	350	130	170	2.1 @ age 190
10 Sitka spruce, good site	55	350	50	55	8.8 @ age 100
11 Interior spruce, medium site	95	300	80	95	3.4 @ age 110
12 Interior spruce, poor site	145	300	120	145	2.2 @ age 160
13 Pine/larch, good site	70	300	60	70	4.5 @ age 70
14 Pine/larch, medium site	100	300	90	100	3.1 @ age 80
15 Pine/larch, poor site	140	300	210	140	1.7 @ age 125

16 Alder – all sites	150	40
17 Maple – all sites	150	40

Data source and comments:

Minimum harvestable ages for cedar stands are set at the age at which the estimated growth rate of the stand is within 5% of the culmination (maximum) of mean annual increment (MAI). The reason that minimum harvestable ages for cedar are set using different criteria than is used for other stands is that cedar is not expected to be merchantable at the ages that are indicated if only the minimum volume/piece size criteria are used (i.e., little clear wood and poor decay resistance at young ages).

For all analysis units, minimum harvestable ages are based on managed stands growth and yield estimates. No minimum harvestable age for any analysis unit will be less than 40 years. Estimated minimum harvestable ages may be subject to change once the timber harvesting land base has been finalized, and the productivity of stands included in the timber harvesting land base determined.

Alder and maple stands are only included in the timber harvesting land base if there is more than 150 cubic metres of merchantable volume per hectare currently present. No accounting is made for stands that that may achieve this required volume in the future.

A.4.3 Forest cover requirements

Current forest management practices in the Fraser TSA that were modelled using forest cover requirements and the rationale/source for the forest cover requirements are as follows:

- Landscape-level biodiversity guidelines — only the old-seral guidelines were modelled, consistent with the assumptions used in the *Forest Practices Code Timber Supply Analysis*. As biodiversity-emphases have not yet been approved for landscape units in the Fraser TSA, an average old-seral prescription was applied to all landscape units. This average prescription was calculated assuming a distribution of area between biodiversity-emphases of 45% low-biodiversity, 45% intermediate-biodiversity and 10% high-biodiversity. The per cent area of old-seral forest to be maintained over time under each biodiversity-emphasis is based on values taken from the *Forest Practices Code Biodiversity Guidebook* according to biogeoclimatic variant. determined for each area of the Fraser TSA. The final old-seral requirements calculated using this method for each landscape unit/variant combination are shown in Table A-13.

A.4 Forest Management Assumptions

Table A-13. Seral-stage requirements (per cent old seral) by natural disturbance type (NDT) over time

		Starting year for requirement		
	Base per cent (%)	**1**	**70**	**140**
NDT 1	13	4.3	8.6	13
	13	13	13	13
	19	19	19	19
	Average	10	12	14
NDT 2	9	3	6	9
	9	9	9	9
	13	13	13	13
	Average	7	8	9
NDT 3	14	5	10	14
	14	14	14	14
	21	21	21	21
	Average	11	13	15
NDT 4	13	4.3	8.6	13
	13	13	13	13
	19	19	19	19
	Average	10	12	14

In NDTs 1, 2 and 4, old seral forest is defined as stands older than 250 years. In NDT 3, old seral forest is defined as stands older than 140 years.

Mature plus old requirements for the NDT 3 and NDT 4 types over time were calculated using the same approach. However, given the marginal nature of stands that fall into these natural disturbance types in the Fraser TSA, more than one-half of each variant that falls into these NDTs are already excluded from the timber harvesting land base making a mature plus old requirement redundant.

- Visual quality objectives (VQO) — the visual quality objective for each area of the Fraser TSA was determined by VQO mapping revised by the Chilliwack Forest District staff in 1997. Guidelines provided in *Procedures for Factoring Recreation Input into Timber Supply Analysis* were used to derive forest cover requirements for areas under each VQO within each landscape unit. Table A-14. shows the per cent of the forested area within each VQO that is allowed to be not greened-up at any time, before accounting for the geographic distribution of unharvestable areas (which still contribute forest cover towards visual quality objectives) amongst the timber harvesting land base. The sample calculation shown below Table A-14. provides an example of the way in which the forest cover requirement was determined for each VQO within each landscape unit.

Table A-14. Per cent of the forested portion of each VQO area that may be not greened-up at any time, before accounting for dispersion of inoperable/operable areas

Visual quality objective	Per cent area that may be cutover and not greened-up at any time
Retention	3
Retention/partial retention	6
Partial retention	10
Partial retention/modification	15
Modification	20

Sample calculation:

If:

Operable to "green" ratio (O/G) = ½

VQO = partial retention, per cent not greened-up = 10 (from Table A-14.).

Dispersion of unharvestable areas amongst the harvestable area within each landscape unit/VQO combination is assumed to be 10% well dispersed, 25% dispersed, but in larger "clusters", 65% not dispersed (large contiguous areas of unharvestable and large contiguous areas of harvestable).

Using the above assumptions, the per cent of total forested area within the VQO that may be less than the required green-up height equals:

Per cent well dispersed * 10% cutover plus

Per cent clustered * 10% cutover * (1 + O/G)/2 plus

Per cent not dispersed * 10% cutover * O/G

Filling in the values for per cent dispersed/clustered/not dispersed and the O/G ratio results in the following value:

10% * 10 + 25% * 10 * 1.5/2 + 65% * 10 * 0.5 = 6.2% cutover that is not greened-up at any time

The above calculation was completed independently for areas of each VQO class within each landscape unit and the final maximum per cent cutover calculated for each area varies considerably due to differences in the O/G ratio within each area.

The average time required for stands to reach green-up (estimated to be 5 metres in height) was determined using the mean areas weighted site index of all harvestable stands within each VQO class as input to FREDDIE, a computer based site index estimation program created by the B.C. Ministry of Forests. Given that the mean area weighted site index did not vary significantly between the various VQO classes, all green-up periods rounded to 16 years. This green-up age does not include regeneration delays which are accounted for independently in the timber supply model.

Community watersheds

In this timber supply analysis, a maximum of 5% of the forested area within a community watershed can be harvested within a 5-year period. This forest cover requirement reflects the guideline provided on page 59 of the *Forest Practices Code Community Watershed Guidebook*.

Spotted owl SRMZs

Within each SRMZ, a minimum of 67% of the forested area will be maintained in stands older than 100 years at all times. This forest cover requirement is consistent with the management prescription set out in the spotted owl management plan for the Fraser TSA.

Deer winter range

Management of deer winter range was accounted for in the analysis via the following method:

The area of deer winter range currently identified on the forest inventory (ES1 = "W", ESA modifier = "D") within each landscape unit is summarized by analysis unit.

The proportion of each analysis unit (leading tree species/site productivity combination) that is currently identified as deer winter range within each landscape unit will be maintained in perpetuity. Although the same specific area will not necessarily be maintained, this prescription ensures that forest cover of the same type and within the same landscape unit will be maintained.

A.4 Forest Management Assumptions

Riparian management zones

Riparian management zones were not modelled using forest cover requirements. To account for the timber volume that will be left unharvested in riparian management zones, as specified under the Forest Practices Code Riparian Management Area Guidebook, all volume over age curves for both existing natural and regenerated stands will be reduced by 4.2%. This assumption is based on average coastal stream density figures for the coast, as discussed in Section A.3.10, "Riparian reserve zones".

Wildlife tree patches

A 3% reduction is applied to all volume over age curves to account for the timber volume left unharvested in wildlife tree patches. The figure of 3% shown in Table A-15. is based on the assumption that only one-quarter of the total requirement of 12% must be provided by the timber harvesting land base after considering areas already excluded for other reasons. The figure of 12% is taken from Table 20B of the Forest Practices Biodiversity Guidebook using the assumptions (estimated from inventory file summaries) that about 50% of the forested area of the TSA is harvestable, and that 70% of the area has already been harvested once without recommended wildlife tree retention.

A volume reduction is used to model wildlife tree patch requirements rather than an area reduction because it is felt to more accurately portray the area upon which harvesting has occurred For example, a 10 hectare block with 0.3 hectares (3% of the cutblock area) in wildlife tree patches will have the dimensions of a 10 hectare block (i.e., 200 metres by 500 metres), not a 9.7 hectare block that would be assumed using an area reduction.

Table A-15. Reductions to reflect volume retention in cutblocks for wildlife tree patches

Management zone	Analysis unit	Persistence	Per cent (%) recommended in applicable guidebook	Residual volume estimate on the timber harvesting land base (%)
All	All	Long term	12	3

A.4 Forest Management Assumptions

A.4.4 Unsalvaged losses

This section outlines the methods used to estimate the average annual unsalvaged volume losses due to insect epidemics, fires, and wind. Timber volume losses to insects and diseases that normally occupy stands (so-called endemic losses) are accounted for in inventory sampling for timber yield estimation. The purpose of the unsalvaged losses estimate is to account for catastrophic events and other factors not recognized in yield estimates. Table A-16. summarizes the estimate for unsalvaged losses in the Fraser TSA used in this analysis.

Table A-16. Unsalvaged losses

Cause of loss	Total loss (m^3/year)	Annual unsalvaged loss (m^3/year)
Fire	17 000	15 925
Wind damage	31 500	2 500
Total	48 500	18 425

Data source and comments:

Wind damage

Based on the *1992 Insect and Disease Report* the average area lost to wind damage is 90 hectares per year. The average volume is 350 cubic metres per hectare thus, the total projected volume loss is 31 500 cubic metres. On average about 29 000 cubic metres per year is salvaged, therefore the unsalvaged losses attributed to wind is 2500 cubic metres per year.

A.4.5 Basic silviculture and regeneration assumptions

Basic silviculture consists of any activities required to establish free-growing stands of commercially-valued tree species after harvesting an area. Basic silviculture is a legislated requirement under the Forest Act, and is assumed to occur in the Fraser TSA. Table A-17. outlines the regeneration regime for each analysis unit, and specifies the expected regeneration delay following harvesting.

A.4 Forest Management Assumptions

Table A-17. Regeneration assumptions

Analysis unit	Regen delay	OAFs 1	OAFs 2	Method Type	Method %	Species Code	Species %	Density
1 Fir, good site	2	15	5	Plant	100	Fd	100	1200
2 Fir, medium site	2	15	5	Plant	100	Fd	100	1200
3 Fir, poor site	3	15	5	Plant	100	Fd	100	1200
4 Cedar, good site	2	15	5	Plant	100	Cw	100	1200
5 Cedar, medium site	2	15	5	Plant	100	Cw	100	1200
6 Cedar, poor site	3	15	5	Plant	100	Cw	100	1200
7 Hemlock/balsam, good site	2	15	5	Plant/natural	100	Hw	100	1200
8 Hemlock/balsam, medium site	3	15	5	Plant/natural	100	Hw	100	1200
9 Hemlock/balsam, poor site	4	15	5	Plant/natural	100	Hw	100	1200
10 Spruce, good site	3	15	5	Plant	100	S	100	1200
11 Spruce, medium site	3	15	5	Plant	100	S	100	1200
12 Spruce, poor site	3	15	5	Plant	100	S	100	1200
13 Pine/larch, good site	2	15	5	Plant	100	Pl	100	1200
14 Pine/larch, medium site	2	15	5	Plant	100	Pl	100	1200
15 Pine/larch, poor site	3	15	5	Plant	100	Pl	100	1200
16 Alder	2	15	5	Plant	100	Fd Dr	75 25	1200
17 Maple	2	15	5	Plant	100	Fd Mb	75 25	1200

Data source and comments:

All stands are assumed to have their density controlled by free-to-grow, whether planted or natural regeneration is used. Therefore, yield curves for all regenerated stands are based on planted stands. Operational adjustment factors (OAFs) applied to the managed stand yield curves are as recommended by the Ministry of Forests', Research Branch. The values in the above table are based on current performance as estimated by the forest district staff.

A.4 Forest Management Assumptions

All regenerated stand volume over age curves for coniferous-leading stands were modelled using the table interpolation program for stand yields (TIPSY), deciduous analysis units were modelled using the variable density yield prediction (VDYP).

Table A-18. identifies stands of existing immature forest where the density (stems per hectare) was controlled. These stands will be immediately assigned to managed stand yield curves (TIPSY).

Table A-18. Immature plantation history

	Area managed (%)		
Analysis unit	**Age 1-10**	**Age 11-20**	**Age 21-30**
All Douglas-fir	100	100	100
All hemlock/balsam	100	100	
All cedar	100		
All pine/larch	100		
All spruce	100		

A.4.8 Not satisfactorily restocked (NSR) areas

Land classified in the Fraser TSA inventory file as type identity 4 or 9 is included in the current timber harvesting land base. These type identities indicate not satisfactorily restocked land base. Table A-19. identifies the total area of NSR currently existing in the timber harvesting land base, and the estimated rate at which the NSR area will be restocked.

A.4 Forest Management Assumptions

Table A-19. Not satisfactorily restocked (NSR) areas

Analysis unit	Area (hectares)	Hectares of NSR restocked during the first decade	
		Already restocked	1 – 10
1 Fir, good site	961	538	423
2 Fir, medium site	681	381	300
3 Fir, poor site	2 624	1 469	1 155
4 Cedar, good site	133	74	59
5 Cedar, medium site	91	51	40
6 Cedar, poor site	150	84	66
7 Hemlock/balsam, good site	4 111	2 301	1 810
8 Hemlock/balsam, medium site	2 170	1 215	955
9 Hemlock/balsam, poor site	9 277	5 193	4 084
10 Spruce, good site	145	81	64
11 Spruce, medium site	1 642	919	723
12 Spruce, poor site	660	369	291
13 Pine/larch, good site	72	40	32
14 Pine/larch, medium site	21	12	9
15 Pine/larch, poor site	125	70	55
16 Alder	55	31	24
17 Maple	26	15	11
Total	22 945	12 844	10 100

Data source and comments:

A total of 22 945 hectares is classified as NSR on the forest inventory. However, ISIS and MLSIS summaries (which are more up-to-date) indicate that only 10 100 hectares of NSR remain to be restocked. The difference between these two figures (12 844 hectares) is assumed to have already been restocked and will be immediately assigned to age group 1 to 10 years in FSSIM.

A.5 Volume Estimates for Existing Stands

The variable density yield projection (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. Table A-20. shows the volume estimates by analysis unit for existing natural stands.

A.5 Volume Estimates for Existing Stands

Table A-20. Timber volume tables for existing natural stands (cubic metres)

Table no.	1	2	3	4	5	6	7	8	9
Age	**Fir-G**	**Fir-M**	**Fir-P**	**Cedar-G**	**Cedar-M**	**Cedar-P**	**Hem/Bal-G**	**Hem/Bal-M**	**Hem/Bal**
10	0	0	0	0	0	0	0	0	0
20	0.89	0.03	0.02	0.71	0.02	0	0.55	0.01	0.01
30	89.7	31.59	0.29	95.42	23.98	0.17	51.67	0.85	0.31
40	207.57	128.18	22.66	209.2	106.24	17.19	169.02	19.49	1.07
50	307.79	213.43	81.62	314.17	185.86	60.79	271.94	72.12	12.14
60	393.76	286.23	132.81	410.98	260	106.78	363.42	130.54	42.03
70	467.06	348.79	176.72	495.77	326.36	148.93	440.33	184.72	80.68
80	531.62	403.69	215.23	574.07	387.91	188.03	508.03	231.33	115.82
90	587.04	450.58	248.5	637.05	438.26	221	563.8	271.49	147.28
100	635.85	491.85	277.97	691.68	482.18	250.13	611.61	306.92	175.53
110	679.16	528.56	304.3	739.59	520.83	276.01	652.94	338.33	200.99
120	717.43	560.86	327.59	776.58	550.59	296.13	687.64	365.56	223.67
130	748.11	587.33	346.54	821.75	586.3	318.86	725.41	393.5	246.29
140	773.43	609.14	362.1	863.14	618.98	339.47	760.09	419.26	267.37
150	793.1	626.03	374.23	898.83	647.46	357.26	791.14	442.59	286.84
160	807.19	637.97	382.96	929.23	671.79	372.27	818.84	463.64	304.8
170	815.84	645.08	388.33	954.54	692.1	384.56	843.48	482.59	321.35
180	819.74	648.19	390.94	980.04	712.97	397.3	866.38	500.27	336.9
190	829.31	655.73	396.26	1 005.66	733.62	409.99	888.07	517.18	351.66
200	839.15	663.5	401.64	1 030.12	753.2	422.13	908.26	533.07	365.59
210	848.91	671.17	406.89	1 054.39	771.97	433.66	927.04	547.98	378.73
220	858.43	678.6	411.89	1 083.3	794.82	447.53	944.53	561.99	391.15
230	867.65	685.72	416.62	1 111.37	816.96	461.19	960.86	575.15	402.88
240	876.54	692.52	421.08	1 138.63	838.39	474.41	976.1	587.52	413.99
250	885.07	699	425.26	1 165.08	859.14	487.23	990.33	599.15	424.49
260	885.56	699.93	426.47	1 168.02	862.27	489.34	999.36	607.15	432.99
270	885.99	700.77	427.59	1 170.64	865.14	491.28	1 007.65	614.6	441.02
280	886.35	701.54	428.63	1 172.96	867.77	493.1	1 015.24	621.54	448.61
290	886.66	702.23	429.61	1 175.03	870.17	494.76	1 022.15	628.01	455.78
300	886.91	702.87	430.51	1 176.87	872.36	496.31	1 028.48	634.04	462.57
310	887.12	703.44	431.37	1 178.47	874.36	497.74	1 034.25	639.66	469
320	887.28	703.95	432.16	1 179.88	876.18	499.06	1 039.53	644.89	475.1
330	887.4	704.41	432.89	1 181.09	877.82	500.27	1 044.32	649.77	480.87
340	887.48	704.81	433.56	1 182.1	879.31	501.4	1 048.68	654.32	486.36
350	887.54	705.17	434.19	1 182.92	880.64	502.43	1 052.64	658.54	491.56

continued

A.5 Volume Estimates for Existing Stands

Table A-20. Timber volume tables for existing natural stands (cubic metres) (concluded)

Table no.	10	11	12	13	14	15	16	17
Age	**Spruce-G**	**Spruce-M**	**Spruce-P**	**Pine/Lx-G**	**Pine/Lx-M**	**Pine/Lx-P**	**Alder-All**	**Maple-All**
10	0.01	0	0	0	0	0	2.06	8.77
20	7.26	0.6	0.16	0.16	0.07	0	40.41	64.37
30	30.6	2.97	3.59	5.04	2.38	0.19	108.65	139.47
40	105.05	7.6	8.92	54.1	22.36	3.01	173.92	207.75
50	194.38	21.22	17.32	104.52	60.57	28.6	225.74	260.33
60	271.72	81.4	30.54	150.75	97.12	62.72	266.97	301.65
70	338.11	139.67	47.35	193.15	130.49	94.96	285.88	331.34
80	395.26	191.56	85.6	232.24	161.15	125.4	302.25	356.49
90	443.78	237.16	126	268.42	189.52	153.95	316.05	377.41
100	485.25	277.04	163.19	302.23	215.89	180.86	328.1	395.56
110	520.84	311.84	197.43	333.93	240.58	205.97	338.35	408.73
120	551.07	342.09	228.64	363.98	263.79	229.67	347.23	420.17
130	579.76	370.08	258.29	391.12	285.34	251.32	355.33	430.19
140	605.01	394.97	285.6	407.46	300.15	266.69	362.29	438.57
150	627.08	416.92	310.72	418.61	311.41	278.65	368.29	445.58
160	646.22	436.35	333.77	425.74	318.76	286.96	373.09	451.08
170	662.7	453.52	354.94	429.11	322.98	291.61	377.01	455.26
180	677.18	468.77	374.39	428.8	324.42	292.87	380.51	458.92
190	690.88	482.66	392.43	426.53	324.05	292.48	384.3	463.4
200	703.48	495.24	409.28	428.14	326.38	294.66	387.96	467.75
210	715.08	506.68	424.95	430.15	328.95	296.98	391.45	472.05
220	725.77	517.03	439.53	432.33	331.48	299.24	395.08	476.75
230	735.53	526.5	453.09	434.5	333.97	301.41	398.54	481.29
240	744.54	535.09	465.76	436.7	336.32	303.45	401.87	485.74
250	752.79	542.97	477.6	438.73	338.52	305.29	405.06	490.03
260	759.68	549.63	488.23	440.74	340.21	306.85	406.01	490.49
270	766.07	555.61	498.17	442.65	341.75	308.27	406.88	490.9
280	772.08	560.99	507.49	444.35	343.18	309.54	407.7	491.28
290	777.7	565.86	516.27	445.96	344.46	310.54	408.43	491.62
300	782.88	570.16	524.51	447.45	345.61	311.04	409.11	491.94
310	787.8	574.11	532.25	448.75	346.61	311.31	409.72	492.22
320	792.45	577.7	539.56	449.9	347.43	311.31	410.3	492.48
330	796.75	581	546.41	450.95	348.01	311.08	410.81	492.71
340	800.86	583.98	552.82	451.85	348.35	310.67	411.28	492.92
350	804.71	586.75	558.78	452.61	348.24	309.99	411.71	493.11

A.6 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. The area-weighted site index for each analysis unit was used, along with regeneration assumptions, as input to TIPSY. Section A.4.5 and Table A-18. document which stands are assumed to be managed in the analysis.

Operational adjustment factors (OAFs) used in managed stand yield table generation were:
OAF1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand), and OAF2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age).

Table A-21. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age.

A.6 Volume Estimates for Regenerated Stands

Table A-21. Timber volume tables for managed stands (cubic metres)

Table no.	101	102	103	104	105	106	107	108	109
Age	**Fir-G**	**Fir-M**	**Fir-P**	**Cedar-G**	**Cedar-M**	**Cedar-P**	**Hem/Bal-G**	**Hem/Bal-M**	**Hem/Bal**
0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
20	4	0	0	4	0	0	0	0	0
30	129	34	2	141	11	0	50	0	0
40	262	142	22	325	129	6	174	8	0
50	403	228	68	496	253	53	292	63	5
60	519	309	123	670	357	118	411	127	18
70	624	385	165	823	460	178	526	188	58
80	716	452	200	986	562	240	630	243	96
90	791	505	230	1 120	652	294	732	295	134
100	852	554	256	1 245	723	334	823	344	167
110	904	599	284	1 351	803	369	897	396	199
120	946	638	308	1 457	884	409	960	444	228
130	982	674	330	1 554	951	448	1 024	487	254
140	1 013	705	350	1 631	1 006	482	1 082	525	280
150	1 039	730	369	1 699	1 056	513	1 136	559	304
160	1 064	752	385	1 762	1 104	542	1 186	595	325
170	1 089	772	400	1 817	1 146	567	1 229	629	347
180	1 112	789	413	1 868	1 183	589	1 263	661	370
190	1 132	804	424	1 917	1 214	608	1 293	689	391
200	1 149	817	434	1 959	1 242	624	1 320	716	411
210	1 165	829	443	2 002	1 268	638	1 349	740	429
220	1 179	840	451	2 051	1 300	655	1 375	762	445
230	1 191	849	458	2 095	1 336	671	1 399	783	459
240	1 199	857	464	2 136	1 369	686	1 420	800	473
250	1 205	863	470	2 180	1 399	702	1 438	815	485
260	1 210	869	475	2 221	1 427	722	1 454	828	496
270	1 214	874	480	2 259	1 451	740	1 468	841	507
280	1 217	878	485	2 293	1 471	757	1 480	852	516
290	1 219	882	490	2 330	1 490	772	1 492	862	526

continued

A.6 Volume Estimates for Regenerated Stands

Table A-21. Timber volume tables for managed stands (cubic metres) (concluded)

Table no.	110	111	112	113	114	115
Age	Spruce-G	Spruce-M	Spruce-P	Pine/Lx-G	Pine/Lx-M	Pine/Lx-P
0	0	0	0	0	0	0
10	0	0	0	0	0	0
20	0	0	0	7	1	0
30	19	0	0	72	28	10
40	128	10	0	142	78	45
50	285	58	1	209	126	87
60	420	117	12	268	166	123
70	542	179	44	314	210	153
80	665	231	83	351	247	182
90	783	281	122	380	275	214
100	882	336	162	405	299	239
110	969	375	198	425	320	258
120	1 052	404	229	443	337	275
130	1 120	427	260	457	351	290
140	1 176	445	293	469	363	303
150	1 225	460	325		373	314
160	1 268	473	350		382	323
170	1 305	484	371		390	331
180	1 335	492	387		396	338
190	1 353	498	401		402	344
200	1 368	503	413		407	349
210	1 381	506	422		411	353
220	1 392	504	430		415	357
230	1 402	503	438		418	360
240	1 409	501	445		420	363
250	1 415	500	450		422	366
260	1 420	498	456		424	368
270	1 424	494	460		425	369
280	1 426	491	463		426	371
290	1 428	488	465		427	372

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The report identifies employment and income impacts, changes in government revenues, and community impacts at various harvest levels and times in the future. This type of analysis requires several assumptions of which the reader should be aware. Some of these assumptions are outlined below:

- Employment multipliers — the multipliers used in the analysis of indirect and induced impacts are based on analytical assumptions and estimated using data collected at a certain time, thus they reflect industry and employment conditions at that time. Consequently, they may not accurately reflect future industry conditions. While generally good indicators when based on fairly recent information, older multipliers can be dated and potentially unreflective of the industry under examination. In any impact analysis, the information should be considered as order of magnitude indicators.
- Employment coefficients — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, the employment coefficients may change in future, as a result of changing market conditions or production technologies, for example.
- Timing of impacts — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Additionally, indirect and induced impacts will likely occur over a longer period of time, as business and consumer spending levels adjust.
- Processing thresholds — processing job impacts are unlikely to occur in direct proportion to harvest changes, i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction. Impacts are more likely to occur in a step-wise manner related to processing thresholds. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay-off a shift or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is not possible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. Over the medium- to long-term the impact figures should be reasonably accurate, however.
- Government expenditures — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This would amplify the community impacts of forestry job losses or gains.
- Proportional harvest reductions — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

B.2 Economic Impact Analysis Methodology

To estimate employment and income impacts associated with TSA timber harvests and AAC changes the forest sector has been divided into three sub-sectors: harvesting, processing, and silviculture. Current direct forestry activity was first assessed, followed by an estimation of indirect and induced impacts. Employment coefficients were calculated and then applied to the base case harvest forecast of the timber analysis. Other indicators of forestry's contribution to the provincial economy were also examined.

All employment is measured in terms of person-years. A person-year is defined as a full-time full year job, which lasts at least 200 days per year. All reported part-time positions have been converted to person-years.

Data sources

Data for the economic impact section were drawn from several sources. Harvest volume and stumpage data came from the Ministry of Forests. Timber flow and employment data were obtained through surveys of licensees, smaller operators, and processing facilities operating within the TSA. Other general economic data came from B.C. Statistics., the Ministry of Finance and Corporate Relations, Statistics Canada, and local communities.

Harvesting

Direct harvesting employment consists of all woodlands related jobs including harvesting, log salvage, planning and administration functions. It does not include log hauling, road building or maintenance work. While log hauling, road building and road maintenance work are important components of forestry operations, the employment multipliers used in this analysis treat these activities as indirect. Including log hauling, road building and road maintenance in the estimate of direct employment would result in double-counting, thus overstating impacts related to changes in harvest levels.

Data on employment, place of residence, and timber flows were obtained by surveying licensees and smaller operators. The information was used to estimate employment averages associated with the harvest and the proportion of workers living within the Fraser TSA.

Two estimates of direct harvesting employment were generated:

1) TSA direct harvesting employment — consisting of direct harvesting related employees who work in the TSA and reside in communities within the TSA; and
2) provincial direct harvesting employment — consisting of the employment included above, plus those individuals who reside outside the TSA, but who come to the TSA to work in harvesting related activities.

The estimates of local- and provincial-direct employment are used to determine ratios of employment per 1000 cubic metres. These employment coefficients can then be used to estimate harvesting employment associated with any harvest level.

B.2 Economic Impact Analysis Methodology

Processing

Questionnaires were sent to primary processors in the Fraser TSA to verify direct employment and production levels and to obtain timber supply information. The timber flow information from the harvest questionnaires was used to determine where TSA timber was processed, and the dependence of local mills on TSA timber. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the contribution of TSA timber to a mills' total timber requirement. Employment was also adjusted to reflect place of residence.

Employment supported by chip by-products from milling operations was also estimated by considering the volume of chip by-products and the locations of mills subsequently using these chips, employment at the downstream mill, and the percentage of TSA chips to total chip inputs.

As with the harvesting sub-sector, two estimates of direct processing employment were generated: TSA direct processing employment, and provincial direct processing employment. The resulting employment components were then used to calculate direct processing employment coefficients similar to the harvest employment coefficients.

Silviculture

Silviculture employment consists of all basic and intensive reforestation efforts, including surveys, site preparation, planting, fertilizing, pruning and spacing. Silviculture data was collected from the B.C. Forest Service and licensees whose tenures requires post-harvest silviculture work. Employment information was generally reported in part-time units and converted into person-years. Respondents were also asked to provide estimates of the percentage of silviculture employees residing within the Fraser TSA.

Indirect and induced employment estimates

Indirect impacts result from direct businesses purchasing goods and services. Induced impacts result from direct- and indirect-employees purchasing goods and services. Indirect- and induced-employment were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.1

---

[1] The Revised Forest District Tables, Ministry of Finance and Corporate Relations. 1996
A Provincial Impact Estimation Procedure for the British Columbia Forest Sector. Ministry of Finance and Corporate Relations. 1996.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Fraser TSA analysis are as follows:

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial coastal migration multiplier	Provincial coastal no-migration multiplier
Harvesting	1.87	1.49	2.02	1.72
Solid wood processing	1.74	1.41	2.31	1.93
Plywood	1.74	1.41	1.93	1.64
Pulp	2.10	1.69	2.54	2.28

Two sets of employment multipliers are available: migration and no-migration multipliers. The migration multipliers assume a displaced worker leaves the region, thus reducing total income in the region by a full wage. The no-migration multipliers assume a displaced worker remains 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 no-migration multipliers reduces the induced impact associated with a change in direct employment.

Employment income estimates

Employment income was calculated using average industry income estimates. The average 1996 pre-tax income less benefits for the forest sector was roughly $46,950, and for indirect- and induced-occupations, approximately $32,500. Income taxes were calculated based on marginal tax rates of 23% to 28% with one-third of the tax total accruing to the province.

Assessment of harvest flows

To estimate employment of alternative timber supplies, the timber supply level of the base case is 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 perfectly reflect industry conditions decades into the future. As such, the employment estimates should only be viewed as order of magnitude indicators.

Provincial government revenues

Government revenue impacts were estimated for the province using industry averages, except for stumpage and rents which are TSA specific. Similar to the assessment of employment impacts, revenue figures per 1000 cubic metres were estimated and applied to the harvest levels outlined in the base case timber supply forecast.

B.2 Economic Impact Analysis Methodology

Table B-2. Fraser TSA provincial government revenue estimates

	Average revenue 1994-1996 ($1996 millions)	Revenue ($ per 000's m^3)
Stumpage, rents and royalties	21.2	16,653
Industry taxes	11.0	8,664
Provincial income tax	11.8	8,720
Total government revenues	44.0	34,037

Source: Ministry of Forests.