



TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Cranbrook Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and a social-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is 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 Cranbrook 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 Cranbrook TSA covers about 1 410 000 hectares in the southeastern portion of British Columbia. About 439 000 hectares of the area are considered available for timber production and harvesting under current management practices. Within the area available for timber harvesting, most of the forests are dominated by lodgepole pine, Douglas-fir, larch, Engelmann spruce and subalpine fir tree species. Smaller areas are also dominated by yellow pine, western hemlock, western redcedar, whitebark pine, cottonwood, birch and aspen.

Current forest management practices, including the protection of wildlife and the environment, follow the standards and legislation set out by the *Forest Practices Code* and therefore the protection of wildlife and the environment will be managed through the Code. Management practices are also influenced by the *Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP IS)* and the direction provided to licensees by the Cranbrook District Manager for the preparation of forest development plans. This direction is consistent with the *Kootenay-Boundary Land Use Plan (KBLUP)* and reflects those parts which the forest district is implementing in the short term.

The results of this timber supply analysis suggest that the current allowable harvest level in the Cranbrook TSA of 838 000 cubic metres per year (issued woodlots excluded) can be maintained for up to 13 decades while allowing for gradual and controlled changes in timber supply in the medium to long term. After 13 decades, the harvest level would have to be reduced by 10% for a period of

five decades before gradually increasing to the long-term level of 883 000 cubic metres per year, in decade 20. This period of reduction and increase is referred to as the "transition" period.

The base case for this analysis projects a higher timber supply than the previous analysis completed for the Cranbrook TSA (March 1995). The 1995 analysis suggested that harvest levels would need to decline over the next few decades to avoid severe timber supply disruptions in the future. The difference in timber supply outlook relative to the 1995 analysis can be attributed to an increase in the size of the timber harvesting land base by about 15 000 hectares; a decrease in the estimate of unsalvaged losses; changes in the application of forest cover requirements for visual quality, riparian areas and old growth, and reductions in regeneration delays and green-up ages.

The base case results discussed above reflect current knowledge and information on forest inventory, growth, and management. However, it is important to recognize that uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees.

These sensitivity analyses show that, within the range of uncertainty examined in this analysis, short-term timber supply (over the next 20 years) in the Cranbrook TSA is stable. In only one case was short-term timber supply affected within the range of uncertainty examined. Uncertainty generally affected the timing of the transition to the long-term harvest level which began from 10 to 160 years from now depending on the variable examined, and in some cases affected the long-term harvest level.

Uncertainty about the size of the timber harvesting land base had the largest effect on projected harvests over the next 250 years. If the timber harvesting land base was 10% smaller than determined for the base case, the initial harvest level projected in the base case could be maintained for only three decades; if the timber harvesting land base was 10% larger than determined for the base case, the initial harvest level could be increased by 5.6% and maintained for 16 decades before a rise to the long-term harvest level could be implemented. The long-term level is directly affected by changes in the size of the timber harvesting base land base with increases or decreases in the long-term level roughly corresponding to the magnitude of the change in the timber harvesting land base.

Executive Summary

Uncertainty about timber volumes in existing stands also had a large effect on projected harvests over the next 250 years. If existing stand volumes were 10% lower than estimated in the base case, the initial harvest level projected in the base case could be maintained for two decades; if existing stand volumes were 10% higher than estimated in the base case, the initial harvest level could be increased by 4.5% and maintained throughout the analysis horizon. A 1997 inventory audit indicated that, while height, age and volume information on mature forests is statistically reliable, actual volumes are on average 5.5% smaller than indicated in the inventory for the entire forested area. Analysis indicated that if volumes in existing stands were 5.5% lower, timber supply could be maintained at the current AAC for only four decades. This is the maximum implication of the audit findings, in part because the volume difference on the physically operable forest is smaller (4%).

Uncertainty about timber volumes in stands located at high elevations, where the greatest amount of uncertainty exists, affects projected harvests in a similar way. If volumes from high elevation stands were 30% less than estimated for the base case, a decline of 10% would be required seven decades sooner than projected in the base case.

Uncertainty about minimum harvestable ages could affect timber supply in the short term. If minimum harvestable ages reflected the age at which the maximum mean annual increment for a stand is achieved, the initial harvest level could be maintained for one decade before a 10% decline would be necessary to avoid larger future disruptions.

Uncertainty about the unsalvaged losses estimate, regeneration delay estimates, the scheduling of mature stands for harvest, the desired mix of species in the harvest, and the application of landscape-level biodiversity requirements each has a moderate to large impact on timber supply in the period 20 to 200 years from now — often on the timing of the transition to the long-term level — and a small impact on the timber supply after 200 years.

Uncertainty about regenerated stand volume estimates affects the timing of the transition to the long-term harvest level and the long-term level itself. The effect on the long-term supply is approximately proportionate to the change in regenerated stand volume estimates.

Factors with small effects on timber supply include the age at which stands reach green-up conditions and the maximum amount of disturbance allowed in the caribou and integrated management zones. These factors have only a small impact on timber supply in the period 20 to 200 years from now, and a small or negligible impact on the timber supply after 200 years.

In addition to the areas of uncertainty examined in the sensitivity analyses, other issues have recently been brought forward. These issues include concerns about the management of fire-maintained ecosystems, the potential to harvest more area of densely-spaced lodgepole pine, and the increasing forest health risk of maturing lodgepole pine stands. Preliminary assessment of management options to address these issues indicates that there may be a potential opportunity to increase the harvest level in the short term, or to offset projected reductions in the long term. Related information will be compiled and provided to the chief forester to assist in the AAC determination for the Cranbrook TSA. The sensitivity analyses shown in this report will be useful for assessing how information related to these issues might affect the projection of timber supply.

The socio-economic analysis for the Cranbrook TSA indicates that the current AAC of 850 000 cubic metres (which includes woodlot AAC) can support an estimated 806 person-years of direct employment and an estimated 514 to 761 person-years of indirect and induced employment across the province annually.

The base case harvest forecast for the next 13 decades is 838 000 cubic metres per year, which is the same as the current AAC once it is adjusted to account for woodlot licences issued since the last determination. Because the 12 000 cubic metres has been transferred to woodlot licences, the current level of forestry activity reported for the TSA only changes slightly.

If fully harvested and utilized, the base case harvest level would generate an estimated average of \$25 million to \$26 million per year in provincial government revenues.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, timber harvests in the Cranbrook TSA can be maintained at the current allowable level for the next 130 years. Several factors related to the current forest inventory and management regime could affect timber supply; however, no conclusive evidence was available prior to completion of this analysis to suggest that significant inaccuracies exist in the information used.

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Introduction

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

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

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

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

of debate, and is complicated by changes in social objectives over time.

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

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

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

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

Timber supply

The amount of timber that is forecast to be available over a specified time period, under a particular management regime.

Timber supply area (TSA)

An integrated resource management unit established in accordance with Section 7 of the Forest Act.

Allowable annual cut (AAC)

The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

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

The following sections outline the timber supply analysis for the Cranbrook 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.

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 harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Cranbrook 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.

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.

Model

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

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 practices. 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.

Person-year(s)

One person working the equivalent of one full year, defined as at least 180 days of work. If someone works full-time for 90 days, he or she accounts for 0.5 person-years.

Introduction

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

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

Multiplier

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

Employment coefficient

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

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 Cranbrook Timber Supply Area

The Cranbrook Timber Supply Area (TSA) is within the boundaries of the Cranbrook Forest District and is administered by the district office in Cranbrook. It is situated in the southeastern corner of British Columbia within the Nelson Forest Region (Figure 1). The Cranbrook Forest District covers approximately 1.48 million hectares, of which 1.41 million hectares is within the TSA. Except for the exclusion of some large provincial park areas, the TSA boundaries coincide with those of the Cranbrook Forest District.

The Cranbrook TSA is bounded by the Skookumchuck Valley to the north, the Canada-U.S. border to the south, the Alberta border to the east, and the southern Purcell Mountains height-of-land to the west. Three major physiographic regions characterize the varied terrain of the Cranbrook TSA: the Rocky Mountains to the east, the Purcell Mountains to the west, and the Rocky Mountain Trench in the middle. The trench varies in width from five kilometres in the north to 27 kilometres near Cranbrook. The western side of the trench features irregular, comparatively low foothills gradually rising until they merge with the extremely rugged backbone of the Purcell Mountains. In contrast, the eastern side of the trench is characterized by an abrupt rise and continuous wall of mountains broken only by tributary valleys.

The major drainage* in the Cranbrook TSA is the Kootenay River which flows southward through the Rocky Mountain Trench. Its major tributaries are the Moyie, St. Mary, Wildhorse, Bull and Elk rivers. The Flathead River flows south into the U.S. in the southeastern part of the TSA. The Libby Dam on the Kootenay River, just south of the U.S. border, forms Lake Koocanusa which extends

into the Cranbrook TSA. Moyie Lake is the largest natural lake in the TSA, followed by St. Mary and Wasa lakes.

The Cranbrook TSA includes the cities of Cranbrook, Kimberley and Fernie, and the smaller communities of Sparwood and Elkford. Some small unincorporated communities and a number of rural residences are also dispersed throughout the TSA.

Approximately 55% of the total area of the Cranbrook TSA is considered productive forest in terms of timber growth. The remaining 45% is not considered productive forest, or is not managed by the B.C. Forest Service. Of the productive forest land base, about 57% is considered available for harvesting (31% of the total TSA). Forests of the Cranbrook TSA are dominated by lodgepole pine, Douglas-fir, larch, Engelmann spruce and subalpine fir. Other tree species include yellow pine, western hemlock, western redcedar, whitebark pine, cottonwood, birch and aspen.

The current allowable annual cut (AAC), which took effect in 1996, is 850 000 cubic metres. The AAC is apportioned by the Minister of Forests to various licences and includes 12 000 cubic metres apportioned to the woodlot licence program. The current AAC represents a reduction of about 6% from the previous AAC.

Significant changes in forest management or information that have occurred since the last timber supply review was completed include:

- implementation of the *Forest Practices Code**;
- updating of the forest inventory of the entire TSA, including the area of former Tree Farm Licence* (TFL) 13;
- completion of an inventory audit that confirms volume estimates* to be statistically acceptable;

Drainage

The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Forest Practices Code

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

Tree farm licence (TFL)

Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

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

1 Description of the Cranbrook Timber Supply Area

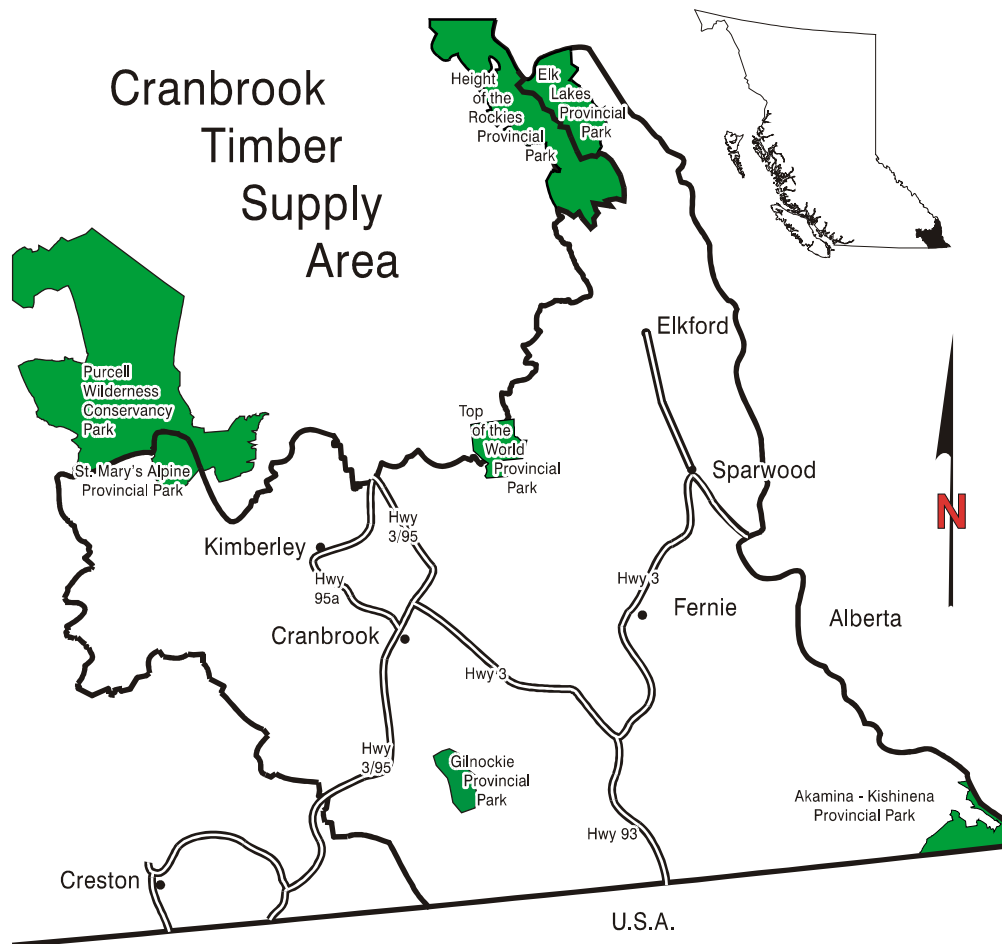


Figure 1. Map of the Cranbrook Timber Supply Area, Nelson Forest Region.

1 Description of the Cranbrook Timber Supply Area

- review of timber volumes left within cutblocks* after harvesting as a result of using non-clearcut harvesting systems and leaving wildlife trees*; and,
- government approval of the *Kootenay-Boundary Land Use Plan Implementation Strategy* (July 1997) which provides details on forest practices for the Kootenay-Boundary region.

The Cranbrook TSA offers many and varied opportunities for recreation and tourism, due to its lakes, parks and spectacular mountains. The area is well travelled as major highways provide access to Alberta and the national and provincial parks in the Canadian Rockies. Within the Cranbrook Forest District, there is the Akamina-Kishinena, Elk Lakes, and Gilnockie Provincial Parks as well as numerous smaller parks and recreation areas and portions of the Purcell Wilderness Conservancy, Height of the Rockies Provincial Park, and Top of the World Provincial Park.

1.1 The environment

The Cranbrook TSA contains six biogeoclimatic zones*, an indication of the climatic and biological diversity in this area.

The Ponderosa Pine Zone occurs at low elevations (700 to 900 metres) in very dry valleys of the Rocky Mountain Trench. Summers in this zone are hot and dry resulting in large moisture deficits during the growing season. Winters are cool with light snow cover. Forests are dominated by ponderosa pine, and historically tended to be open and parklike with an understory of grasses.

Douglas-fir, trembling aspen and birch also occur on moister sites. Due to very successful fire suppression activities over the last 70 years, these areas are increasingly characterized by a dense understory of immature and regenerating ponderosa pine and Douglas-fir.

The Interior Douglas-fir Zone also occurs in the Rocky Mountain Trench, generally between the Ponderosa Pine Zone and the Montane Spruce Zone (between 800 and 1200 metres). The continental climate is characterized by warm, dry summers, a fairly long growing season and cool winters. Moisture deficits are common during the growing season. Douglas-fir is the climax tree species in this zone, and historically, widespread fires created transitional woodlands and open grasslands. Other species include ponderosa pine at lower elevations; western larch and lodgepole pine at higher elevations; and cottonwood, spruce and aspen on moister sites such as floodplains. As in the Ponderosa Pine Zone, these areas are increasingly characterized by a dense understory of immature and regenerating Douglas-fir.

The Montane Spruce Zone is found at mid-elevations, often between the Interior Douglas-fir Zone and the Engelmann Spruce-Subalpine Fir Zone (between 1200 and 1600 metres). This zone is characterized by cold winters and moderately short, warm summers. Moisture deficits can occur during the growing season. Although subalpine fir and varieties of spruce are the dominant, climax tree species, one of the most distinctive features of this zone is the extensive stands of lodgepole pine that have formed following wildfire. Other common species found in this zone are Douglas-fir, western larch, western redcedar, trembling aspen and cottonwood.

Cutblock

A specific area, with defined boundaries, authorized for harvest.

Wildlife tree

A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Biogeoclimatic zones

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

1 Description of the Cranbrook Timber Supply Area

The Interior Cedar-Hemlock Zone occurs at low to middle elevations (700 to 1500 metres) in the wetter portions of the Purcell and Rocky Mountains. This zone has a climate dominated by easterly moving air masses that produce cool wet winters and warm dry summers. Snow melt minimizes soil moisture deficits in the summer. This is the most productive zone in the interior of B.C. and also has the highest diversity of tree species of any zone in the province. Western redcedar, western hemlock and hybrid white spruce dominate the rare climax forests that occur in the Cranbrook TSA. Other species are Douglas-fir, lodgepole pine, white pine, western larch, ponderosa pine, birch, trembling aspen and cottonwood.

The Engelmann Spruce-Subalpine Fir Zone is the uppermost forested zone, lying below the Alpine Tundra from 1600 to 2000 metres. Growing seasons are cool and short while winters are long and cold. Forests are continuous at the lower elevations of this zone, but at higher elevations clumps of trees occur together with areas of heath, meadow and grassland. Engelmann spruce and subalpine fir are the dominant climax tree species, but whitebark pine, lodgepole pine, alpine larch and trembling aspen are also common.

The Alpine Tundra Zone lies above the Engelmann Spruce-Subalpine Fir Zone, and is by

definition treeless although stunted (or krummholz) trees are common at the lower elevations of this zone. Overall, this zone is dominated by rock, ice and grassy meadows.

The Cranbrook TSA is unique in North America in the density and diversity of ungulate populations, other large mammals, small mammals and birds. This wealth of wildlife is made possible by the great variety of habitat types available in the area. Species include elk, mule deer, whitetail deer, moose, Rocky Mountain bighorn sheep, mountain goat, caribou, black bear, grizzly bear, cougar, lynx, marten, raptors and owls. The valley floor of the Rocky Mountain Trench offers high quality ungulate habitat due to its limited snowfall and low elevation (800 metres above sea level).

The Cranbrook TSA supports a high value sport fishery in its lakes and river systems, particularly the Kootenay and Flathead Rivers and their tributaries. The most common game fish are cutthroat trout, rainbow trout, bull trout, Rocky Mountain whitefish and kokanee.

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

Table 1. Vulnerable, endangered and threatened vertebrate species that occur or potentially may be found in the Cranbrook TSA

Endangered or threatened (red-listed)	Vulnerable (blue-listed)
Tailed frog (Kootenay pop.)	southern red-backed vole (<i>galei</i>)
northern leopard frog	wolverine (<i>Iuscus</i>)
Swainson's hawk	fisher
prairie falcon	northern long-eared myotis
American peregrine falcon	Rocky Mtn. Bighorn sheep
western screech-owl	woodland caribou (southern pop.)
Williamson's sapsucker	grizzly bear
least chipmunk (<i>Oreocetes</i>)	rubber boa
red-tailed chipmunk (<i>Ruficaudus</i>)	painted turtle
badger	
	white-throated swift
	great blue heron
	short-eared owl
	American bittern
	bobolink
	sandhill crane
	Lewis's woodpecker
	long-billed curlew
	flamulated owl
	sharp-tailed grouse (<i>Columbianus</i>)
	mottled sculpin
	bull trout

Source: B.C. Conservation Data Centre, April 26, 1999.

1 Description of the Cranbrook Timber Supply Area

Approximately 150 domestic watersheds* in the Cranbrook TSA provide water for human consumption or use. These range from small, remote streams supplying a single user to large watersheds serving communities like Cranbrook. The maintenance of quality, quantity and flow timing in the TSA's streams is important both for water consumption and for fishery values.

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the Code. As well, the implementation of the *Kootenay-Boundary Land Use Plan* provides additional strategies and guidance for forest practices.

1.2 First Nations

Most First Nations people in the Cranbrook TSA are part of the Ktunaxa people. They have traditional territory within the TSA, and archaeological evidence suggests the Ktunaxa have inhabited the East Kootenay region since the last glaciation over 10,000 years ago. In 1884, reserves for two First Nations groups were established at St. Mary's and Tobacco Plains. These continue to exist as First Nation communities with a combined population of approximately 400.

Also resident in the Cranbrook TSA are non-status Ktunaxa, as well as other status and non-status First Nations people such as Cree, Sioux, and Peigan. The total First Nations population within the TSA is estimated to be about 1100.

The Ktunaxa-Kinbasket Tribal Council has submitted a comprehensive land claim which covers the southeast corner of the province, including the Cranbrook TSA. Members of the tribal council include the St. Mary's and Tobacco Plains Bands, as well as three bands based outside the Cranbrook TSA who also have territorial claims to the area.

First Nations are employed in the forest sector, particularly in silviculture, fire fighting and harvesting and processing. The Tobacco Plains Band has a small sawmill and logging operation which employs about 12 people. Total employment is approximately 20 to 25 person-years, about 7.5% of the First Nations labour force. First Nations have expressed concern that they do not receive an equitable share of forest industry employment. Other concerns include:

- the effects of logging on fish and wildlife;
- the need to integrate the use of the timber resource with other sectors, including tourism, trapping, hunting, fishing and other traditional, spiritual and commercial uses;
- need to preserve archaeological and cultural sites; and,
- forest management practices.

A traditional-use survey has been completed in the Cranbrook TSA. It focuses on oral presentations by community members to clarify which lands in the TSA were used traditionally. In addition, a number of archaeological overview assessments have been completed to identify sites of potential archaeological significance.

Watershed

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

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 1998 by the Land and Information Management Section of the Forest Service at Nelson, B.C. This file contains information on the forest land in the Cranbrook 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 characteristics such as environmental sensitivity and physical accessibility (operability*). Stand characteristics such as tree height, stocking* and age have been projected to 1997 or 1998 depending on the mapsheet. Except for a few mapsheets shared with adjacent forest districts, the inventory file has been updated to account for timber harvesting up to the end of 1996 for the majority of the Cranbrook TSA.

The inventory file represents the land base for all of the Cranbrook Forest District which includes the Cranbrook TSA in its entirety. 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 Cranbrook TSA is provided below. These types of areas do not contribute to the timber supply of the Cranbrook 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 Cranbrook 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 approach.

This section describes the types of areas that do not contribute 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.

Operability

Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Stocking

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

Timber harvesting land base

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

2 Information Preparation for the Timber Supply Analysis

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

- not administered by the province of B.C. — this includes areas under federal government jurisdiction and private land.
- non-forest and non-productive forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- not managed by the B.C. Forest Service for timber supply — areas managed by other agencies (for example, parks and wilderness conservancies) and forest land not administered as part of the TSA (for example woodlot licences and Christmas tree permits).
- existing unclassified roads — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- streamside, wetland and lakeside buffers — areas that provide protection for riparian* and stream ecosystems.
- environmentally sensitive areas* — environmentally sensitive areas identified as too environmentally sensitive to harvest due to extreme soil sensitivity, significant soil sensitivity in community and domestic watersheds, high risk to water values, avalanche problems or severe regeneration problems in areas outside of NDT* 4.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- specific excluded forest types* — stands of non-merchantable coniferous species, low quality timber or low volume.
- inoperable* — areas classified as unavailable for harvest for terrain-related or economic reasons.
- problem forest types — stands partially comprised of non-merchantable or low quality timber.
- future logging roads — estimated losses of productive forest land resulting from future development. These areas are initially included in the timber harvesting land base, and are subsequently removed following the first harvest.
- Fire Maintained Ecosystem Restoration (FMER) open range — forested or partially forested areas which are planned to be restored to open range after first harvest. These areas are initially included in the timber harvesting land base and are subsequently removed immediately following the first harvest.

A more detailed description of these categories, including specific criteria for identification is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category and shows the total 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, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Natural disturbance type (NDT)

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

Forest type

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

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.

2 Information Preparation for the Timber Supply Analysis

Table 2. Timber harvesting land base for the Cranbrook TSA

Classification	Area (hectares)	Per cent of TSA area	Per cent of productive forest area
Total inventory land base (Cranbrook Forest District)	1 483 083.2		
Not Cranbrook TSA ^a	72 847.7		
Total Cranbrook TSA	1 410 235.5	100.0	
Not administered by province of B.C. ^b	228 764.2	16.2	
Non-forest and non-productive forest land	388 760.4	27.6	
Non-commercial cover	3 816.8	0.3	
Not managed by B.C. Forest Service for timber supply ^c	14 641.3	1.0	
Productive forest managed by B.C. Forest Service	774 252.7	54.9	100.0
Reductions to Forest Service managed productive forest			
Existing unclassified roads	10 860.6	0.8	1.4
Riparian management areas	34 147.2	2.4	4.4
Environmentally sensitive areas	112 541.3	8.0	14.5
Low timber productivity	38 496.2	2.7	5.0
Specific excluded forest types	28 635.2	2.0	3.7
Inoperable	88 691.3	6.3	11.5
Problem forest types	21 690.4	1.6	2.8
Total current reductions^d	335 062.2	23.8	43.3
Current timber harvesting land base	439 190.5	31.1	56.7
Future reductions			
Logging roads (estimate)	12 473.3	0.9	1.6
FMER open range	19 659.1	1.4	2.5
Total future reductions	32 132.4	2.3	4.2
Long-term timber harvesting land base	407 058.1	28.8	52.5

a) Includes Purcell Wilderness Conservancy, Elk Lakes Provincial Park, Height-of-the-Rockies Provincial Park, Gilnockie Provincial Park, Top of the World Provincial Park and Akamina Kishinena Provincial Park.

b) Includes private land and areas under federal government jurisdiction.

c) Includes some provincial parks, ecological reserves, Christmas tree permits, and woodlot licences.

d) Reductions were performed in the order listed in the table.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents both the total Cranbrook TSA area, and the productive forest land base. The total area chart shows that about 45% of the area in the TSA is either not managed for timber supply purposes, or is not forested or is covered by non-productive forest (i.e., has very few trees). The productive forest chart details the categories of forest land and shows that about 30.4% of the forest land in the Cranbrook TSA is considered to be unavailable for harvesting at this time due to

environmental sensitivity, physical or economical inoperability or streamside, lakeside or wetland buffering. An additional 11.5% is identified as low productivity sites, excluded forest types, and problem forest types. Approximately 1.4% of the productive forest is unavailable for harvesting due to existing roads. The remaining 57% of the productive forest area is considered available for timber harvesting. The productive forest includes forest land currently not satisfactorily restocked (NSR)*.

Not satisfactorily restocked (NSR)

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

2 Information Preparation for the Timber Supply Analysis

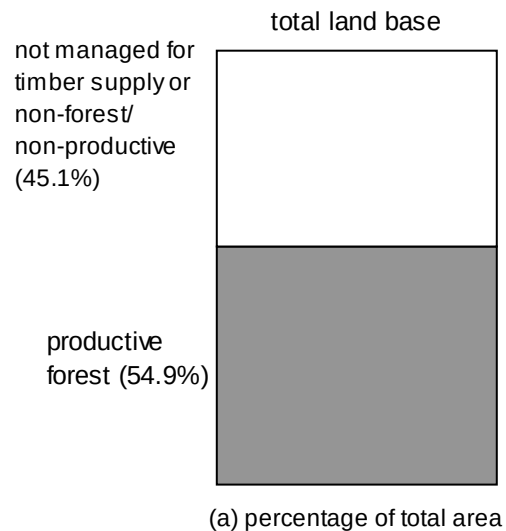
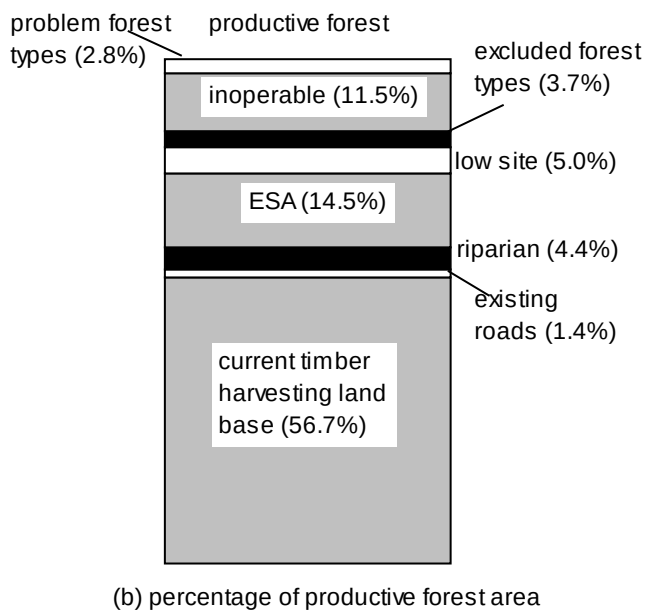


Figure 2. Composition of the total and productive forest land bases — Cranbrook TSA, 1999.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Stands dominated by lodgepole pine species cover about 47.3% of the timber harvesting

land base, with Douglas-fir and larch dominating on 30.6%, spruce and sub-alpine fir (balsam) on 19.0%, and yellow pine, hemlock and cedar on 3.1% of the timber harvesting land base.

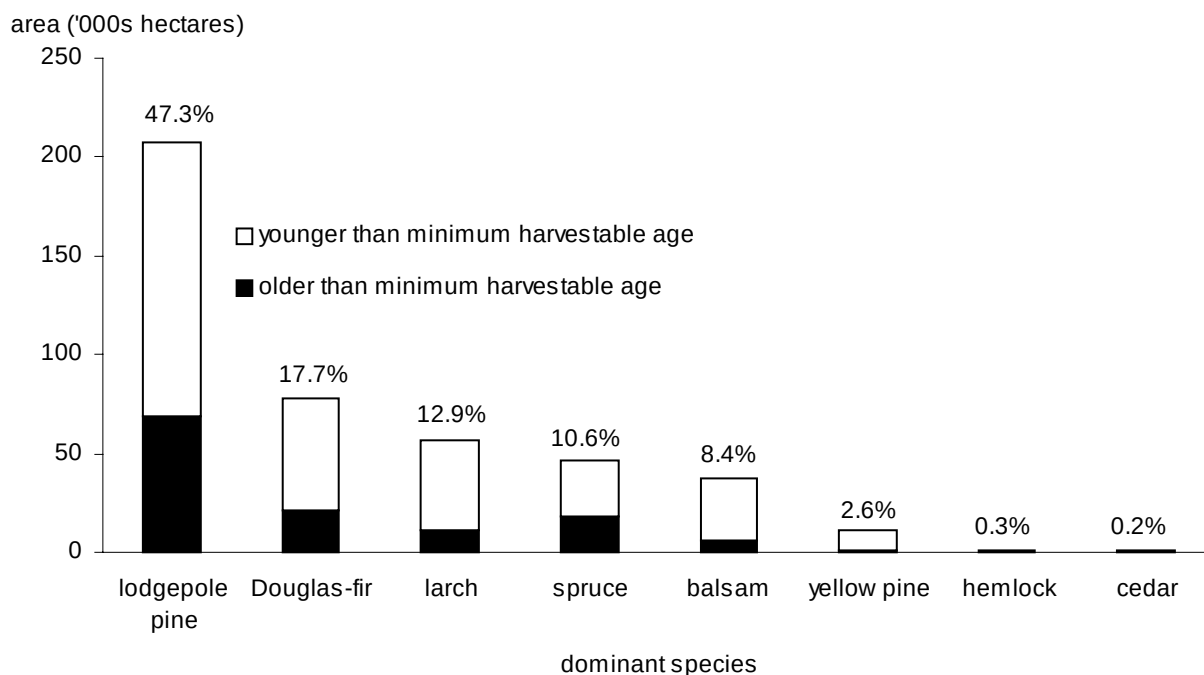


Figure 3. Area by dominant species — Cranbrook TSA timber harvesting land base, 1999.

Figure 3 also shows the proportion of area of each species that is either 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 71% of the stands in the timber harvesting land base are younger than the minimum harvestable age.

2 Information Preparation for the Timber Supply Analysis

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 15% of the sites in the timber harvesting land base are classified as having good productivity, 60% as medium, and 25% as poor.

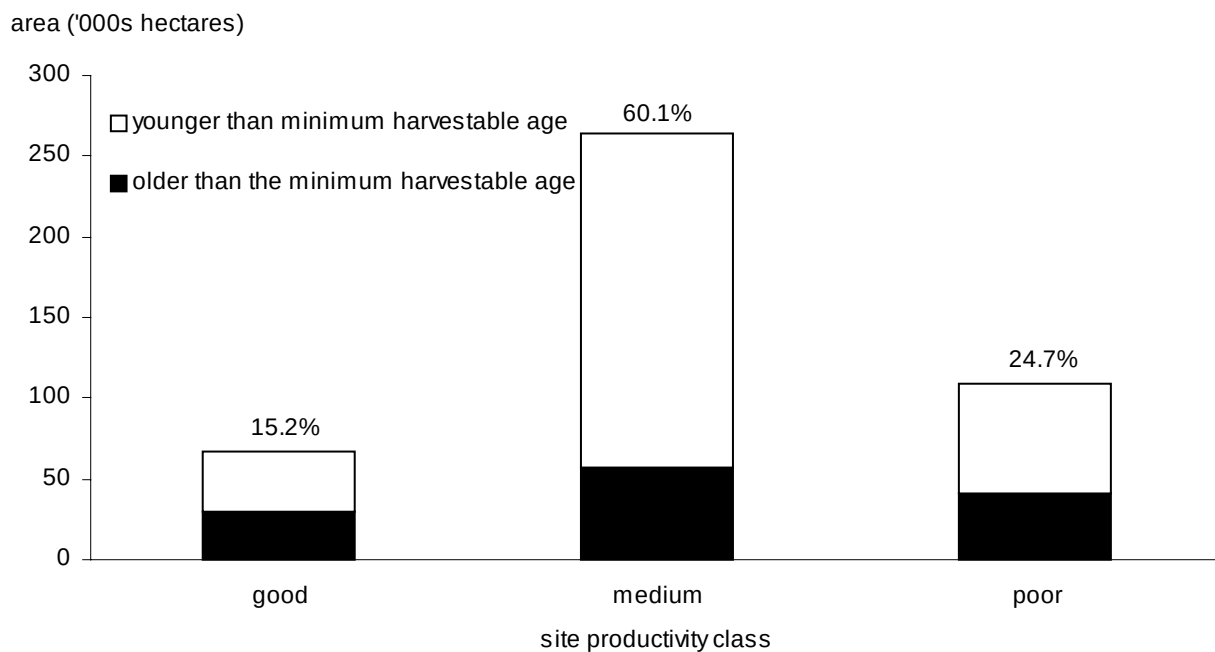


Figure 4. Area by site productivity class — Cranbrook TSA timber harvesting land base, 1999.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age class distribution of forest stands on the current timber harvesting land base. Stands are grouped into 20-year age classes, except for the oldest stands. About 11% of stands are older than 140 years, and just 0.5% of these stands are older than 250 years of age. There is a preponderance of stands between

61-80 years old (27%). After the age of 80 the percentage of stands in each 20-year age class declines, which likely reflects the practice of favoring older stands for harvest and increased natural losses as stands age.

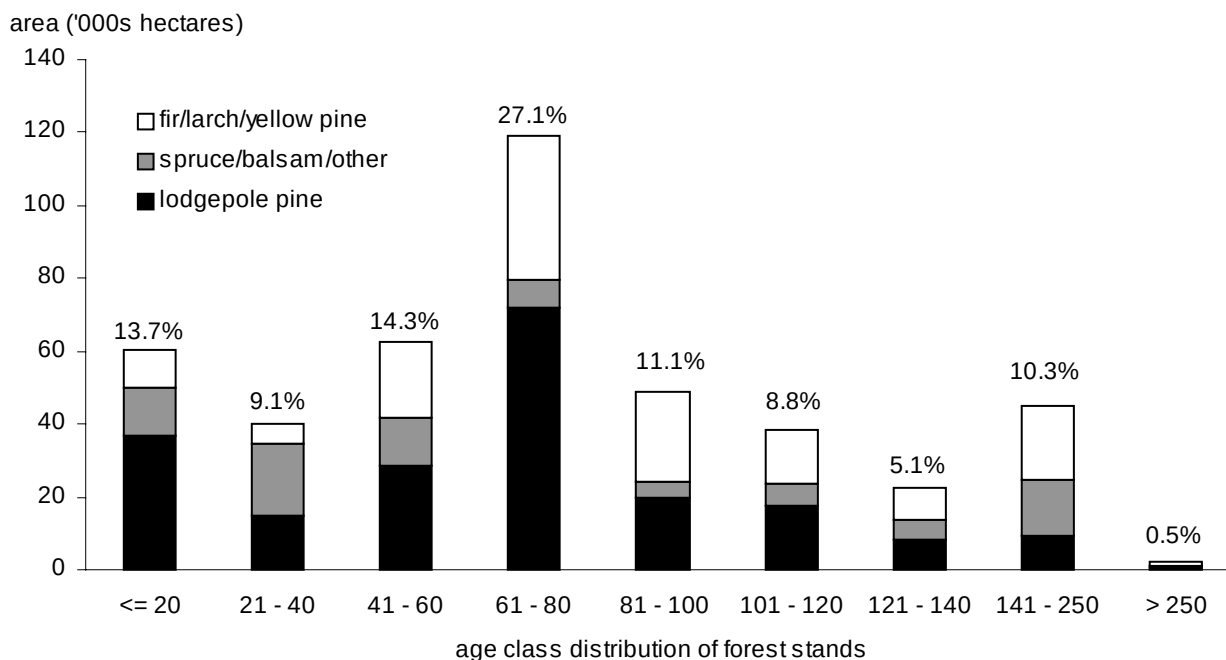


Figure 5. Current age class composition — Cranbrook TSA timber harvesting land base, 1999.

2 Information Preparation for the Timber Supply Analysis

Figure 6 compares the current age composition of stands on the total Provincial Crown forested land base to stands on the timber harvesting land base. Crown forested stands outside the timber harvesting land base may contribute to landscape level seral stage targets and other biodiversity* requirements but are not subject to timber harvesting. The age composition of the total Crown forested land base is similar to that of the timber harvesting land base except for stands greater than area ('000s hectares)

140 years old. About 19% of the Crown forested land base is comprised of stands older than 140 years old as compared to 11% for the timber harvesting land base, and about 2.2% of the Crown forested land base is comprised of stands older than 250 years as compared to 0.5% of the timber harvesting land base. Generally, there are a significant number of stands outside of the timber harvesting land base in every age class to help meet biodiversity requirements.

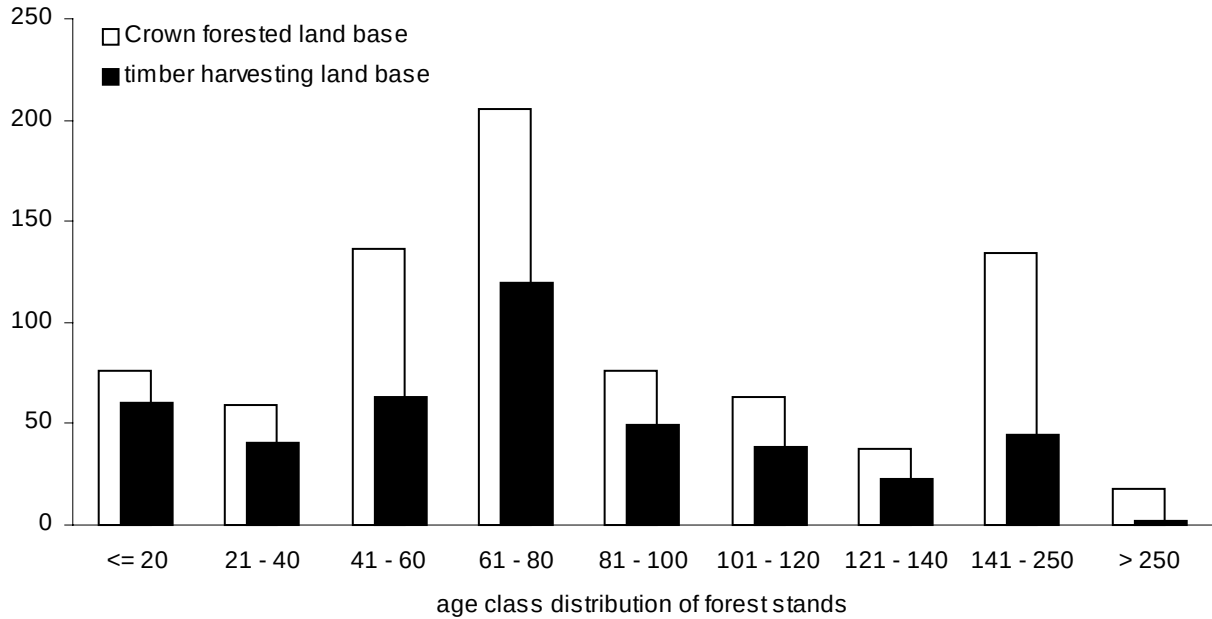


Figure 6. Current age class composition — Cranbrook Forest District area, 1999.

Biodiversity (biological diversity)

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.

2 Information Preparation for the Timber Supply Analysis

As noted previously, the area of Crown forest excluded from the timber harvesting land base also affects timber supply because it may be used to meet biodiversity requirements. Landscape-level biodiversity* requirements can be met outside of the timber harvesting land base if there is a sufficient amount of suitable land base for a given landscape unit* / biogeoclimatic variant* combination. Landscape-level biodiversity requirements vary with natural disturbance types (NDT) and biogeoclimatic units. Figure 7 shows the Engelmann Spruce-Subalpine

Fir (ESSF), Montane Spruce (MS) and the Interior Cedar-Hemlock (ICH) biogeoclimatic units having at least 28% of their forest stand area outside of the timber harvesting land base. The Interior Douglas-fir (IDF) and Ponderosa Pine (PP) zones occur mostly within the timber harvesting land base and have a smaller proportion of their forest stand area, about 20%, outside of the timber harvesting land base. The ESSF parkland biogeoclimatic units (ESSFwm-p and ESSFdk-p) which occur within NDT 5 are completely excluded from the timber harvesting land base.

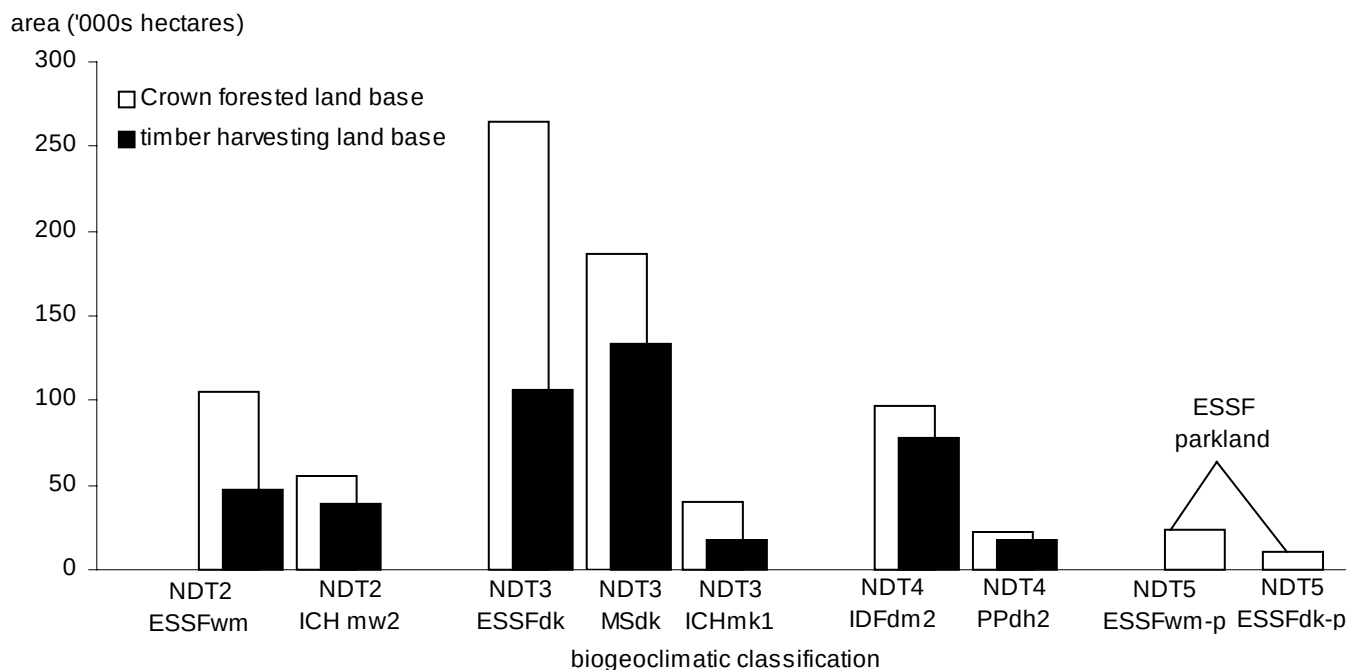


Figure 7. Distribution of biogeoclimatic units—Cranbrook Forest District area, 1999.

Landscape-level biodiversity

The Forest Practices Code Biodiversity Guidebook provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Landscape unit

A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Biogeoclimatic (BEC) variant

A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

2 Information Preparation for the Timber Supply Analysis

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 that could be the subject of growth and yield (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 are 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 Cranbrook TSA analysis. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing natural stands. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for managed stands. Lodgepole pine leading stands harvested over the last 30 years, and all harvested in the future, are assumed to grow according to managed stands yield 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 timber volume estimates* for existing stands, the current timber inventory on the timber harvesting land base is approximately 54 million cubic metres. About 38 million cubic metres, or 70% of the total volume, is found in stands older than the minimum harvestable age.

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 on the timber supply review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Cranbrook 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* — unsalvaged timber losses on the timber harvesting land base due to insect attack, blowdown, fire and other natural agents are expected to average 77 241 cubic metres per year.

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.

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.

2 Information Preparation for the Timber Supply Analysis

- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting. Volume estimates are based on the utilization of all trees which meet or exceed the following standards: a minimum 10-centimetre top diameter; a maximum 30-centimetre high stump; and a minimum diameter of 17.5 centimetres at 1.3 metres above the ground, except for lodgepole pine for which the minimum diameter is 12.5 centimetres at 1.3 metres above the ground.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were based on several criteria including: minimum merchantable volume, minimum diameter and achievement of at least 95% of culmination mean annual increment* and professional judgment. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age in the model may be greater but not less than the

minimum, and will depend on ages of other stands, forest cover objectives* (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets.

- Cutblock adjacency* and green-up* — in the Cranbrook TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up, before adjacent stands may be harvested. In the integrated resource management* and FMER managed forest zones, the area in the timber harvesting land base that does not meet green-up conditions — trees at least two metres in height, in this case — cannot exceed 33% except for the MSdk zone where it cannot exceed 40%. In caribou management zones, area in the operable Crown forested land base (which includes forest outside the timber harvesting land base) that does not meet a green-up condition of trees reaching three metres in height cannot exceed 25%. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.

Mean annual increment (MAI)

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

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).

Cutblock adjacency

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

Green-up

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

Integrated resource management

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

2 Information Preparation for the Timber Supply Analysis

- Management of wildlife habitat — maintenance of caribou habitat types and ungulate winter range is required in the Cranbrook Forest District. The rate of harvest in caribou habitat is limited in this analysis by biogeoclimatic zone to distribute harvest and to maintain habitat in two biogeoclimatic zones. Caribou habitat areas in the ESSF biogeoclimatic zone cover 41 211 hectares of suitable forested area, which includes 32 908 hectares (7.5%) of the timber harvesting land base (forest cover requirements are applied to suitable Crown forested area which includes the timber harvesting land base and all other operable forest area with slopes less than 80%). In ESSF caribou habitat areas, at least 30% of the suitable forested area must be covered by stands older than 140 years, and at least 10% of the suitable forested area must be covered by stands older than 250 years. Caribou habitat in the ICH biogeoclimatic zone covers 3965 hectares of suitable forested area, which includes 3169 hectares (0.7%) of the timber harvesting land base. In the ICH biogeoclimatic portion of the caribou habitat areas, at least 40% of the suitable forested area must be covered by stands older than 140 years, and at least 10% of the suitable forested area must be covered by stands older than 250 years. Ungulate winter range area comprises 150 767 hectares of the Crown forested land base, which includes 107 325 hectares (24.4%) of the timber harvesting land base. Older stands must be maintained throughout ungulate winter range, and the age at which stands meet older forest conditions and the percentage of winter range area required to be covered by older stands varies for each ungulate species. In ungulate winter range area, generally 30 to 50% of the Crown forested land base must be covered by stands older than 82 to 121 years.
- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits where the maintenance of scenic landscapes is a priority for recreation and tourism management, particularly in areas that are adjacent to major travel corridors or are visible from major population centres. Visually sensitive areas in the Cranbrook TSA are assigned a visual quality objective*(VQO) of either retention*, partial retention* or modification* or a recreation rating of either highest, high or moderate. Retention VQOs cover 2785 hectares (0.6%) of the timber harvesting land base and 11 765 hectares (1.5%) of the Crown forested land base. In these areas, at most 5% of the forested area within a landscape unit may be covered by stands less than six metres tall (visually effective green-up). Partial retention VQOs cover 24 367 (5.5%) hectares (0.6%) of the timber harvesting land base and 41 500 hectares (5.2%) of the Crown forested land base. In partial retention VQOs, at most 15% of the forested area within a landscape unit may be covered by stands less than six metres tall. Modification VQOs cover 9303 hectares (2.1%) of the timber harvesting land base and 15 576 hectares (1.9%) of the Crown forested land base. In modification VQOs, at most 25% of the forested area within a landscape unit may be covered by stands less than six metres tall.

Visual quality objective (VQO)

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

Retention VQO

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

Partial retention VQO

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

Modification VQO

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

2 Information Preparation for the Timber Supply Analysis

- Management of recreation areas — recreation areas rated as 'highest' cover 3282 hectares (0.7%) of the timber harvesting land base within 5260 hectares (0.7%) of the Crown forested land base. In these areas, at most 5% of the Crown forested area within a landscape unit may be covered by stands less than six metres tall (the visual green-up). Recreation areas rated as high cover 8155 hectares (1.9%) of the timber harvesting land base within 16 145 hectares (2.0%) of the Crown forested land base. In areas rated as high, at most 15% of the forested area within a landscape unit may be covered by stands less than four metres tall. Recreation areas rated as moderate cover 116 326 hectares (26.5%) of the timber harvesting land base within 259 189 hectares (33.5%) of the Crown forested land base. In these areas, at most 25% of the forested area within a landscape unit may be covered by stands less than three metres tall.
- Management of community and domestic watersheds — the primary objectives within these watersheds are to maintain water quality and quantity. There are several licensed community watersheds in the Cranbrook TSA including: Mark Creek, Upper Gold Creek, Joseph Creek, Matthew Creek, Fairy Creek, Boivin Creek, Silver Spring Lake, Glencairn Creek, Cummings Creek, Reserve Creek, Blavatsky Creek, and Kimberley Creek. In total, community watersheds cover 24 353 hectares (5.5%) of the timber harvesting land base within 42 444 hectares (5.5%) of the Crown forested land base. To model management in community watershed, a maximum of 25% of the forested area was allowed to be under cover of stands that have not reached green-up conditions. Hydrologic green-up height for community watershed areas is assumed to be nine metres. Domestic watersheds cover 52 376 hectares (11.9%) of the timber harvesting land base within 90 959 hectares (11.7%) of Crown forested land base. For management of domestic watersheds, a maximum of 30% of the forested area within a landscape unit was allowed to be covered by stands less than nine metres tall in the analysis.
- Fire-maintained ecosystems — important habitat areas have been identified through the *Kootenay-Boundary Land Use Plan Implementation Strategy* for the restoration of fire-maintained ecosystems. Specific harvest guidelines designed to maintain essential attributes such as forest cover and forage requirements have been applied to these areas in the analysis.
- The integrated resources management (IRM) zone consists of areas outside other resource emphasis zones. The integrated resource management zone covers 130 972 hectares (29.8%) of the timber harvesting land base. In the analysis, the IRM zone is divided by landscape unit boundaries and biogeoclimatic subzone boundaries (i.e., ESSFwm, ICHmw2, ESSFdk, ICHmk1, MSdk), and forest cover requirements for green-up are applied within these subdivisions to distribute the harvest. Green-up conditions are met in an integrated resources management area when trees reach two metres in height.

2 Information Preparation for the Timber Supply Analysis

- The community and domestic watersheds, visually sensitive areas, recreation areas, wildlife habitat and fire-maintained ecosystems resource emphasis areas overlap in many places. Thus there may be more than one forest cover requirement applied to an area within the TSA. In the cases where the area must meet several requirements, the analysis is designed to ensure that all requirements are met.
- Stand-level biodiversity* — to maintain biological diversity in forest stands, wildlife trees* and wildlife tree patches are retained after harvesting cutblocks. Outside of the fire-maintained ecosystems in the Cranbrook TSA, retention of wildlife trees and patches are estimated to reduce stand-level timber yields by 3.9%, after accounting for contributions from forest outside the timber harvesting land base. In the fire maintained ecosystems, many trees are left after harvest to meet *Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP-IS) FMER*

Guidelines. For these areas, reductions to stand-level timber yields due to stand-level biodiversity and choice of silvicultural system are estimated at 32.7% in open forest types and 18.3% in open range types.

- Landscape-level biodiversity — to maintain biological diversity throughout a landscape unit, requirements are placed on the amount of area in the landscape unit that must be covered by stands with old-forest characteristics. In the Cranbrook TSA, within each biogeoclimatic variant, a proportion of the forested area must be covered by stands older than 140 or 250 years, depending on the biogeoclimatic variant.

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 Input and Assumptions of the Timber Supply Analysis."

Stand-level biodiversity

A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

Wildlife tree

A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

2 Information Preparation for the Timber Supply Analysis

Figure 8 displays the composition of the timber harvesting land base according to broad management emphasis. The percentages total to more than 100% due to the overlap between resource emphasis areas. Information on the overlap of management emphasis areas and details

on the area associated with each can be found in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

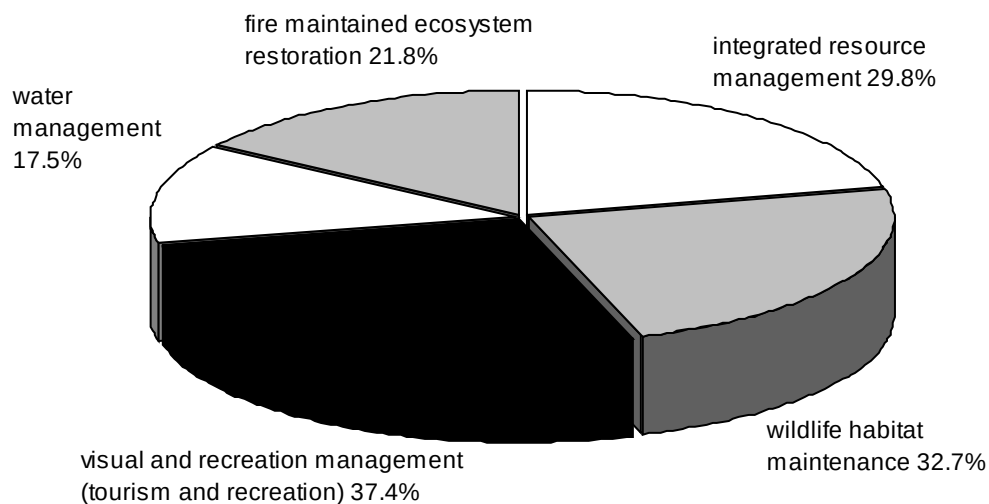


Figure 8. Forest management emphasis — Cranbrook TSA timber harvesting land base, 1999.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Cranbrook 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 green-up and old-forest 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 Cranbrook TSA. The harvest forecasts* presented in this section use 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 harvest forecasts in this section provide only a part of the timber supply picture for the Cranbrook TSA, and should not be viewed in isolation of the sensitivity analysis*.

4.1 Harvest forecasts

There are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short-and long-term harvests.

The harvest forecasts illustrated in Figure 9 were defined using the following criteria: managing the rate of any changes (particularly declines) in harvests, 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.

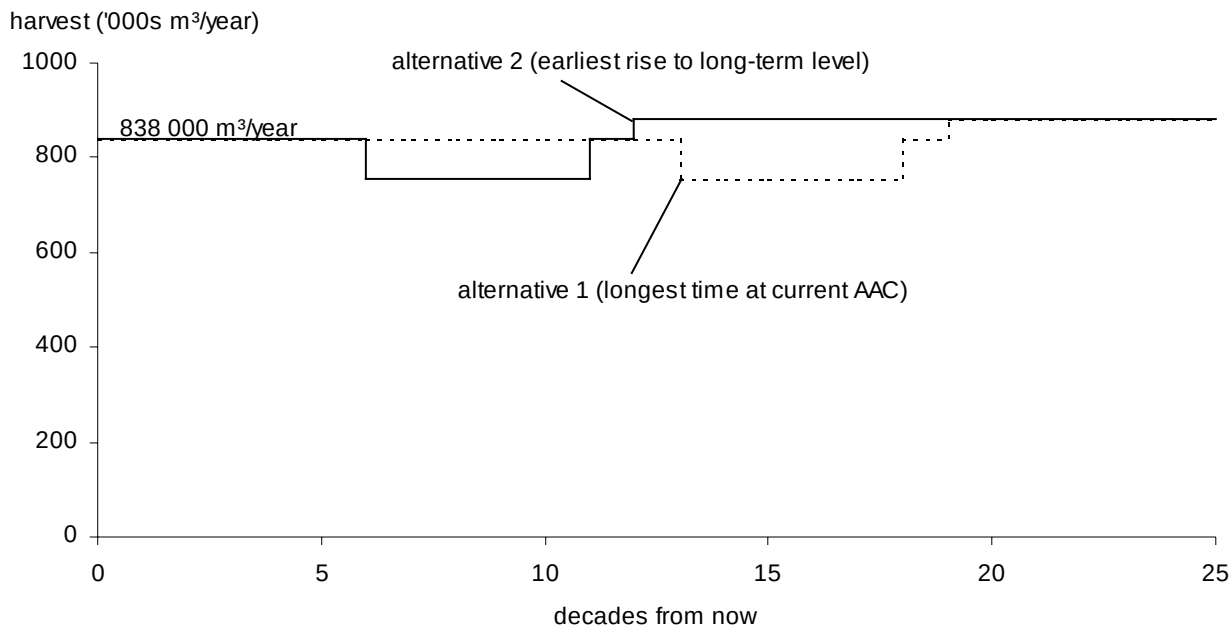


Figure 9. Alternative harvest forecasts — Cranbrook TSA, 1999.

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 practices. 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.

Sensitivity analysis

Examines how uncertainty in data and management assumptions affect timber supply.

Growing stock

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

4 Results

The current AAC of 850 000 cubic metres per year for the Cranbrook TSA was last set in 1996. The AAC associated with new issued woodlots or issued woodlot expansions established since then is 11 746 cubic metres per year. Since woodlots AACs are administered separately from the TSA, the current AAC attributable to the TSA is 838 000 cubic metres per year (838 254 cubic metres rounded to the nearest 1000 cubic metres).

Unsalvaged losses to natural forces such as insects and fire are estimated to be 77 241 cubic metres per year for the entire 250-year period examined in this analysis, and have already been subtracted to create all the harvest forecasts shown in this report.

Alternative 1 (the dashed line in Figure 9) shows that an annual harvest level of 838 000 cubic

metres can be maintained for 13 decades, without causing severe timber supply shortages in the future, if followed by one downward step of 10% to a harvest level of 754 000 cubic metres per year. This harvest level is maintained for five decades before rising to a long-term level of 883 000 cubic metres reached in decade 20. Extending the harvest level at the current AAC past decade 13 would result in large disruptions in supply in decades 14 to 16. Alternative 2 (the solid line in Figure 9) shows the potential harvest that would result if the temporary decline below the long-term harvest level* was made earlier in order to allow the earliest possible climb to the long-term level. If the current harvest level was dropped by 10% after six decades for a period of five decades, the long-term harvest level could be reached in decade 12, seven decades sooner than in alternative 1.

Long-term harvest level

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

4 Results

Figure 10 shows two other potential harvest forecasts for the Cranbrook TSA. Alternative 3 shows the highest initial harvest level that can be achieved while avoiding large and abrupt harvest shortfalls in the future, and allowing a reasonable rate of decline as harvesting shifts from existing stands to regenerated, managed stands. In this case, the initial harvest level could be raised to 1 058 000 cubic metres per year and maintained for one decade before a decline would be necessitated by limited availability of mature timber in decade 3.

This starting level is about 25% higher than those of alternatives 1 and 2 (the current TSA AAC), while over the first 100 years the alternative 3 forecast has 2.5% less cumulative timber supply than alternative 1. Results for alternative 3 show that increasing timber supply above the current AAC over the first few decades would lead to harvesting of some stands prior to the age of maximum productivity; hence slightly less volume is harvested over the long term.

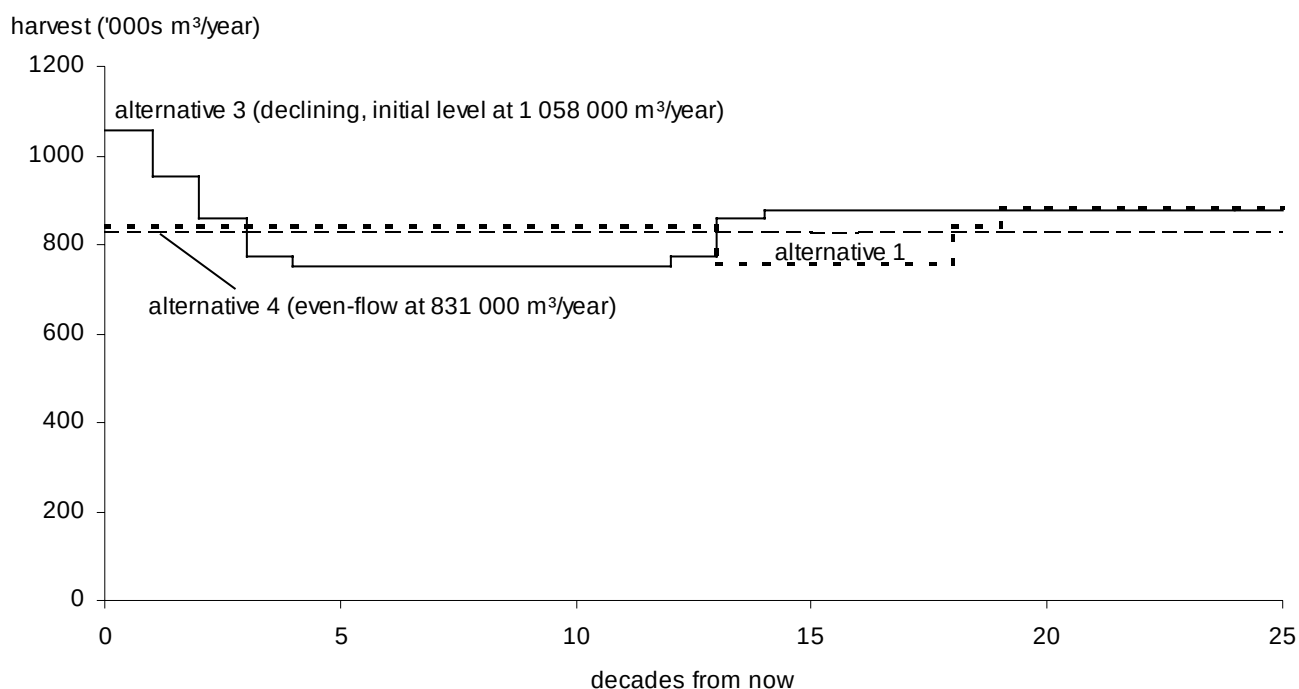


Figure 10. Alternative harvest flow patterns using base case data: range for possible starting harvest levels — Cranbrook TSA, 1999.

4 Results

Alternative 4 is an even-flow harvest forecast. The maximum even-flow level that can be achieved over the 250-year analysis horizon is 831 000 cubic metres per year. To reserve timber to fill the timber supply gap from decades 14 to 18 shown in alternative 1, a small decrease in harvest levels for the first 13 decades would be necessary. Also, an increase to the productive potential of the land base under current management would not be achievable until after the 250-year analysis horizon. Over the

250-year horizon, about the same volume would be harvested under this constant flow pattern as in alternative 1, and approximately 1.6% less volume compared to alternative 2.

For the purposes of conducting sensitivity analysis to examine the impact of uncertainty on timber supply, alternative 1 was selected as a basis for comparison. For the remainder of this analysis, alternative 1 (shown below in Figure 11) will be referred to as the 'base case harvest forecast'.

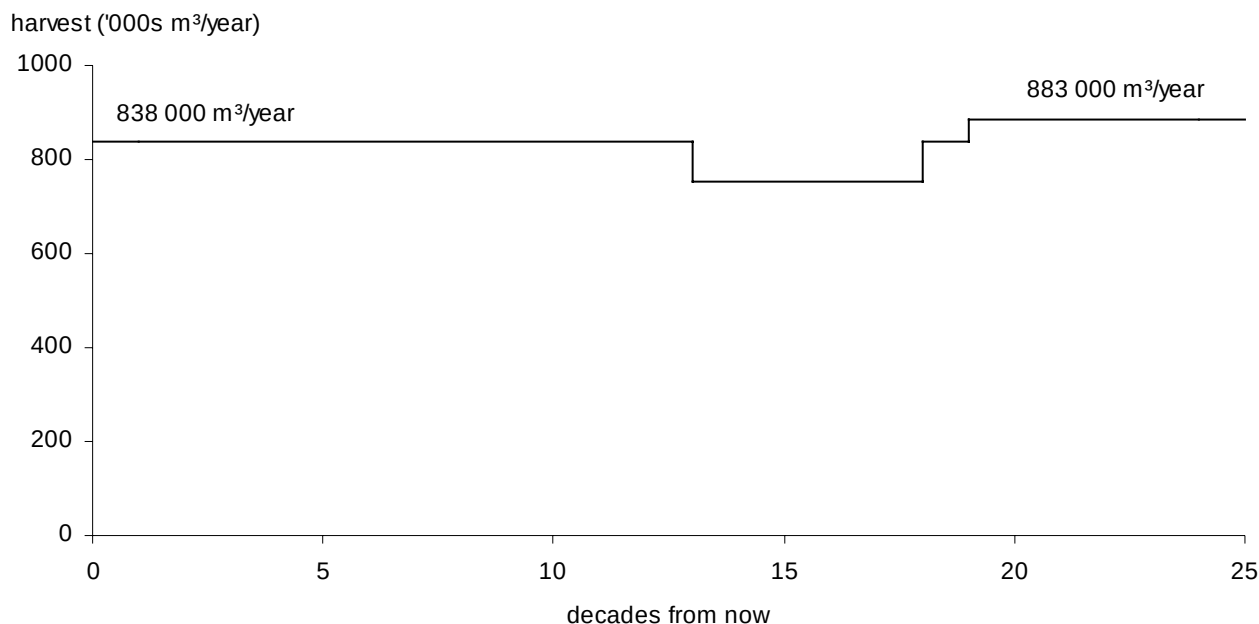


Figure 11. Base case harvest forecast for the Cranbrook TSA, 1999.

Several criteria were used to define the base case harvest forecast. In the short- and medium-terms, the criteria were to maintain the current harvest level for the Cranbrook TSA (838 000 cubic metres per year) for as long as possible while avoiding substantial timber supply shortages in the future and allowing a gradual, controlled transition to the long-term level. The long-term harvest level was defined as the harvest rate that will maintain the total timber growing stock at an even level, on average, indicating that

harvesting can continue at that level in perpetuity (see Figure 12). A continually declining growing stock would signify that timber is being harvested above the productive capability of the land. The total growing stock of the timber harvesting land base declines over the next 12 decades in the base case as existing mature stands are harvested and replaced with younger stands on the timber harvesting land base. However, after harvests occur predominately in younger managed stands, the growing stock stabilizes at approximately 51 million cubic metres.

Base case forecast

The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

4 Results

In defining the base case, one criterion was to manage the transition from the current harvest level to the long-term harvest level. This transition corresponds to a shift from harvesting existing stands to harvesting regenerated, managed stands. A 10% decline, held for five decades, was employed, which allowed the current harvest level to be maintained for several decades and prevented large drops in the timber supply further into the future.

As shown in Figure 12, the amount of merchantable timber is at a minimum of

approximately 19.7 million cubic metres in decade 15. The availability of stands old enough to harvest in this period affects the rate at which timber can be harvested over the short and medium terms, and the timing of the increase to the long-term level. These basic factors — controlled, gradual changes in the short and medium term, no prolonged declines below the long-term level, and a sustainable long term signified by stable growing stock — were considered when generating all harvest forecasts in this report.

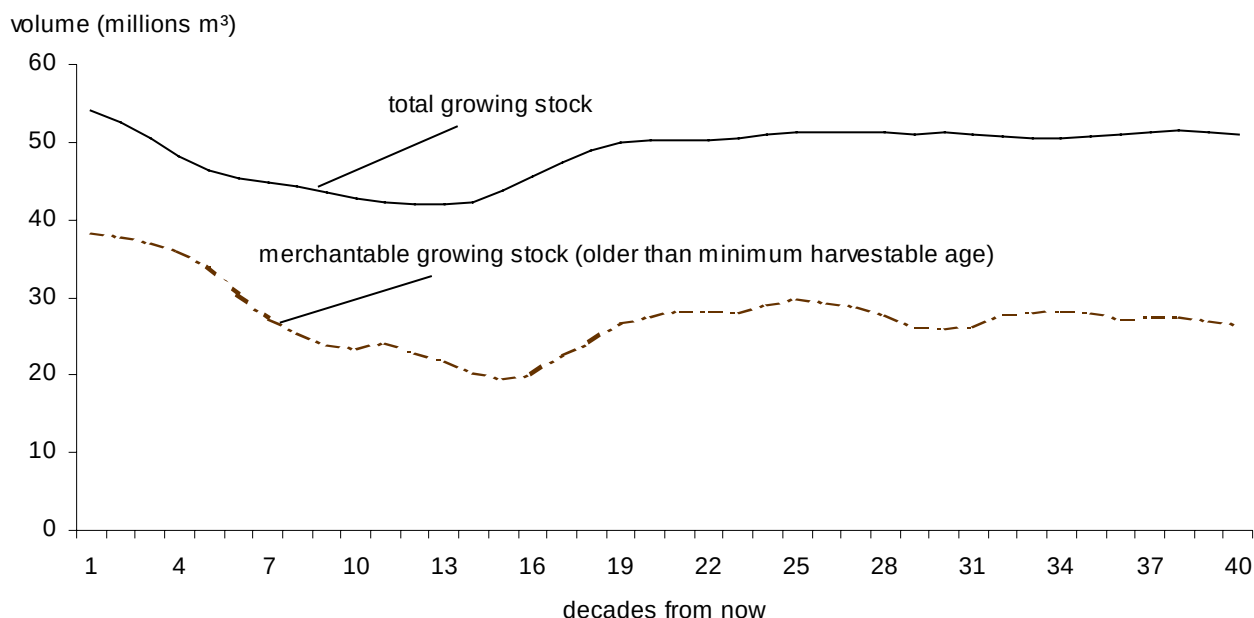


Figure 12. Changes in timber growing stock over time — Cranbrook TSA base case, 1999.

The average growth rate projected for managed second-growth stands is about 2.6 cubic metres per hectare per year, about 30% more than the 2.0 cubic metres per hectare per year for naturally-regenerated stands with no density control. This growth rate difference is reflected in volume projections for existing stands. Higher growth rates are expected in managed stands because stocking levels will be controlled to ensure full site occupancy while avoiding over-stocking that would cause severe competition among trees. The full benefit of silvicultural management will not occur until most second-growth stands become available for harvesting, in 50 to 150 years from now. However, because management is anticipated to result in more volume being available for harvest sooner than if future stands grew at the same rate as did existing stands, silvicultural management does

allow higher harvests from existing stands over the medium term.

The long-term harvest level is below the maximum productive capacity of the timber harvesting land base because forest cover requirements for maintaining wildlife habitat, maximum allowable disturbance levels, and the objective of maintaining a fairly even harvest flow over time result in stands not necessarily being scheduled for harvest at the time of maximum average productivity. If dramatic fluctuations in harvests were acceptable, stands could be harvested at the age for maximum productivity. Theoretically, if all stands were harvested at the age of maximum average productivity, an average annual harvest rate of approximately 1 200 000 cubic metres (26% higher than in the base case) could be achieved in the long term.

4 Results

In the long term, requirements for wildlife habitat and older forest cover (see Sections A.4.4 "Forest cover requirements" and A.4.5, "Biodiversity" of Appendix A) are not limiting on timber supply because forested stands outside the timber harvesting land base are projected to be in a condition to meet most of those requirements in the long term. Therefore, as time progresses less of the timber harvesting land base has to be reserved to achieve non-timber objectives. Similarly, medium-term harvest levels and the timing of the increase to the long-term harvest level are not greatly limited by these old-forest cover requirements because such stands are abundant in the medium term, and because most older forest requirements are met by areas outside the timber harvesting land base. Rather, harvest levels are limited mainly by the amount of timber of a harvestable age, and by the maximum allowable amount of recent disturbance, particularly in community and domestic watersheds and to a lesser degree, in caribou habitat, visual management, recreation management and integrated resource management zones.

The base case for this analysis presents a higher forecast of timber supply than the previous analysis completed for the Cranbrook TSA (March 1995). Several changes in land base and management for

both timber and non-timber resources have led to the increase relative to the 1995 analysis. The most significant changes include:

- an increase of about 15 000 hectares in the timber harvesting land base, resulting from changes in operability information and approaches to environmentally sensitive areas and marginally merchantable forest types;
- a decrease in the unsalvaged losses estimate by approximately 60 000 cubic meters per year;
- less stringent visual quality objectives;
- a decrease in old-growth requirements relative to the *Cranbrook Forest District Interim Old Growth Strategy* employed at the time of the 1995 analysis, combined with greater recognition of the role of forest outside the timber harvesting land base in achieving those requirements;
- changes in riparian management requirements resulting from a decrease in the area over which they apply, as well as changes in the forest retention requirements; and,
- overall reductions in regeneration delays* and green-up ages.

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.

4 Results

4.2 Area, average volume, and average age harvested

Figure 13 shows how annual area harvested would change over the next 250 years if the base case harvest forecast was followed. The area harvested is projected to range from a minimum of about 3600 hectares per year in decade one, to a maximum of 4400 hectares per year in decade 6. During the first three decades, even though the harvest level remains the same, the area harvested is projected to increase because the harvest increasingly comes from younger stands with less

volume. After decade three, the average harvested area drops because older high volume stands which have been required to meet forest cover requirements become available for harvest. The harvested area then increases and achieves its largest size in decade 6. After decade 6, the area harvested gradually declines until decade 14 because higher volume stands are harvested and a temporary drop in the harvest level occurs. After decade 14, the area harvested fluctuates because of an increase in harvest level to the long-term level and because the harvest comes from stands of different productivities and ages.

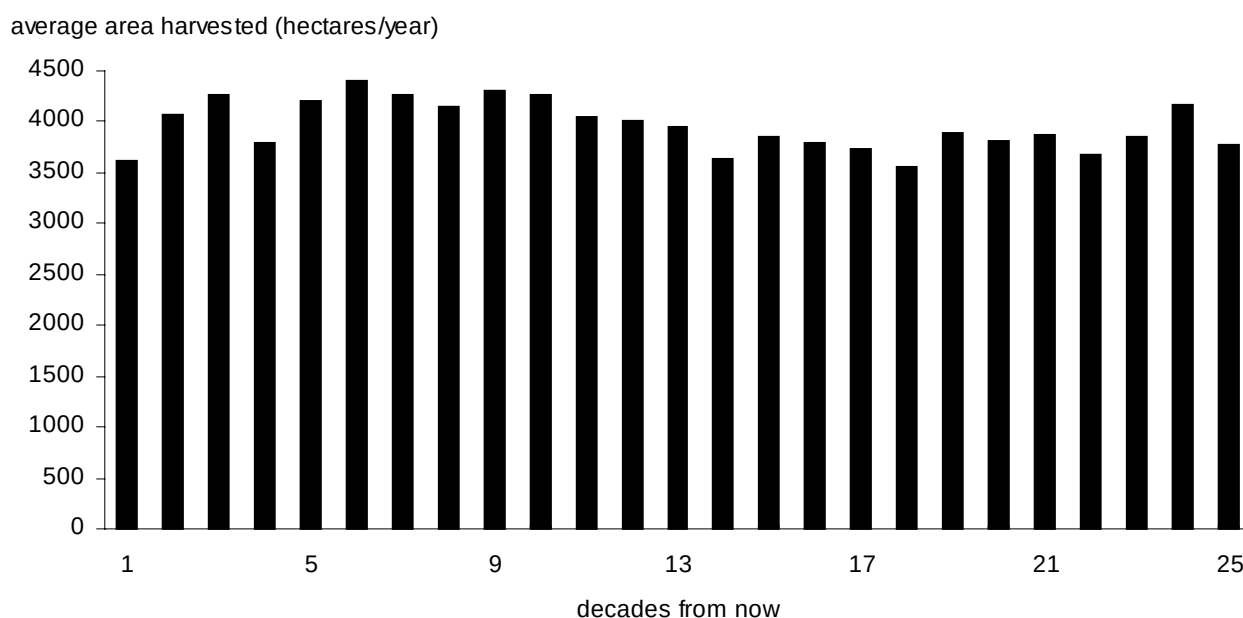


Figure 13. Area harvested over time — Cranbrook TSA base case, 1999.

4 Results

Figure 14 shows the average timber volume per hectare harvested in the base case forecast. The average volume harvested ranges from a maximum of 254 cubic metres per hectare in decade one, to a minimum of 208 cubic metres per hectare in decade 6. When Figure 14 is compared to Figure 13, it can be seen that the average volume

per hectare harvested is higher when the area harvested is lower, and lower when the area harvested is higher. This relationship is expected since the objective is to maintain a constant volume harvested per decade rather than a steady area harvested per decade.

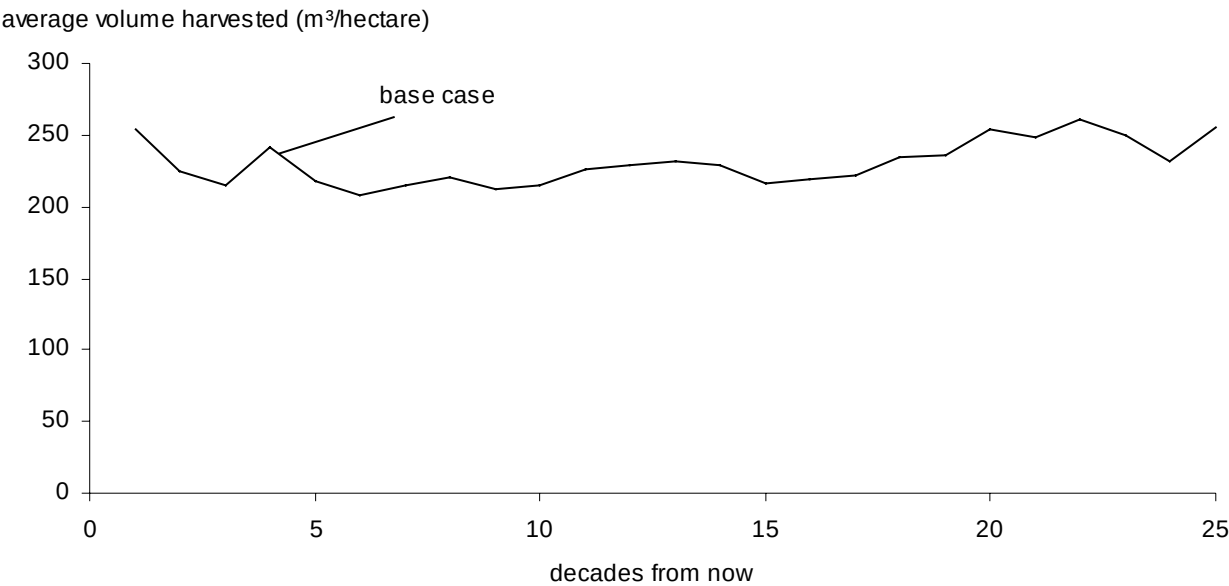


Figure 14. Average volume per hectare over time — Cranbrook TSA base case, 1999.

4 Results

Figure 15 illustrates the projected average harvest age for the Cranbrook TSA base case. In decade one the average harvest age is at the maximum of 160 years, followed by a steep drop to 115 years in decade 2, and a further drop in decade 3 to 110 years. Older stands not required to meet older forest requirements are harvested in the first decade resulting in fewer older stands available for

harvest in the two subsequent decades. During decades 4, 5 and 6 average age harvested increases as more stands become old enough to meet older forest requirements, leaving a higher percentage of older stands available for harvest. The patterns observed in this graph reflect that in the base case, older stands are given a higher priority for harvesting.

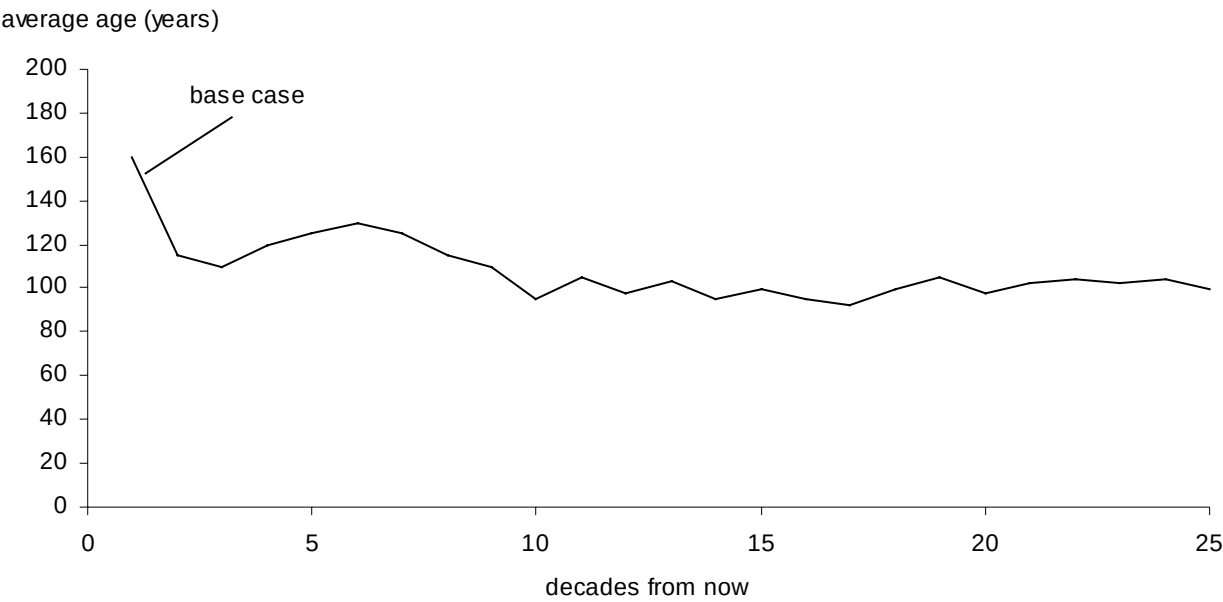


Figure 15. Average harvested age over time — Cranbrook TSA base case, 1999.

4 Results

4.3 Age class composition over time

The charts in Figure 16 show how the age composition of the forest within the Cranbrook Forest District would change over the next 250 years under the base case forecast. The Cranbrook Forest District includes the entire Cranbrook TSA, the Purcell Wilderness Conservancy, and a number of smaller parks and recreation areas. The Cranbrook TSA makes up over 95% of the Cranbrook Forest District.

Forested areas within Cranbrook Forest District that are not included in the Cranbrook TSA can contribute to landscape-level biodiversity and therefore can influence timber supply from the Cranbrook TSA. However, because this area makes up only 5% of the area considered in this analysis, and because much of the forest is currently not old enough to meet mature and old seral biodiversity requirements, its contribution to mature and old seral requirements does not benefit the timber supply over the next 20 years, and will have at best a small benefit to the timber supply over the long term.

4 Results

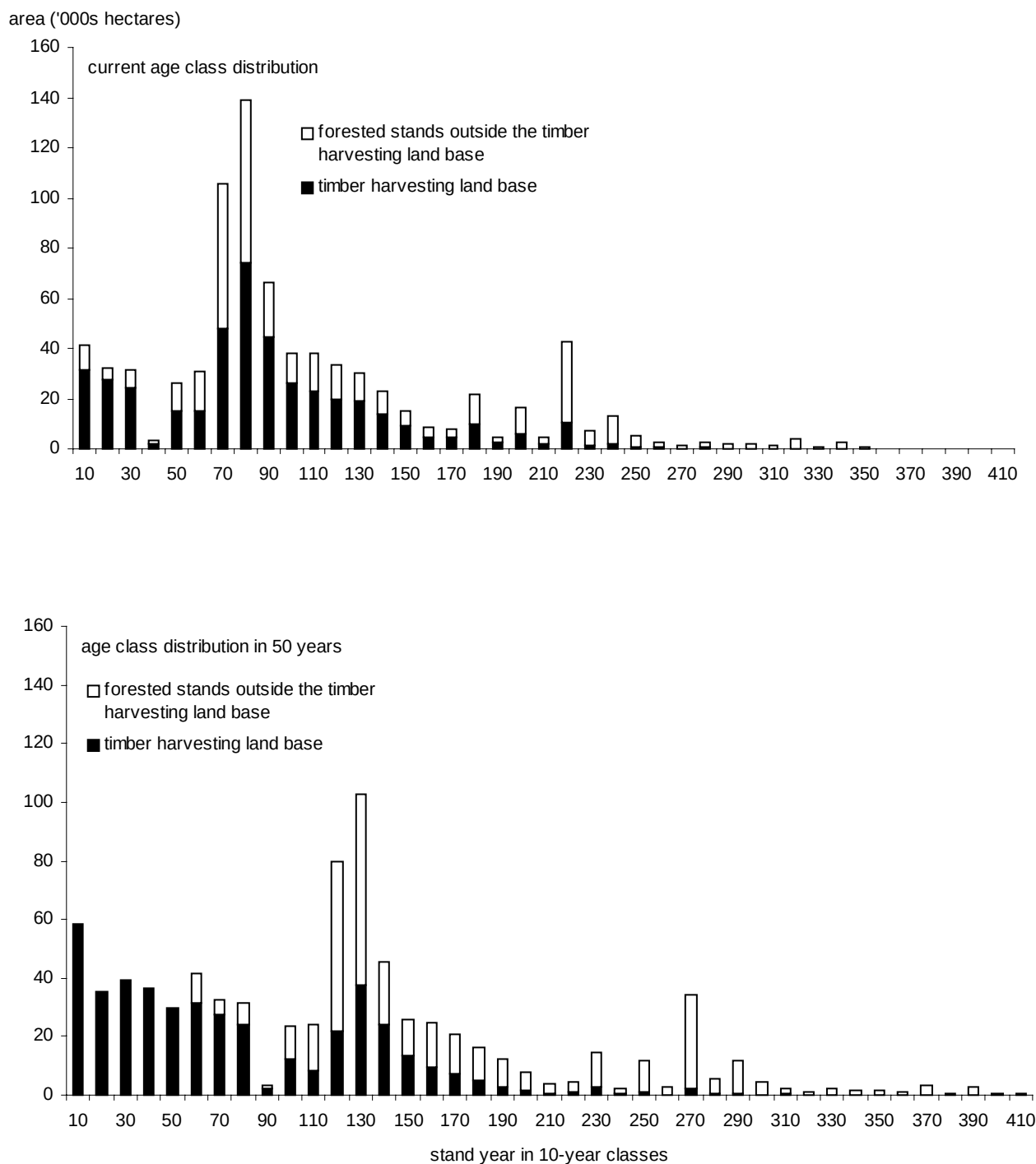


Figure 16. Changes in age composition on the Crown forested land base over time — Cranbrook TSA base case, 1999.

continued

4 Results

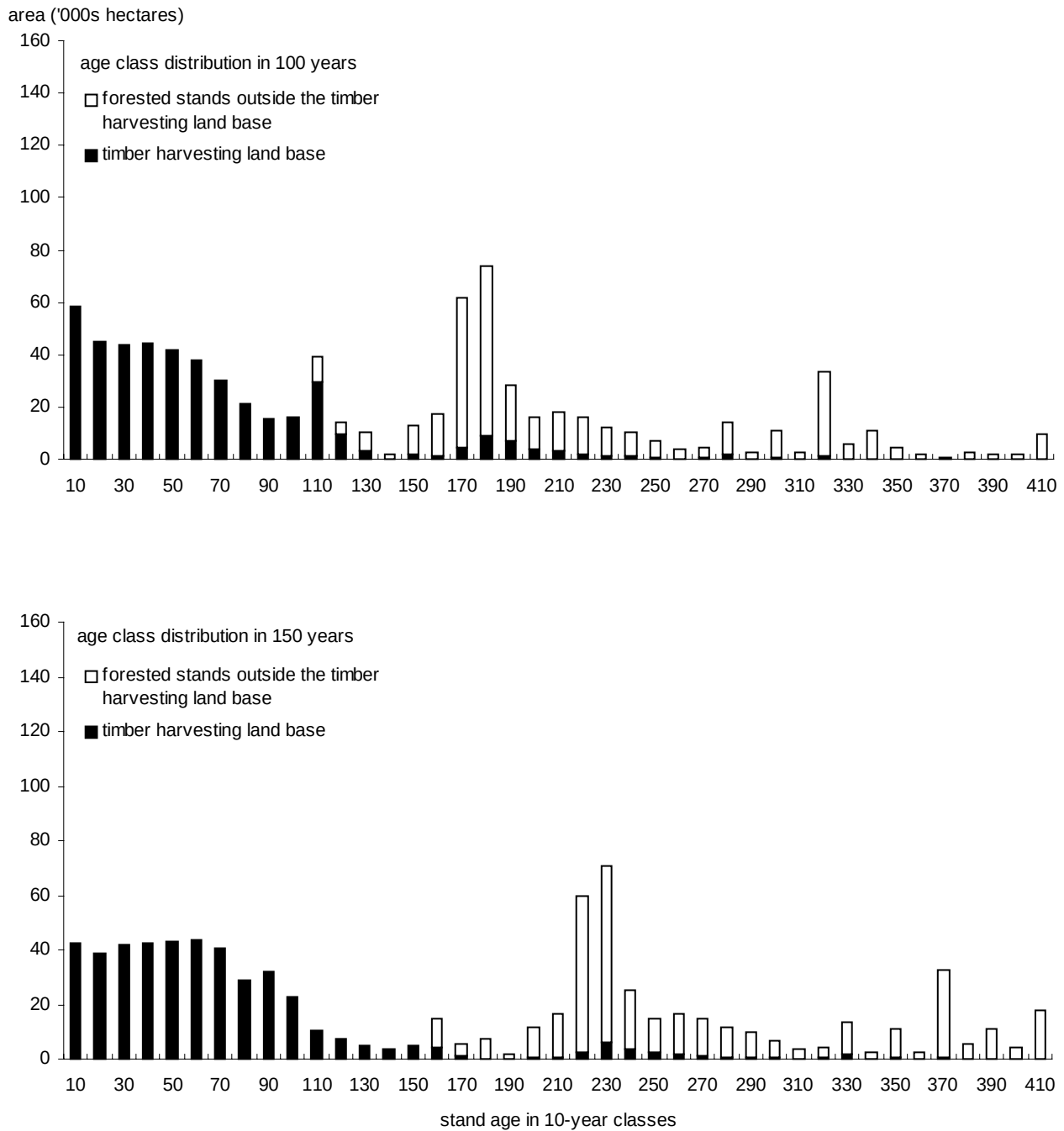


Figure 16. Changes in age composition on the Crown forested land base over time — Cranbrook TSA base case, 1999.

continued

4 Results

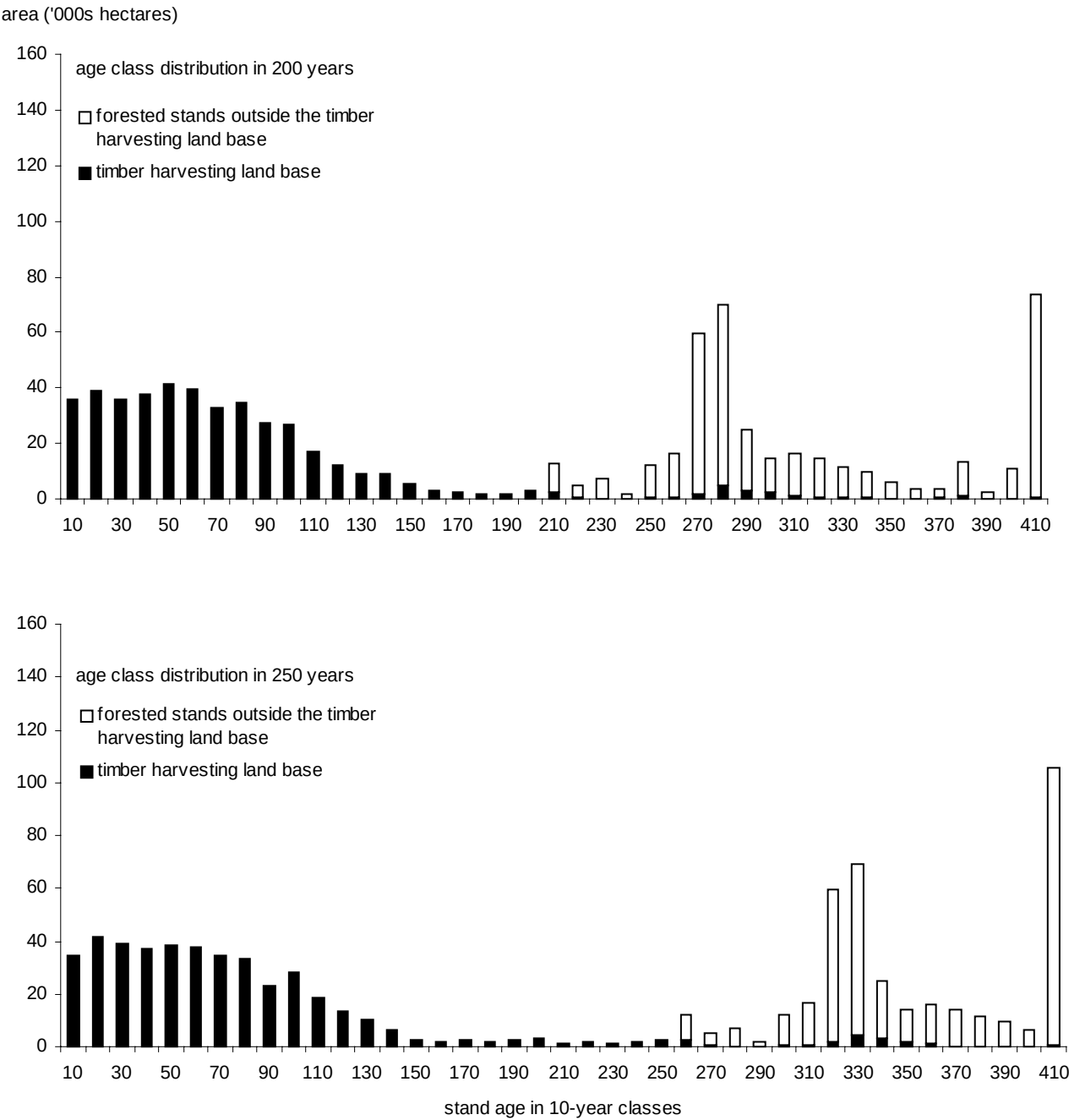


Figure 16. Changes in age composition on the Crown forested land base over time — Cranbrook TSA base case, 1999.

concluded

4 Results

Currently, most of the timber harvesting land base (71%) consists of stands below the minimum harvestable age. The total Crown forested land base also contains forest stands that have been excluded from the timber harvesting land base ("inoperable" stands). These inoperable stands range significantly in age. Initially most of the older forest requirements for wildlife habitat and landscape-level biodiversity are met by inoperable stands, so a proportionately small amount of the timber harvesting land base must be retained for older forest requirements. As time progresses, inoperable stands are assumed to continue aging, thereby increasing their contribution to meeting wildlife habitat and landscape-level biodiversity requirements for the Cranbrook Forest District. After 150 years, no young inoperable stands are forecast to remain and

the forest on the timber harvesting land base is roughly evenly distributed in 10-year age classes between 10 and 90 years. While the age class composition of the timber harvesting land base is fairly stable over the last 100 years of the analysis horizon, there is some fluctuation as stands of different productivity — and hence different volumes and minimum harvestable ages — are harvested and regenerated. The distribution of age classes at 200 years demonstrates this pattern, showing some area of the timber harvesting land base is covered by relatively older stands which are from poorer sites with older minimum harvestable ages. In addition, even though older stands have the highest priority for harvest in the base case, the percentage of stands on the timber harvesting land base older than 140 years changes little over the analysis horizon, ranging from 10.8% at the beginning, to 9.7% at the end of the 250-year horizon.

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 endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

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

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

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions (shown in Figures 11 to 16) are referred to as the base case.

5 Timber Supply Sensitivity Analyses

5.1 Sensitivity analyses on factors important in defining the base case

Table 3 outlines a series of standard sensitivity analyses designed to quantify the uncertainty surrounding some of the factors important in defining the timber supply as indicated in the base

case. To allow for a meaningful comparison between each sensitivity analysis only one assumption was changed compared to the base case in each sensitivity analysis. The timber supply impacts of making these changes to the base case are illustrated in Sections 5.1.1 – 5.1.7. Table 21 provides a summary of the results of each sensitivity test.

Table 3. Standard sensitivity analyses performed on the base case harvest forecast

Factor	Sensitivity test	Section
Land base changes	Increase and decrease size of timber harvesting land base by +/- 5% and by +/- 10%	5.1.1
Growth and yield	Change existing natural stand volumes (VDYP) by +/- 10%	5.1.2
	Change existing future and managed stand volumes (TIPSY) by +/- 10%	5.1.2
	Change minimum harvestable ages by +/- 10 years	5.1.3
	Set minimum harvestable ages at culmination of mean annual increment (CMAI)	5.1.3
	Change green-up time by +/- 3 years	5.1.4
	Change regeneration delay by +/- 2 years	5.1.4
	Change estimate of unsalvaged losses by +/- 50%	5.1.5
	Apply unsalvaged losses as a per cent of standing inventory	5.1.5
Management assumptions and forest cover requirements	Apply full landscape-level biodiversity requirements in low emphasis areas	5.1.6
	Apply landscape-level biodiversity early seral requirements	5.1.6
	Remove landscape-level biodiversity mature and old seral requirements	5.1.6
	Alter adjacency (maximum disturbance) requirements in caribou, FMER managed forest and IRM zones	5.1.7

5 Timber Supply Sensitivity Analyses

5.1.1 Uncertainty in land base available for harvesting

Defining the timber harvesting land base for this analysis involved several assumptions about the types of forest land that are available for harvesting. Inventory classifications together with the watershed stream atlas (used for riparian area estimates) and geographical information systems (GIS) analysis were used to approximate areas to be excluded from timber harvesting. Since approximations were used to define the land base,

and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the timber harvesting land base under current management.

Table 4 and Figures 17 and 18 show how changes of 5% and 10% in the timber harvesting land base would affect potential harvests. As might be expected, these changes have a proportional impact on long-term timber supply and significantly change the timing of the transition to the long-term harvest level.

Table 4. Average harvest levels if the size of the timber harvesting land base is changed

Period (decades)	Base case (m ³ /year) ^a	Change to timber harvesting land base area			
		– 5% (m ³ /year) ^a	+ 5% (m ³ /year) ^a	– 10% ((m ³ /year) ^a)	+ 10% (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000	888 000 ^c
3 – 10	838 000	775 000 ^c	838 000	708 000 ^c	888 000 ^c
11 – 20	801 000	787 000 ^b	882 000 ^c	744 000 ^c	917 000 ^c
21+	883 000	835 000 ^c	925 000 ^b	793 000 ^c	960 000 ^c

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

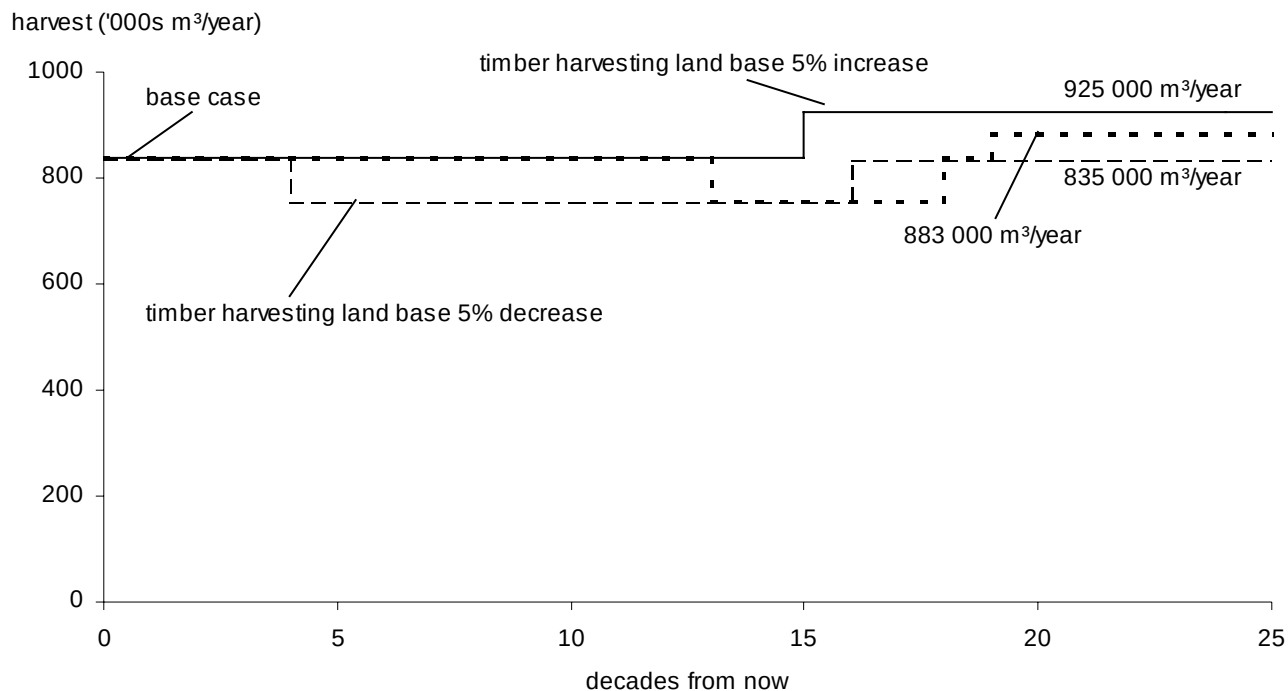


Figure 17. Harvest forecasts if the timber harvesting land base is increased or decreased by 5% — Cranbrook TSA, 1999.

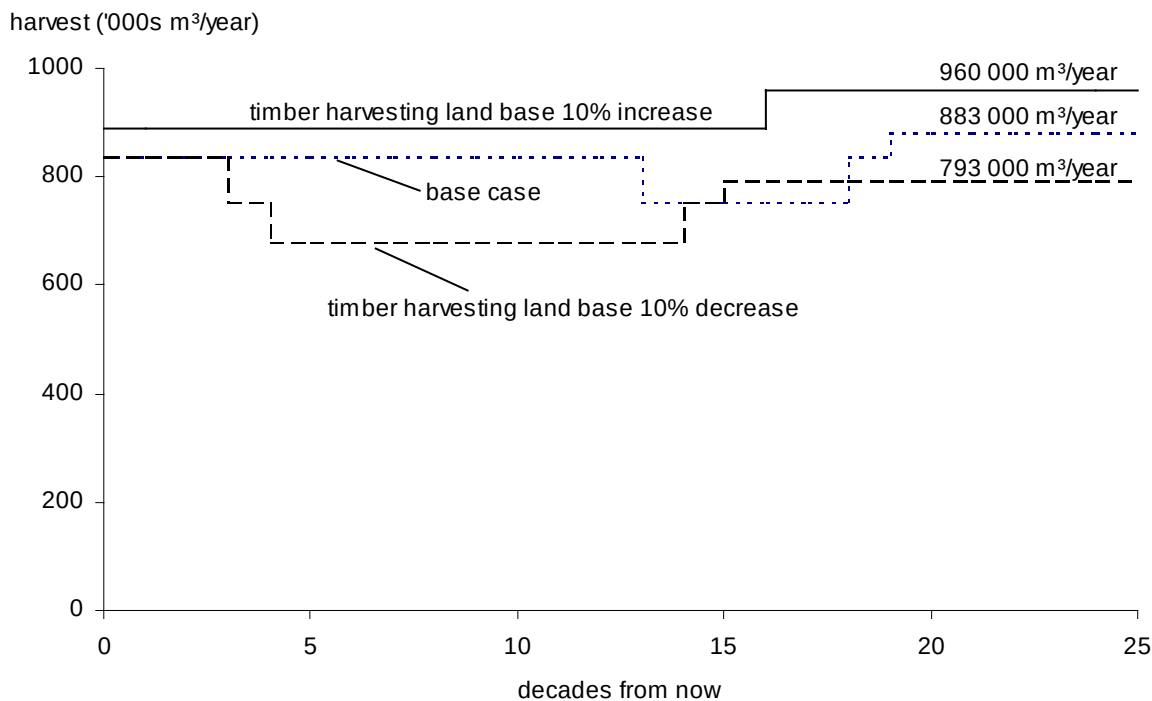


Figure 18. Harvest forecasts if the timber harvesting land base is increased or decreased by 10% — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.2 Uncertainty in estimates of timber volumes

Estimates of timber volumes are subject to some uncertainty because they are based on extrapolation of measurements from some stands to all stands in an area, and on inventory classifications which contain some uncertainty. The volume estimates are more accurate when averaged over large areas, but may not reflect actual volumes in a specific stand. Uncertainty may also stem from estimates of the volume lost to decay in standing trees, and to waste and breakage during timber harvesting, as well as estimates of utilization levels practiced during harvesting. In addition, volume estimates for future stands can also be affected by

management practices. Factors such as species favoured in the future, tree density, and volume lost to root rot, for example, increase the uncertainty in future stand volume estimates. To examine this uncertainty, arbitrary changes of $\pm 10\%$ were made to timber volume estimates for both existing natural stands (VDYP) and regenerated stands (TIPSY).

Table 5 and Figures 19 and 20 show how changes of 10% to the estimates of timber volumes would affect potential harvests. Changing volume estimates for existing natural stands by 10% affects harvest levels in the short- and medium terms but not in the long term. Conversely, changing volume estimates for regenerated stands affects harvest levels in the medium- and long-terms but not in the short term.

Table 5. Average harvest levels if timber volume estimates are changed

Period (decades)	Base case (m ³ /year) ^a	Change to timber volume estimates			
		VDYP – 10 % (m ³ /year) ^a	VDYP + 10% (m ³ /year) ^a	TIPSY – 10% (m ³ /year) ^a	TIPSY +10% (m ³ /year) ^a
1 – 2	838 000	838 000	876 000 ^b	838 000	838 000
3 – 10	838 000	698 000 ^c	876 000 ^b	796 000 ^b	838 000
11 – 20	801 000	827 000 ^b	880 000 ^c	767 000 ^b	900 000 ^c
21+	883 000	883 000	883 000	785 000 ^c	971 000 ^c

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

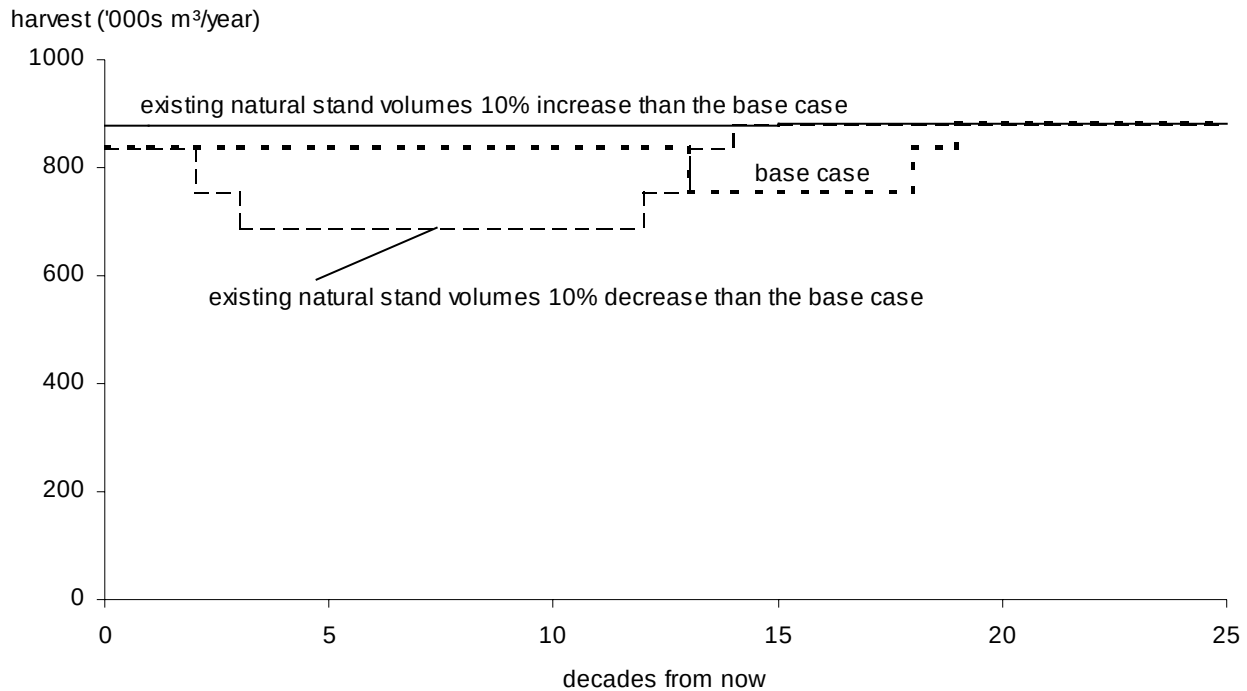


Figure 19. Harvest forecasts with existing stand volume estimates changed by 10% — Cranbrook TSA, 1999.

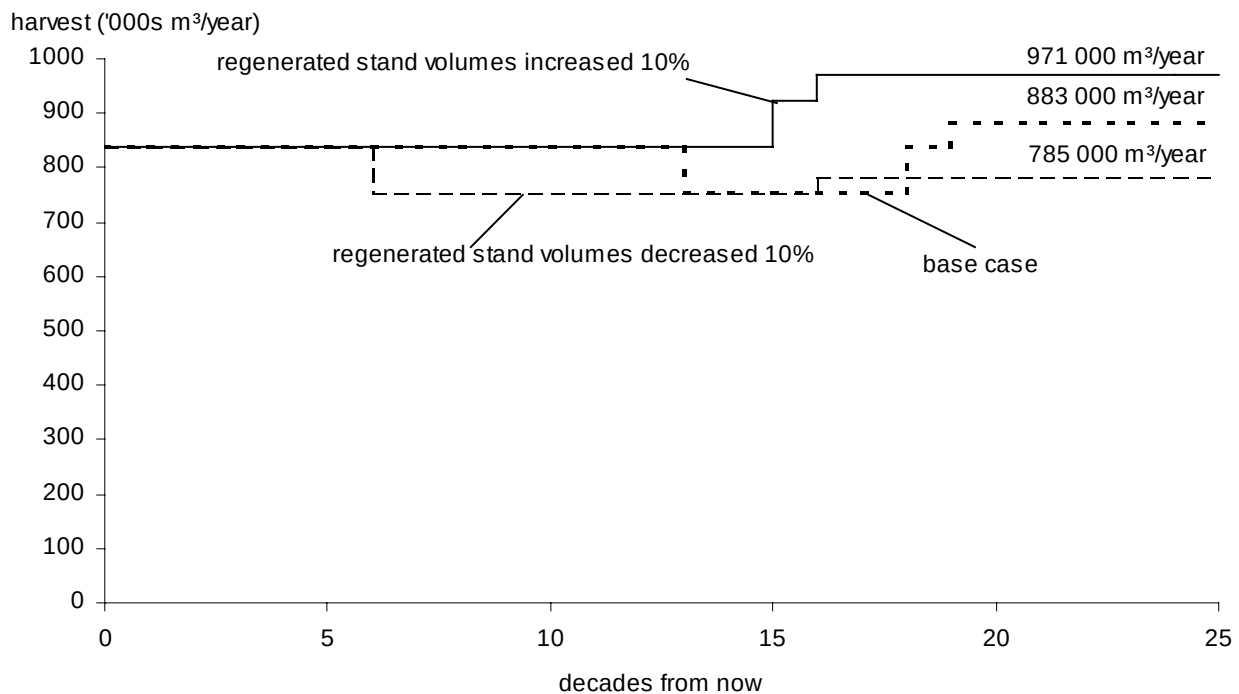


Figure 20. Harvest forecasts with regenerated stand volume estimates changed by 10% — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.3 Uncertainty in minimum harvestable ages

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

For this analysis, minimum harvestable ages were estimated using a combination of the following factors: age at which stands reach a minimum volume, age to a minimum average diameter, the maximum age when stands achieve 95% of mean annual increment, and professional judgment. These criteria are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," and apply to both managed and unmanaged stands. This method was chosen to ensure that only stands with sufficient merchantable volume and with trees

of merchantable size would be considered available for harvest. The harvestable ages are minimums; stands may be harvested at older, but not younger, ages. In fact, many stands are harvested at ages beyond the minimum because they are retained to meet objectives such as forest cover requirements and harvest level stability. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Table 6 and Figures 21 and 22 show how timber supply would change if stands in fact become merchantable either 10 years sooner or later than assumed in the base case, or if minimum harvestable age reflected the culmination of mean annual increment age of a stand (CMAI)*. These changes in minimum harvestable ages would have a large impact on the timing of the transition to the long-term level and a moderate impact on the long-term harvest level. If minimum harvestable ages were 10 years younger than those in the base case, the projected long-term harvest level would be 4.0% lower. If minimum harvestable ages were increased to reflect the culmination of mean annual increment age, the projected long-term harvest level would be 1.8% higher than the base case long-term level.

Table 6. Average harvest levels if minimum harvestable ages changed

Period (decades)	Base case (m ³ /year) ^a	Change to minimum harvestable ages		
		– 10 years (m ³ /year) ^a	+ 10 years (m ³ /year) ^a	@ CMAI (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	796 000 ^b
3 – 10	838 000	838 000	775 000 ^c	754 000 ^c
11 – 20	801 000	845 000 ^c	853 000 ^c	893 000 ^c
21+	883 000	848 000 ^b	883 000	899 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

Culmination age

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

5 Timber Supply Sensitivity Analyses

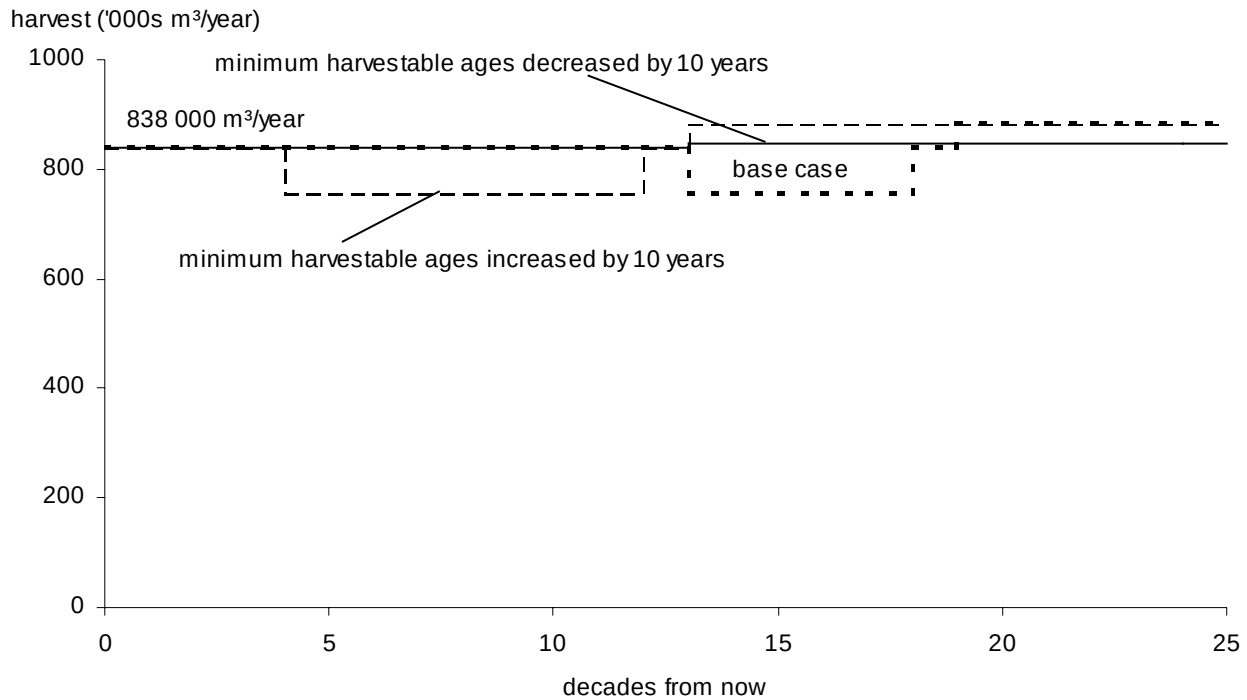


Figure 21. Harvest forecasts if minimum harvestable ages are 10 years younger or older than in the base case — Cranbrook TSA, 1999.

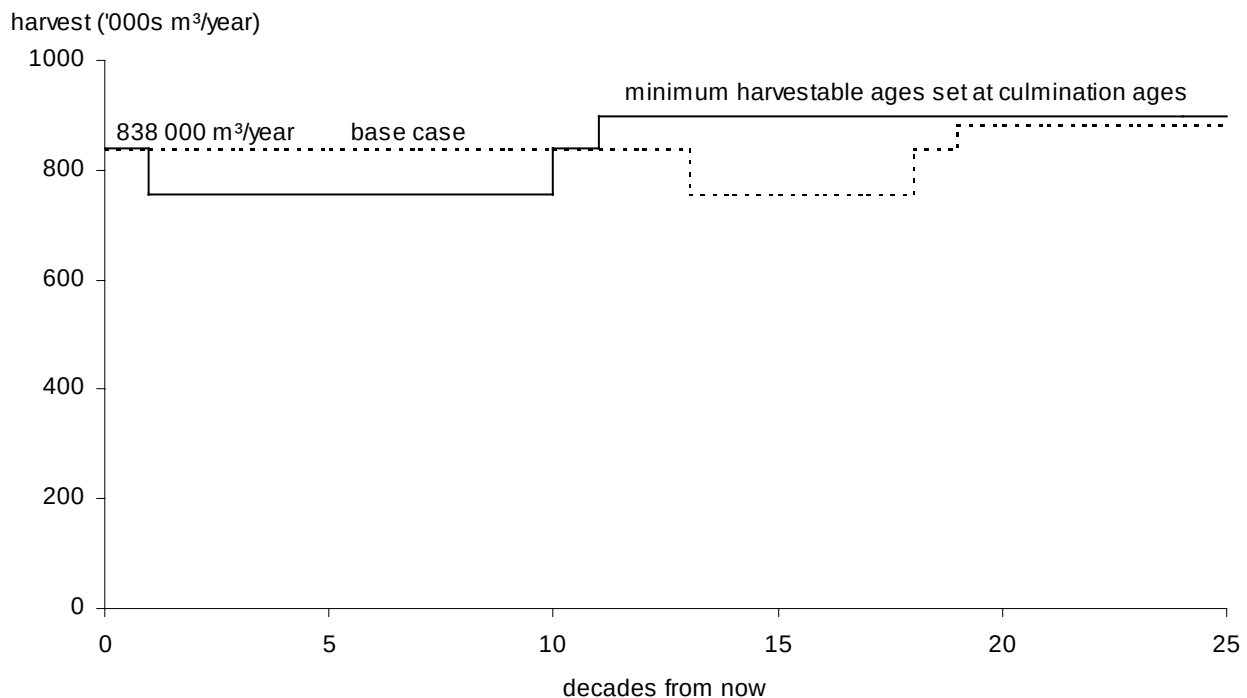


Figure 22. Harvest forecast if minimum harvestable ages are set at the culmination ages — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.4 Uncertainty in green-up requirements and regeneration delay

Forest cover requirements for wildlife habitat, visual quality, recreation management, water quality and adjacency 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 green-up period arises because the desired green-up conditions (that

is, stand 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.

Table 7 and Figures 23 and 24 show that potential harvest levels over both the short- and long-terms are not highly sensitive to uncertainty about green-up ages or regeneration delay. Changes in the green-up and regeneration periods that reasonably reflect the degree of uncertainty in these factors affect the timing of the transition to the long-term level but have little to no impact on short- and long-term harvest levels.

Table 7. Average harvest levels if green-up period changed

Period (decades)	Base case (m ³ /year) ^a	Green-up age		Regeneration delay	
		– 3 years (m ³ /year) ^a	+ 3 years (m ³ /year) ^a	– 2 years (m ³ /year) ^a	+ 2 years (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000	838 000
3 – 10	838 000	838 000	833 000	838 000	822 000
11 – 20	801 000	824 000 ^b	812 000	843 000 ^c	802 000
21+	883 000	888 000	878 000	886 000	881 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

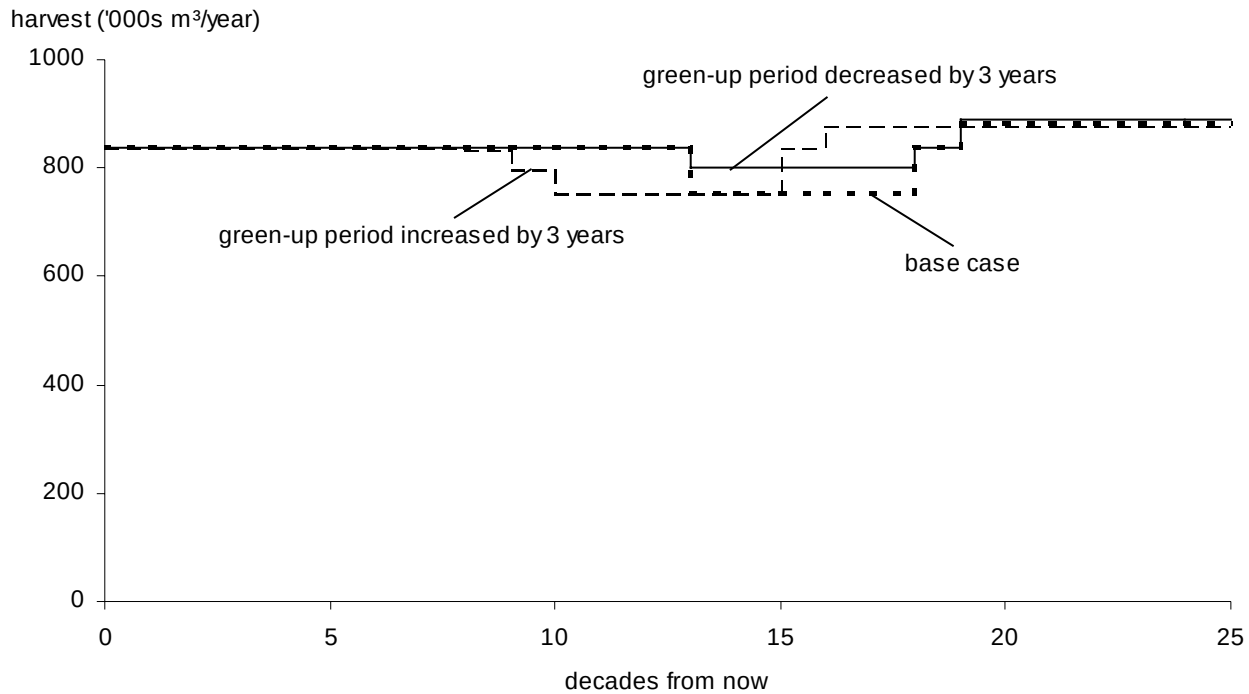


Figure 23. Harvest forecasts if green-up ages were either 3 years longer or shorter than in the base case — Cranbrook TSA, 1999.

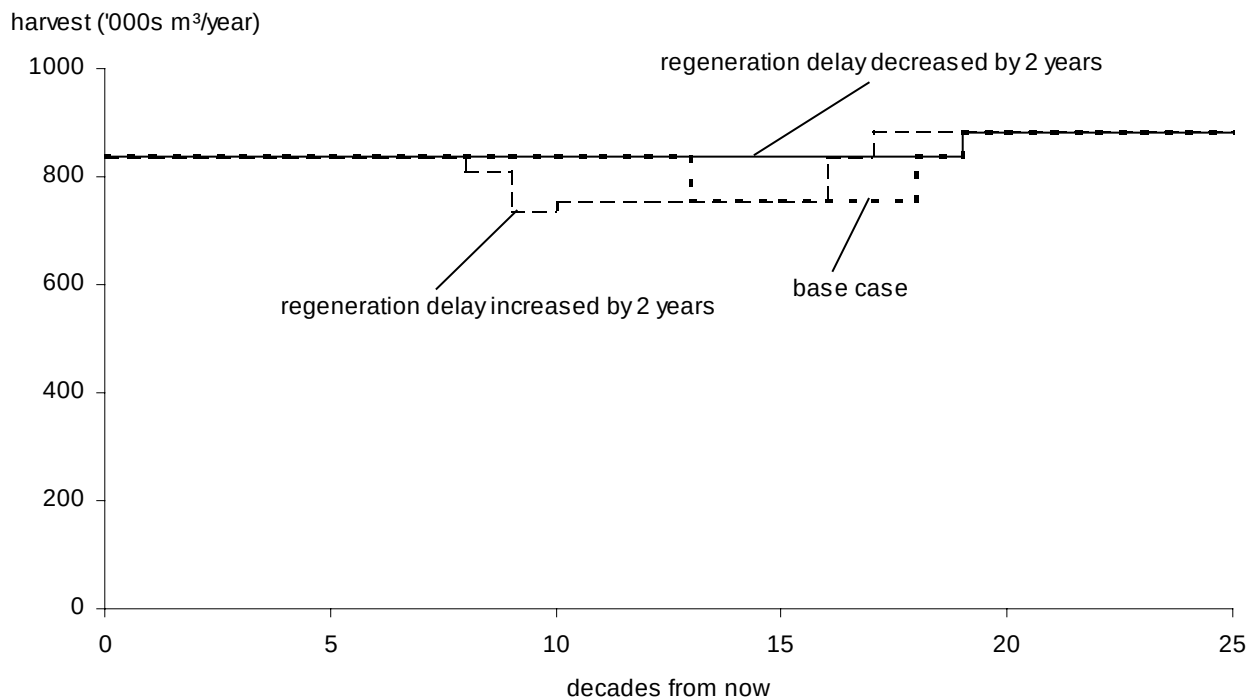


Figure 24. Harvest forecasts if regeneration delays were either 2 years longer or shorter than in the base case — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.5 Uncertainty in estimates of unsalvaged losses

The base case harvest forecast incorporates an estimate of the volume of timber damaged by fire, insects, wind or other abiotic factors that does not get salvaged. The current estimate of these unsalvaged losses is 77 241 cubic metres per year. Combining the base case initial harvest level of 838 000 cubic metres per year with the unsalvaged losses, the actual volume depleted is 915 241 cubic metres per year. Since the unsalvaged losses estimate is a significant amount of volume relative to harvests projected (over 9%), an over- or under-estimate of losses could have a significant

impact on potential harvests. The estimate used in the base case is an average over many years for losses to fire, insects, wind and other abiotic factors.

Uncertainty exists because losses are hard to predict, and potentially, the estimate could be based on an inadequate or unrepresentative time period.

Table 8 and Figures 25 and 26 show that potential harvest levels over both the medium- and long-terms are moderately impacted by changes of 50% in the estimate of unsalvaged losses, or by assuming unsalvaged losses to be a constant 9.2% of the total forest volume on the timber harvesting land base rather than a constant amount of volume (77 241 cubic metres per year).

Table 8. Average harvest levels if estimate of unsalvaged losses changed

Period (decades)	Base case (m ³ /year) ^a	Change to estimate of unsalvaged losses		
		– 50% (m ³ /year) ^a	+ 50% (m ³ /year) ^a	% of standing inventory (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000
3 – 10	838 000	838 000	728 000 ^c	838 000
11 – 20	801 000	880 000 ^c	745 000 ^c	869 000 ^b
21+	883 000	922 000 ^b	845 000 ^b	900 000

(a) Average for the period.

(b) 2 - 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

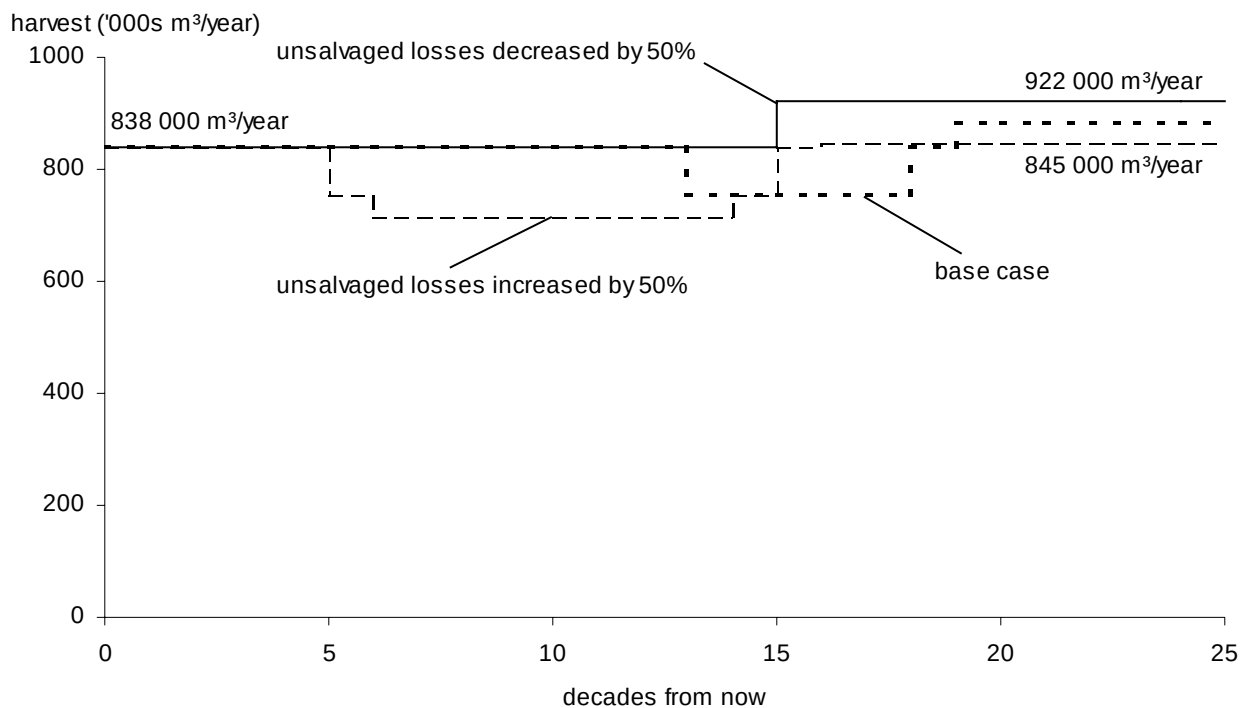


Figure 25. Harvest forecasts if estimate of unsalvaged losses is either 50% more or less than in the base case — Cranbrook TSA, 1999.

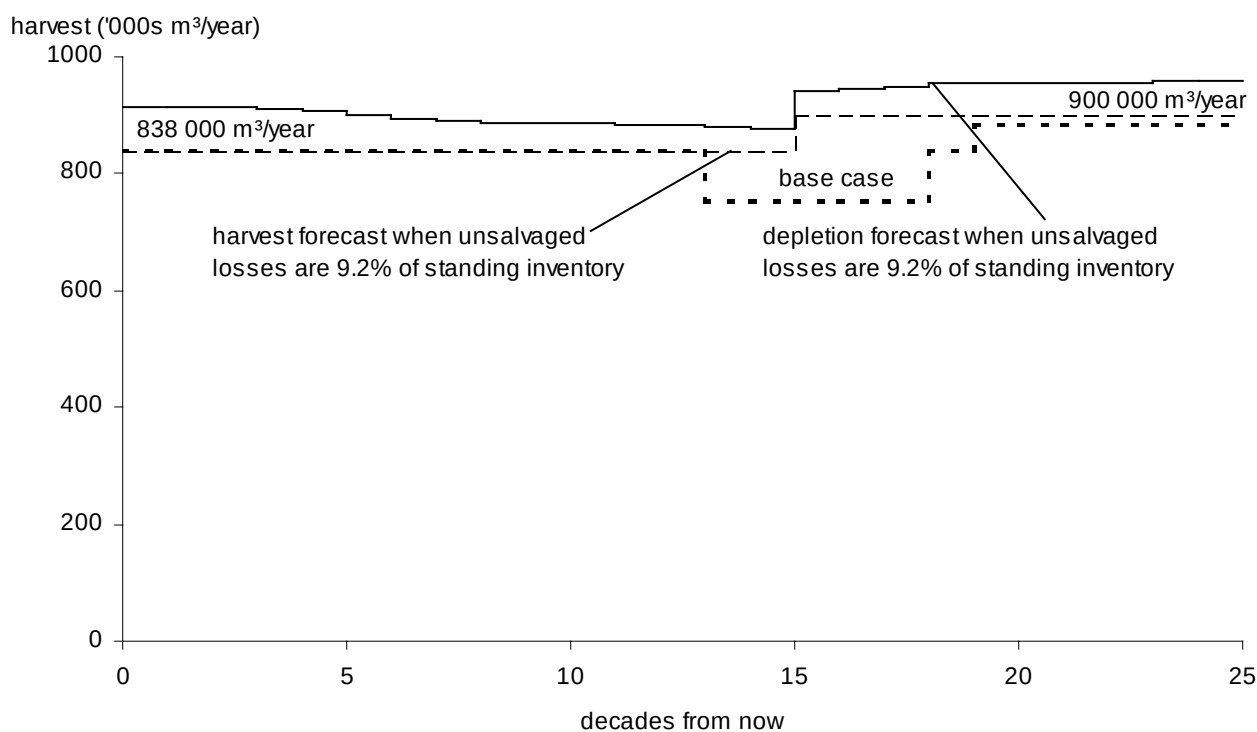


Figure 26. Harvest forecast if estimate of unsalvaged losses is applied as a per cent of the standing inventory — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.6 Uncertainty in biodiversity seral stage requirements

The *Forest Practices Code of British Columbia Act* describes the conservation of biological diversity as an essential component of sustainable use of forests. The *Forest Practices Code Biodiversity Guidebook* provides recommendations for maintaining biodiversity at both the stand and landscape levels. Stand-level biodiversity has been addressed in this analysis through volume reductions for each stand on the timber harvesting land base. Therefore, uncertainty about stand-level biodiversity can be assessed through the sensitivity analyses that examine the effect of uncertainty about timber yields. Landscape-level biodiversity, however, has been represented in this analysis by forest cover requirements applied to natural disturbance types within landscape units. There is uncertainty about how the recommendations in the *Biodiversity*

Guidebook should be interpreted and applied, as well as how the Cranbrook TSA should be delineated into landscape units. The following sensitivity analyses provide an indication of timber supply impacts associated with uncertainty about how the *Biodiversity Guidebook* seral distribution targets are applied in order to meet landscape-level biodiversity requirements.

Table 9 and Figures 27 and 28 show that changes in the application of seral distribution targets would have a large impact on the timing of the transition to the long-term harvest level and little impact on the long-term level. Three separate scenarios are shown: all old seral requirements are applied in full from the beginning of the planning horizon, no mature or old seral forest cover requirements are applied; and early seral requirements are applied, in addition to the mature and old seral requirements applied in the base case.

Table 9. Average harvest levels if landscape-level biodiversity assumptions are changed

Period (decades)	Base case (m ³ /year) ^a	Change to landscape level seral requirements		
		Old seral now (m ³ /year) ^a	No mature or old seral (m ³ /year) ^a	Add early seral (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000
3 – 10	838 000	775 000 ^c	838 000	817 000 ^b
11 – 20	801 000	862 000 ^c	838 000 ^b	814 000
21+	883 000	879 000	883 000	883 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast

5 Timber Supply Sensitivity Analyses

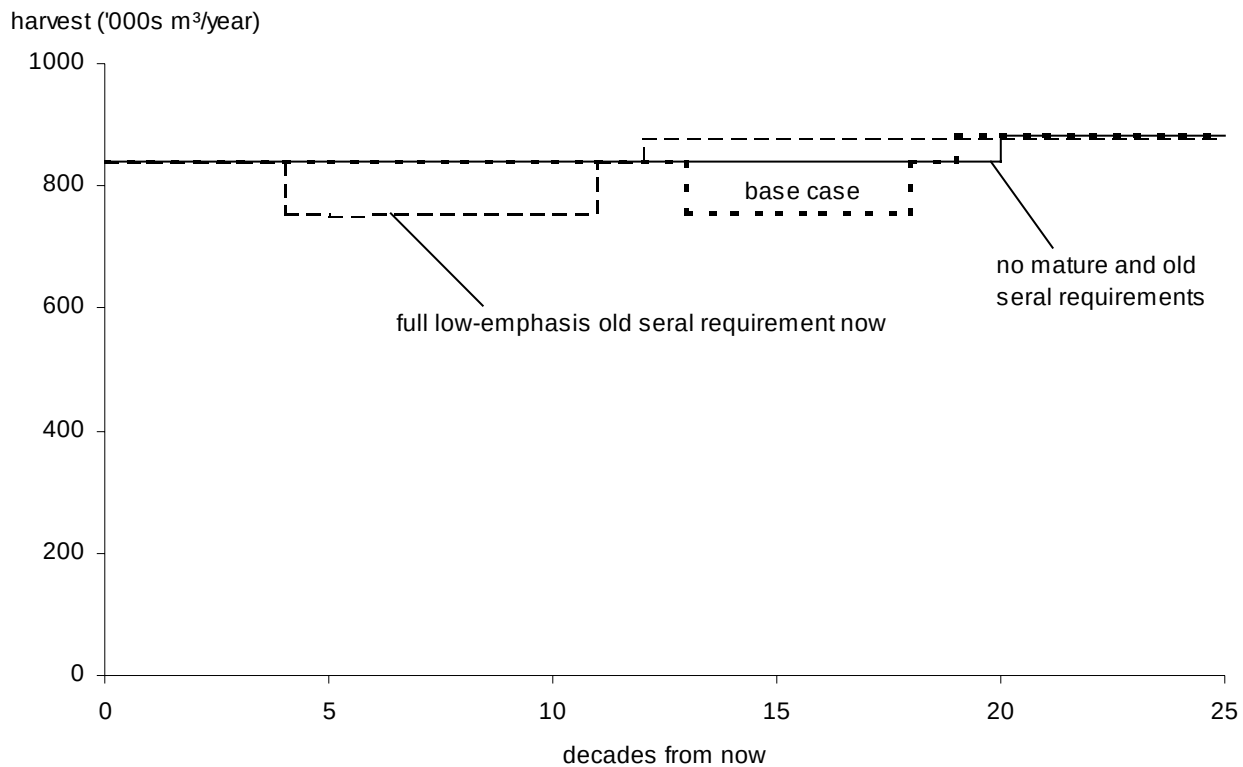


Figure 27. Harvest forecasts if landscape-level biodiversity assumptions are changed — Cranbrook TSA, 1999.

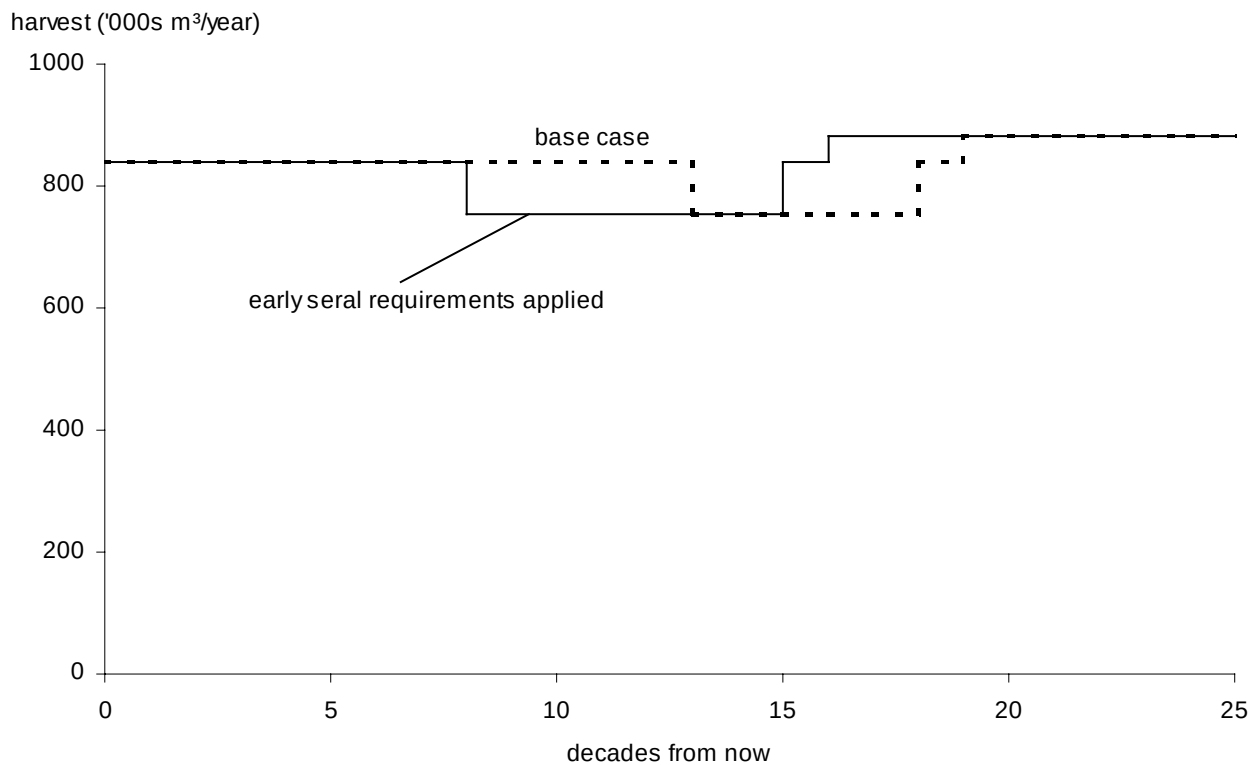


Figure 28. Harvest forecast if landscape-level early seral requirement applied — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.1.7 Uncertainty in adjacency restrictions and modelling approximations

The *Forest Practices Code* (FPC) requires that trees in a harvested area must reach a specific height (green-up height) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area, a maximum limit was set in this analysis on the overall area that has not reached the green-up conditions. It was assumed that maximums of 33% of the timber harvesting land base in the ESSFwm, ICHmw2, ESSFdk, ICHmk1 integrated resource management zones and FMER managed forest zone, 40% in the MSdk integrated resource management zone, and 25% in the caribou habitat zones, could be covered by stands that have not met the green-up condition. Forest cover requirements are used in the analysis to approximate adjacency requirements. These requirements have some uncertainty because they are approximations of the effects of cutblock-level decisions and it is difficult to define the exact forest structure needed to meet the adjacency objectives for a particular area. Furthermore, there is uncertainty about how

adjacency requirements will be implemented in the field.

Table 10 and Figure 29 show the impacts of reducing all disturbance limits for the caribou zone, IRM zones, and the FMER managed forest zone to 25%. Timber supply over the 250-year analysis horizon would change little relative to the base case. Both the reduction from the current AAC and the increase to the long-term level occur three decades earlier than in the base case. These changes in harvest flow are required mostly to stabilize long-term timber supply. Timber supply could be maintained at the current AAC for only one decade less than in the base case with the 25% disturbance limit; however, doing so would require a reduced long-term level.

The only change caused by complete removal of the disturbance limits for the caribou, IRM and FMER managed forest zones was a small reduction in the long-term timber supply. This result reflects that these disturbance limits did not constrain timber supply in the base case. The counter-intuitive reduction in the long term occurred due to a change in the order in which stands are harvested compared to the base case. If the base case schedule were explicitly required, the removal of the disturbance limits would have no impact on timber supply compared to the base case.

Table 10. Average harvest levels if disturbance limits were altered

Period (decades)	Base case (m ³ /year) ^a	Adjacency objectives	
		None (m ³ /year) ^a	Maximum 25% disturbance (m ³ /year) ^a
1 – 2	838 000	838 000	838 000
3 – 10	838 000	838 000	838 000
11 – 20	801 000	801 000	815 000
21+	883 000	881 000	885 000

(a) Average for the period.

5 Timber Supply Sensitivity Analyses

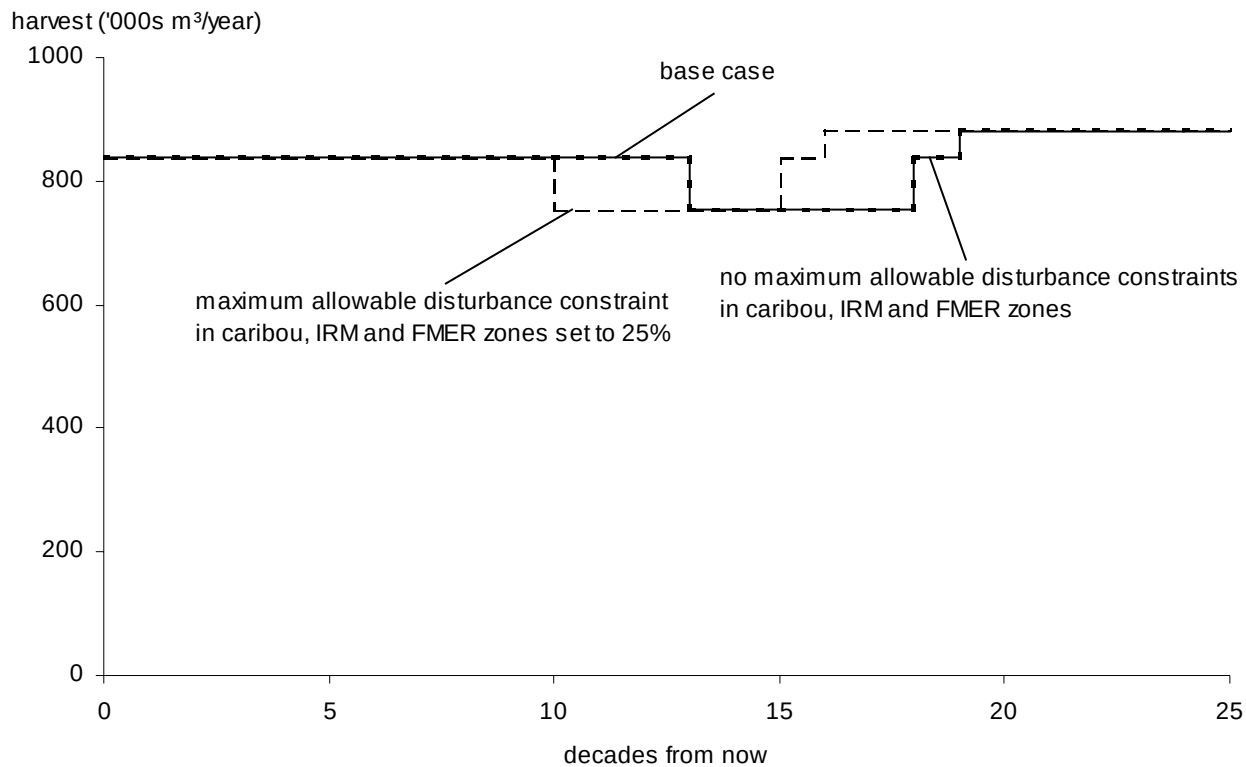


Figure 29. Harvest forecasts if disturbance limits altered — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.2 Sensitivity analyses on issues specific to the Cranbrook TSA

The sensitivity analyses outlined in Table 11 elaborate on the sensitivity analyses described in Section 5.1. For example where an arbitrary change in the size of the timber harvesting land base was

examined in the previous section, here a specific change based on additional or new information is examined. The timber supply impacts of making these changes to the base case are described and illustrated in Sections 5.2.1. – 5.2.9. Table 21 provides a summary of the results of each sensitivity test.

Table 11. Sensitivity analyses on issues specific to the Cranbrook TSA

Factor	Sensitivity test	Section
Land base changes	Include steep slopes in the timber harvesting land base	5.2.1
Growth and yield	Reduce natural stand volumes by 5.5% based on inventory audit results	5.2.2
	Reduce volume estimates for high elevation sites by 30%	5.2.3
	Increase unsalvaged losses by 19 786 m ³ /year in the first 70 years to account for armillaria	5.2.4
Management assumptions and forest cover requirements	Apply biodiversity emphasis options according to <i>Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP-IS)</i>	5.2.5
	Change harvest priorities (test alternative harvest queue rules — oldest stands first, youngest stands first, random harvest order).	5.2.6
	Limit harvest in larch and Douglas-fir analysis units to 18% of harvest to reflect current pulp mill use	5.2.7
	Stand level biodiversity — reduce residual volumes within cutblocks to 2.5%; increase to 7.9%, for cutblocks outside of FMER open forest or FMER open range.	5.2.8
	Apply landscape level seral targets within each biogeoclimatic variant on a district-wide basis rather than on a landscape-unit level.	5.2.9
	Maintain old seral requirements only (remove mature seral requirements).	5.2.9
	Apply landscape-level biodiversity requirements separately to the operable forested area and the entire forest area (i.e., “proportional representation”)	5.2.9

5 Timber Supply Sensitivity Analyses

5.2.1 Inclusion in the timber harvesting land base of steep slope sites below the operability line

In the base case, accessible areas below the operability line were excluded from the timber harvesting land base where the slope was greater than 65% and the leading species was lodgepole pine, or where the slope was greater than 70% and the leading species was not lodgepole pine. These steep slope areas would be otherwise available for harvesting because other classifications of forest

land unavailable for harvesting (e.g., environmentally sensitive areas) are separately accounted for in the analysis. Thus, these steep slope sites could potentially be part of the timber harvesting land base in the future if improvements in harvesting methods and economic conditions occur.

Table 12 and Figure 30 illustrate that including accessible steep slope sites would result in a small increase in the projected long-term level.

Table 12. Average harvest levels if steep slope sites included

Period (decades)	Base case (m ³ /year) ^a	Include steep slopes (m ³ /year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	838 000
11 – 20	801 000	820 000 ^b
21+	883 000	888 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

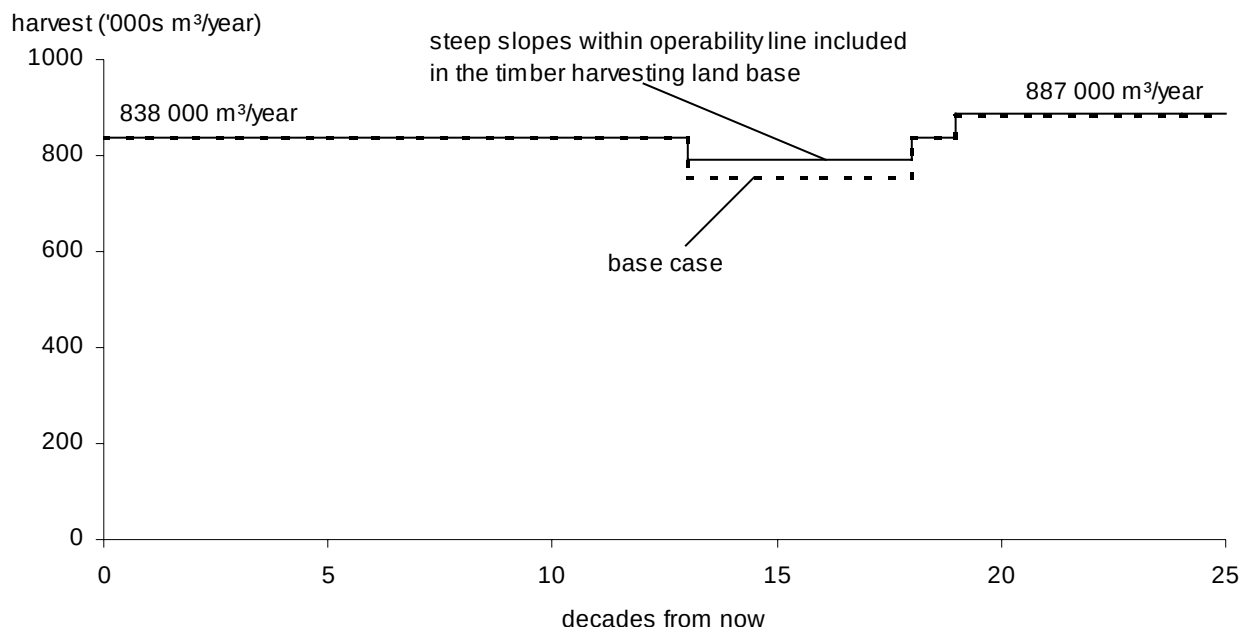


Figure 30. Harvest forecast if steep slope sites included in the timber harvesting land base — Cranbrook TSA, 1999.

5.2.2 Inventory audit results

In 1997 an audit was conducted on the forest inventory for the Cranbrook TSA. The audit indicated that inventory information on mature forests was statistically reliable, but that over the entire forest area, stand volumes derived using audit (ground) measurements were on average 5.5% less than indicated by the inventory. For the physically operable area, the audit suggested that inventory information overestimated ground-measured volumes by 4.1%. Table 13 and Figure 31 show how a decrease of 5.5% in the estimates of volumes in stands currently over 30 years of age would affect the timber supply projection.

If existing natural stand volumes were actually 5.5% lower than in the base case, the current AAC could be maintained for only 4 decades, and medium-term timber supply would be reduced. After 200 years, the harvest forecast would not be affected.

Two points regarding the application of the audit findings suggest caution should be used when interpreting the results of this sensitivity analysis. First, the potential volume overestimate on the operable forest was 4.1%, not 5.5% as for the whole forest area. Second, the audit results may not apply to stands between 30 and 60 years old (7.3% of the timber harvesting land base), since they were not sampled for the audit of mature volume. Therefore, the results displayed in Figure 31 are the maximum likely implication of the audit findings.

5 Timber Supply Sensitivity Analyses

Table 13. Average harvest levels if volume estimates for natural existing stands reduced 5.5% based on inventory audit results

Period (decades)	Base case (m ³ /year) ^a	VDYP –5.5% (m ³ /year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	771 000 ^c
11 – 20	801 000	827 000 ^b
21+	883 000	883 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

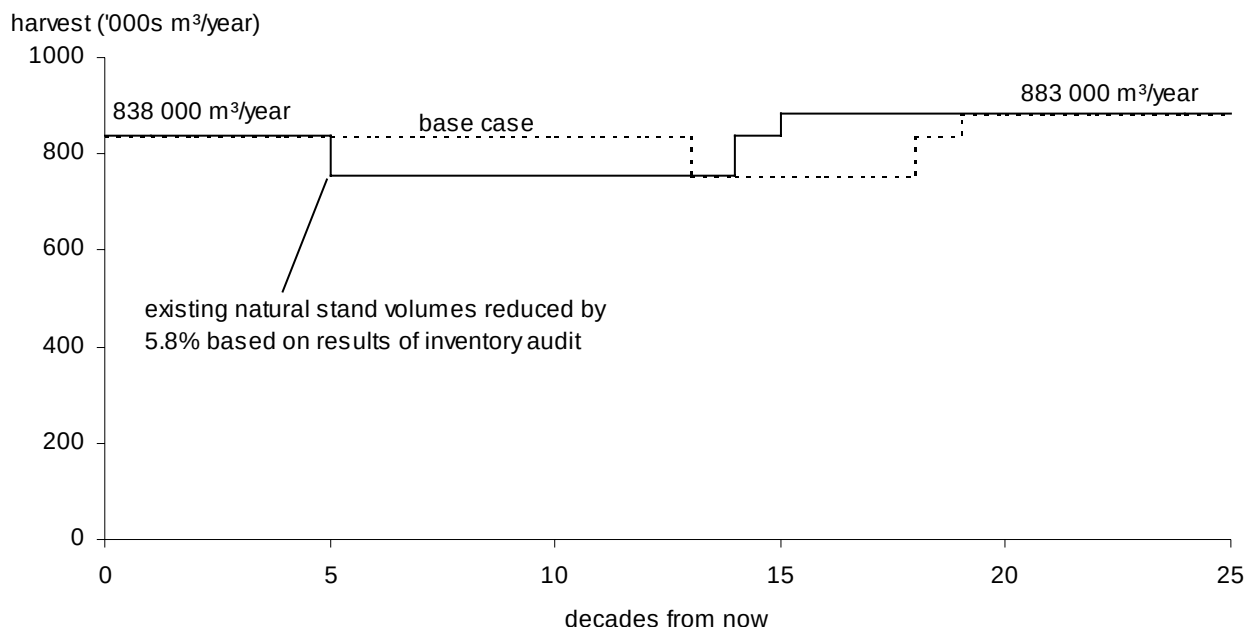


Figure 31. Harvest forecast if volume estimates for existing natural stands are 5.5% lower than in the base case — Cranbrook TSA, 1999.

5.2.3 Volume estimates for high-elevation sites

High-elevation sites occupy just over 8% of the timber harvesting land base. At higher elevations, subalpine climatic conditions often impede the establishment and growth of stands. Subalpine-fir, Engelmann spruce, and whitebark pine are three of the more dominant species in stands at higher elevation, particularly in the ESSF biogeoclimatic zone. Although the silvicultural characteristics of these species are known, it is generally recognized

that less is known about their potential growth in the ESSF zone. Thus, much uncertainty surrounds the volume estimates for high-elevation stands.

Table 14 and Figure 32 show how potential harvest levels would change if volume estimates for high-elevation sites were in fact 30% lower than assumed for the base case. Medium-term harvest levels would be significantly decreased and the long-term harvest level would be moderately decreased.

Table 14. Average harvest levels if volume estimates for high elevation sites are 30% lower

Period decades)	Base case (m³/year) ^a	30% less volume from high elevation sites (m³/year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	796 000 ^c
11 – 20	801 000	824 000 ^b
21+	883 000	856 000 ^b

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

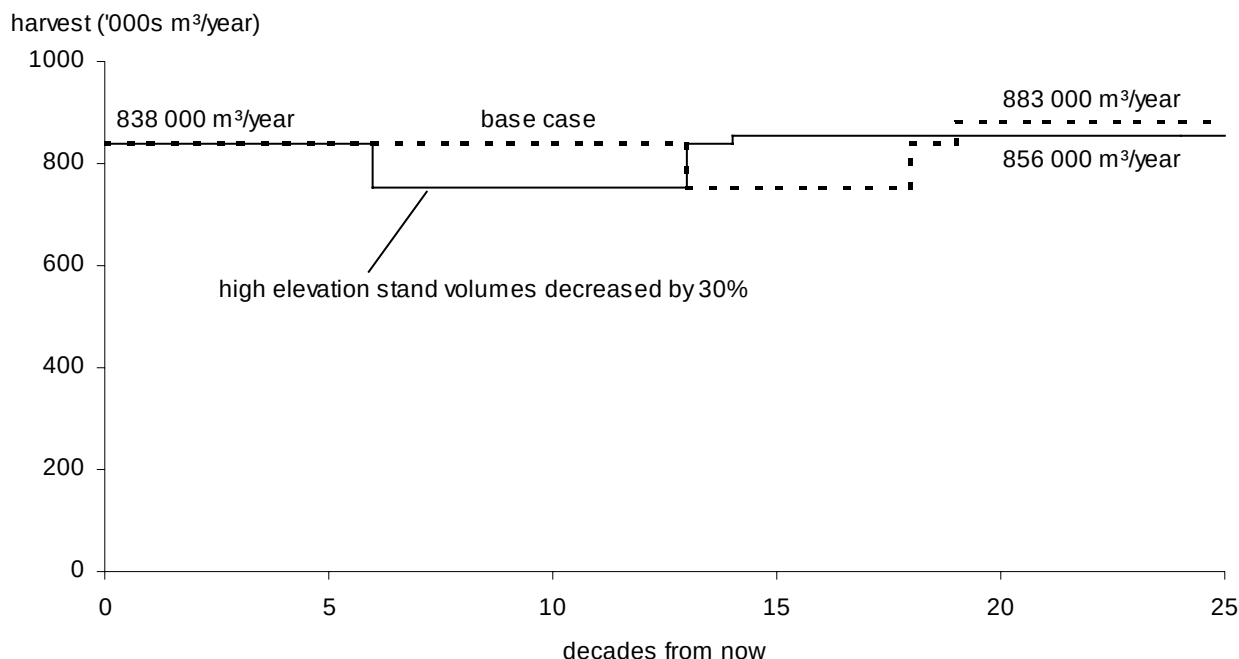


Figure 32. Harvest forecast if volume estimates for high elevation sites are 30% lower — Cranbrook TSA, 1999.

5.2.4 Armillaria losses in the estimate of unsalvaged losses

The estimate for unsalvaged losses of 77 241 cubic metres per year used in the base case did not include losses for disease. These losses were assumed to be accounted for in the estimates of stand volumes. Some uncertainty surrounds the assumption that the volume lost to root rot disease (*Armillaria ostoyae*) in mature standing timber is accounted for by the VDYP growth and yield model. Root rot losses, particularly those of a catastrophic nature, may or may not be fully accounted for in stand volume estimates.

District surveys indicate that mature stands on about 6000 hectares of the timber harvesting land

base have a high incidence of root rot disease.

B.C. Forest Service studies conducted in the Salmon Arm area suggest that the mortality rate in these stands would be 2% per year, resulting in a total volume loss of 19 786 cubic metres per year. These losses are not accounted for in the estimate of unsalvaged losses in the base case.

Table 15 and Figure 33 show how harvest levels would be affected if the estimate of annual unsalvaged losses was increased by 19 786 cubic metres for the first 70 years of the analysis horizon to take into account losses to root rot disease. Harvest levels would be moderately lower in the medium term and would not change in the long term relative to the base case.

5 Timber Supply Sensitivity Analyses

Table 15. Average harvest levels if estimate of unsalvaged losses increased by 19 786 m³/year in the first 70 years

Period (decades)	Base case (m ³ /year) ^a	Increase unsalvaged losses by 19 786 m ³ /year in the first 70 years (m ³ /year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	807 000 ^b
11 – 20	801 000	827 000 ^b
21+	883 000	883 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

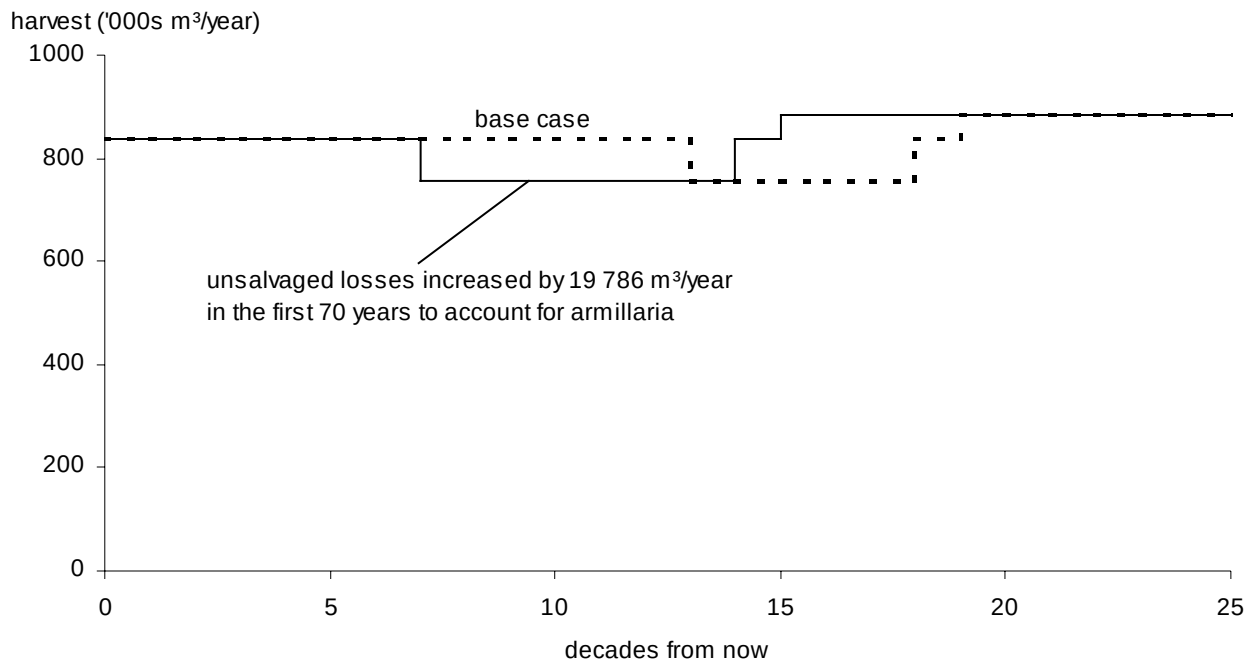


Figure 33. Harvest forecast if estimate of unsalvaged losses increased by 19 786 m³/year in the first 70 years — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.2.5 Biodiversity emphasis assignments based on Kootenay-Boundary Land Use Plan Implementation Strategy

In the base case, biodiversity emphasis option assignments were not specifically modelled because landscape units have not been designated for the Cranbrook Forest District. Instead, to approximate the likely timber supply impacts of FPC *Biodiversity Guidebook* recommendations for landscape-unit biodiversity a procedure was developed that generally recognizes that low-, intermediate-, and high-emphasis options will be assigned to 45%, 45% and 10% of the management unit area respectively. The procedure is meant not

to presuppose any specific area as being high, intermediate, or low biodiversity emphasis before such designations are legally made. Section A.4.5, "Biodiversity" of Appendix A describes this procedure.

Landscape units and corresponding biodiversity emphasis options have been proposed in the *Implementation Strategy for the Kootenay-Boundary Land Use Plan Implementation Strategy (KBLUP-IS)*. Table 16 and Figure 34 show that applying the KBLUP-IS biodiversity emphasis assignment as indicated would significantly affect the timing of the transition to the long-term harvest level and slightly reduce the long-term harvest level.

Table 16. Average harvest levels if Kootenay-Boundary Land Use Plan Implementation Strategy biodiversity emphasis options (KBLUP-IS BEO) assignment assumed

Period (decades)	Base case (m ³ /year) ^a	LU biodiversity emphasis according to KBLUP-IS (m ³ /year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	775 000 ^b
11 – 20	801 000	851 000 ^b
21+	883 000	880 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

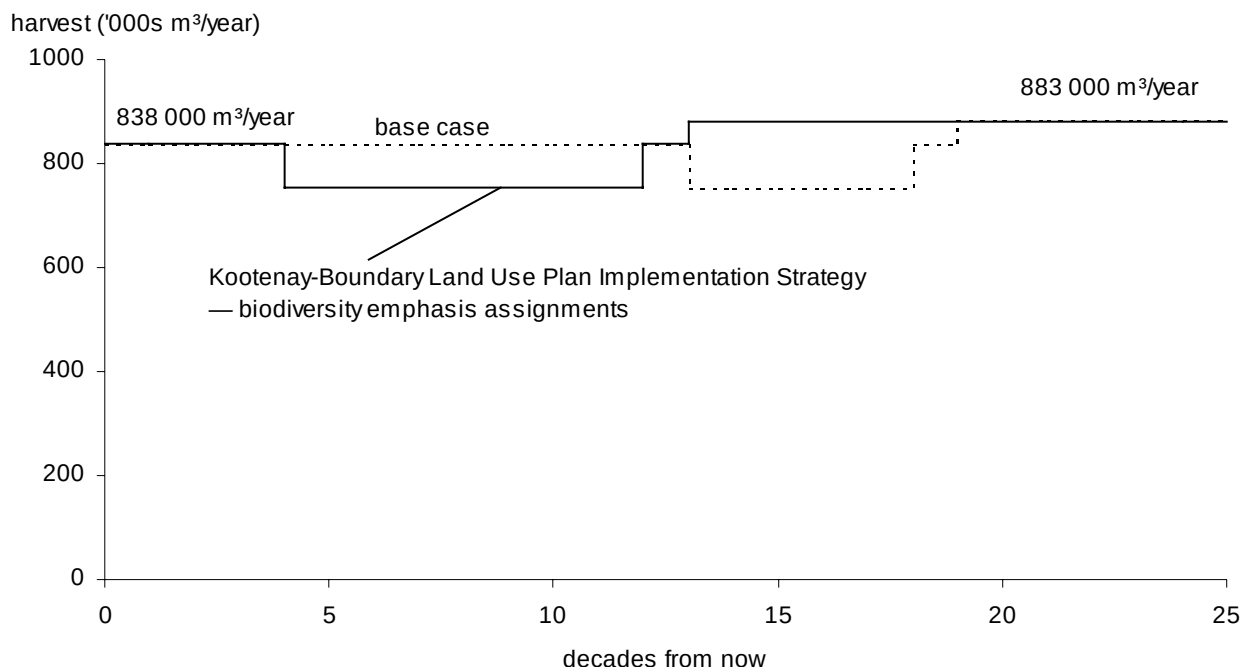


Figure 34. Harvest forecast if the Kootenay-Boundary Land Use Implementation Strategy biodiversity emphasis options applied — Cranbrook TSA, 1999.

5.2.6 Alternative harvest queue rules

In the base case, highest priority for harvest is given to stands that are oldest relative to their minimum harvestable age. This 'relative oldest first' rule is applied only after other requirements and priorities (e.g., forest cover requirements) are taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model permits use of absolute oldest first, absolute youngest first or random scheduling rules. These other rules may

better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest.

Table 17 and Figure 35 show that potential harvest levels would be significantly affected in the medium- and long-terms by changing the way stands are prioritized for harvest. For example, if stands were ordered for harvest using the random harvest scheduling rule instead of the 'relative oldest first' rule, the projected long-term harvest level could be 6.1% lower (although more runs would be needed to determine the actual average). All three alternative harvest scheduling rules would result in lower timber supply over a 250-year period than in the base case.

5 Timber Supply Sensitivity Analyses

Table 17. Average harvest levels if different harvest queue rules assumed

Period (decades)	Base case (relative oldest first) (m ³ /year) ^a	Alternate harvest queue rules		
		Oldest first (m ³ /year) ^a	Youngest first (m ³ /year) ^a	Random (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000
3 – 10	838 000	796 000 ^b	754 000 ^c	775 000 ^c
11 – 20	801 000	839 000 ^b	781 000 ^b	792 000
21+	883 000	863 000 ^b	808 000 ^c	829 000 ^c

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

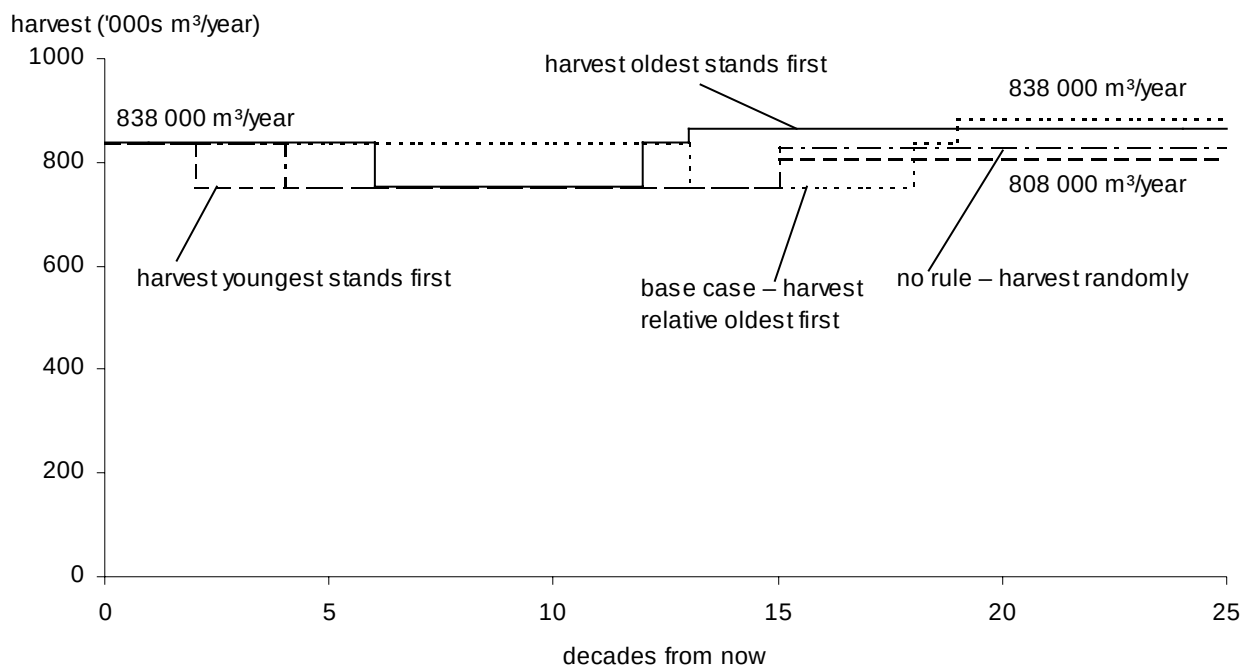


Figure 35. Alternative harvest scheduling rules: oldest first, youngest first and random — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

Figure 36 shows the average harvested volume per hectare over time for the harvest forecast in which stands are randomly scheduled for harvest as it compares to average harvested volume per hectare for the base case. The dashed line in Figure 36 shows how average volumes might change if older stands were not given priority for

harvest. If eligible stands older than the minimum harvestable age were harvested in a random fashion, then average harvested volumes per hectare would be lower throughout the 250-year planning horizon compared to the base case (solid line). In this example, in decade one, average volume per hectare is reduced from 254 cubic metres per hectare to 217, or by 14.6%.

average volume harvested ($\text{m}^3/\text{hectare}$)

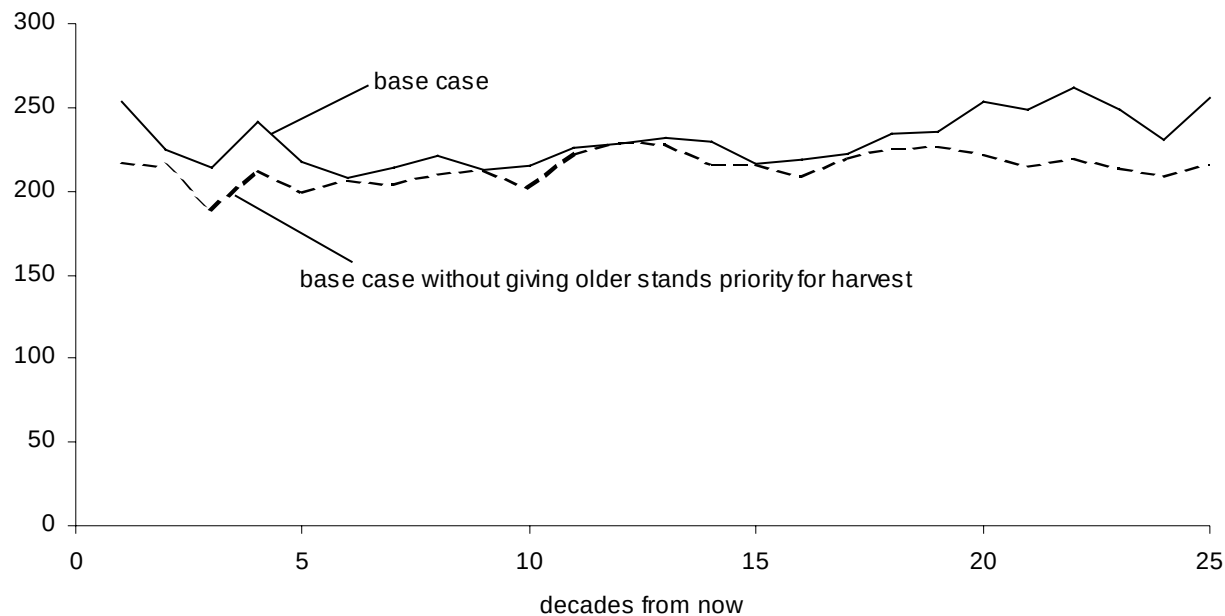


Figure 36. Average volume per hectare over time — Cranbrook TSA base case, 1999.

5 Timber Supply Sensitivity Analyses

Figure 37 shows the average harvested age over time for the randomly-scheduled harvest forecast as it compares to the base case. The dashed line in Figure 37 corresponds to the dashed line in Figure 36 and illustrates what may occur if older stands were not given priority for harvest, but instead were just as likely to be harvested as other available stands beyond their minimum harvestable age. The average harvestable age in decade one

changes significantly compared to the base case (solid line) and the differences in average harvestable age remain significant until decade six. In both cases, after decade six many of the existing older stands have been harvested, resulting in less variability in the age of harvested stands. As a result, average harvest ages are similar in the two scenarios after decade six.

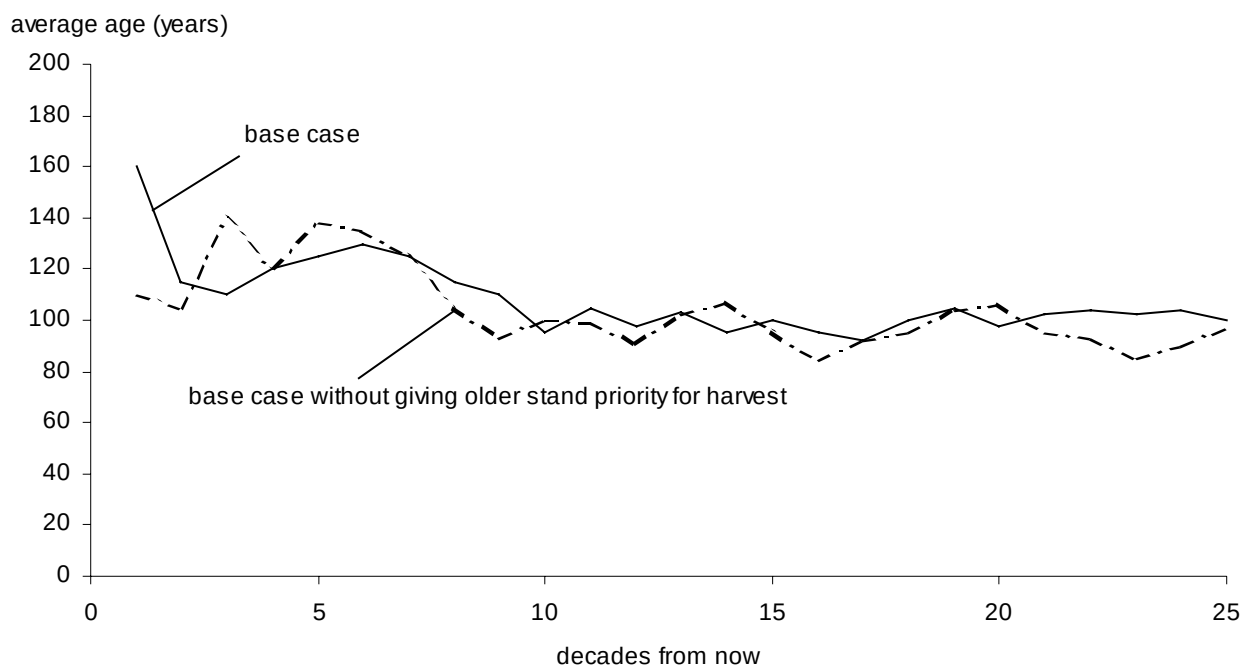


Figure 37. Average harvested age over time — Cranbrook TSA base case, 1999.

5 Timber Supply Sensitivity Analyses

5.2.7 Contribution of Douglas-fir and larch to the annual harvest

It was not taken into account in the base case that some species are more marketable than others, and as markets strengthen or weaken, the demand by regional mills for these species increases or decreases. Similar to the problem of foreseeing future conditions that will determine merchantability (see Section 5.1.3, "Uncertainty in minimum harvestable ages") we cannot foresee market demand and its related impact on the marketability of species such as interior Douglas-fir or larch. Currently in the Cranbrook Forest District, Forest Service staff estimate that the mill demand for Douglas-fir and larch from the Cranbrook TSA is limited to about 150 000 cubic metres per year, or about 18% of the current annual harvest. Douglas-fir and larch stands currently comprise approximately 30% of the timber harvesting land base.

Figure 38 shows what portion of the harvest projected in the base case forecast is made of

predominantly larch or Douglas-fir stands (dotted line). In the base case, the larch and Douglas-fir harvest level is projected to remain below 150 000 cubic metres per year for the next four decades. After decade 4, the larch and Douglas-fir harvest level increases to 322 000 metres per year and remains higher than 150 000 cubic metres for three decades. After decade 7, the harvest level gradually declines as fewer natural stands of this type remain on the timber harvesting land base.

Figure 38 and Table 18 also show the impact of limiting the harvest of Douglas-fir and larch stands to 18% of the annual harvest. Harvest levels would be significantly decreased from 21 to 200 years from now. After 200 years, the harvest level would not be affected because few natural stands of fir and larch would remain, and it is assumed that Douglas-fir and larch would comprise less than 18% of regenerated stand volumes.

Table 18. Average harvest levels if annual harvest of fir and larch stands is limited to 18% of total harvest

Period (decades)	Base case (m ³ /year) ^a	Fir and larch limited to 18% of harvest (m ³ /year) ^a
1 – 2	838 000	838 000
3 – 10	838 000	765 000 ^b
11 – 20	801 000	879 000 ^b
21+	883 000	883 000

(a) Average for the period.

(b) > 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

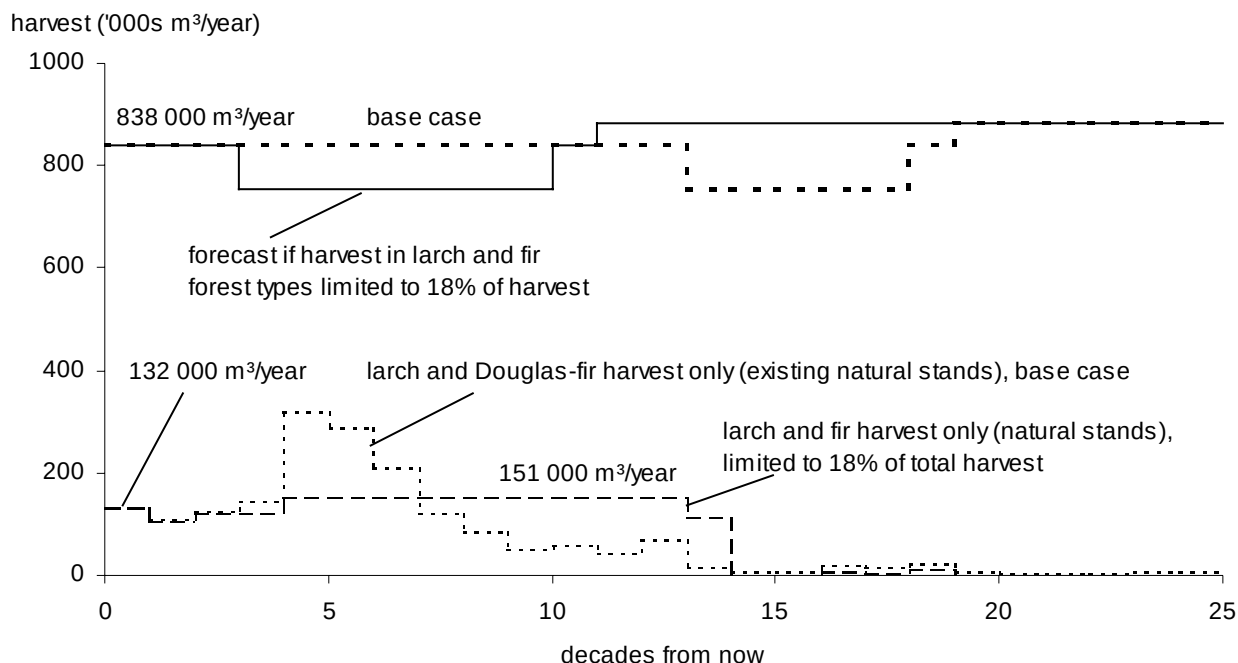


Figure 38. Harvest forecast if fir and larch limited to 18% of harvest — Cranbrook TSA, 1999.

5.2.8 Stand-level biodiversity

Stand-level biodiversity has been addressed in this analysis by reducing volume estimates for stands on the timber harvesting land base. Table 20a of the *Biodiversity Guidebook* sets out the requirements for stand-level biodiversity, particularly the need to leave timber standing in wildlife tree patches. In the base case, for areas not identified as FMER open range or open forest, a volume reduction of 3.9% was estimated to account for timber volume lost to wildlife tree patches and other forest management considerations. This estimate has some uncertainty because it is difficult to predict

what portion of the *Biodiversity Guidebook* targets would be met by forest outside of the timber harvesting land base without knowing the exact future cutblock pattern and forest structure in a given area.

Table 19 and Figure 39 show that if residual volume within cutblocks was increased to 7.9% or decreased to 2.5%, harvest levels in the medium- and long-term would be impacted. If residual volumes were actually 2.5% rather than 3.9% as in the base case, the current harvest level would not need to decline in the future before rising to the long-term harvest level.

5 Timber Supply Sensitivity Analyses

Table 19. Average harvest levels if residual volume within cutblocks changed

Period (decades)	Base case (3.9%) (m ³ /year) ^a	Residual volume within cutblocks	
		2.5% (m ³ /year) ^a	7.9% (m ³ /year) ^a
1 – 2	838 000	838 000	838 000
3 – 10	838 000	838 000	786 000 ^c
11 – 20	801 000	854 000 ^c	772 000 ^b
21+	883 000	891 000	848 000 ^b

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

(c) > 5% change from base case forecast.

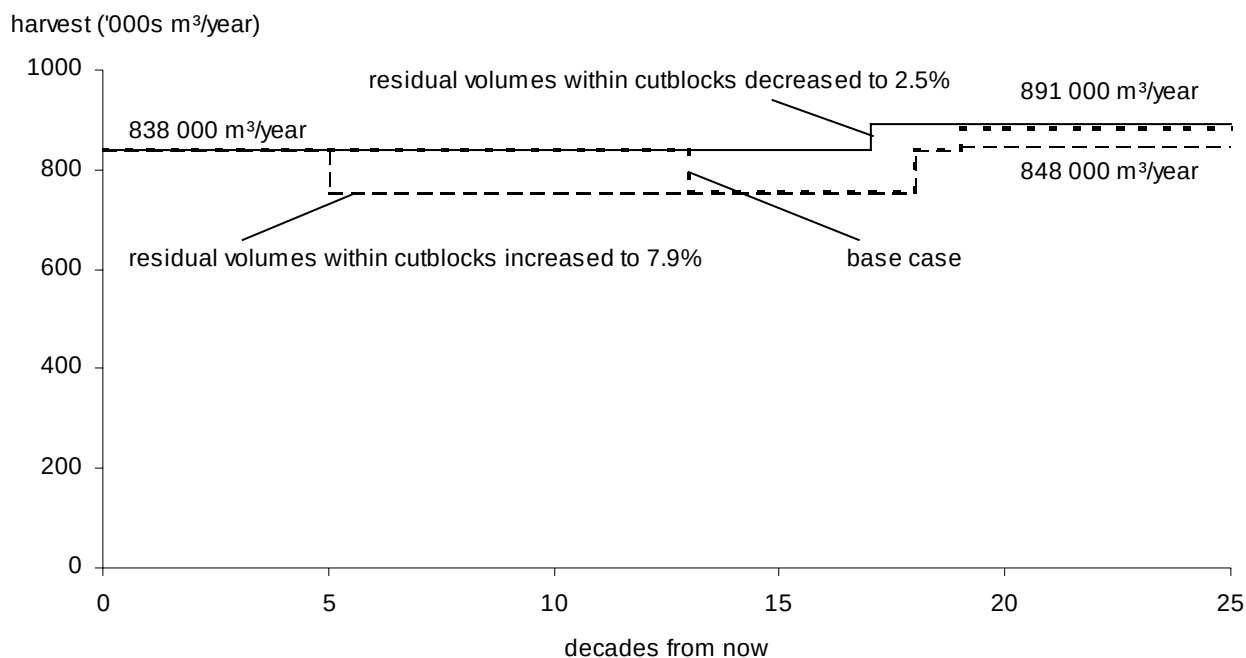


Figure 39. Harvest forecasts if residual volume within cutblocks increased to 7.9% or decreased to 2.5% — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.2.9 Landscape-level biodiversity requirements

Further to the examination of uncertainty in biodiversity seral stage requirements discussed in Section 5.1.6, Table 20 and Figures 40 and 41, below, show that changing the way *Biodiversity Guidebook* seral stage distribution targets are applied would potentially have a moderate to large impact on the timing of the transition to the long-term harvest level and a small or no impact on

the long-term level. These changes include: applying seral stage requirements by biogeoclimatic variant for the entire district (rather than by variant and landscape unit, as in the base case); applying only old seral requirements (excluding the old and mature seral requirements applied in the base case); and ensuring that seral stage forest cover requirements are applied both within the operable forested land base and the total Crown forested land base (proportional representation).

Table 20. Average harvest levels if landscape-level biodiversity requirements changed

Period (decades)	Base case (m ³ /year) ^a	Landscape-level biodiversity requirements		
		BEC zone by forest district (m ³ /year) ^a	Old seral only (m ³ /year) ^a	Proportional representation (m ³ /year) ^a
1 – 2	838 000	838 000	838 000	838 000
3 – 10	838 000	838 000	838 000	817 000 ^b
11 – 20	801 000	800 000	796 000	827 000 ^b
21+	883 000	878 000	887 000	883 000

(a) Average for the period.

(b) 2 – 5% change from base case forecast.

5 Timber Supply Sensitivity Analyses

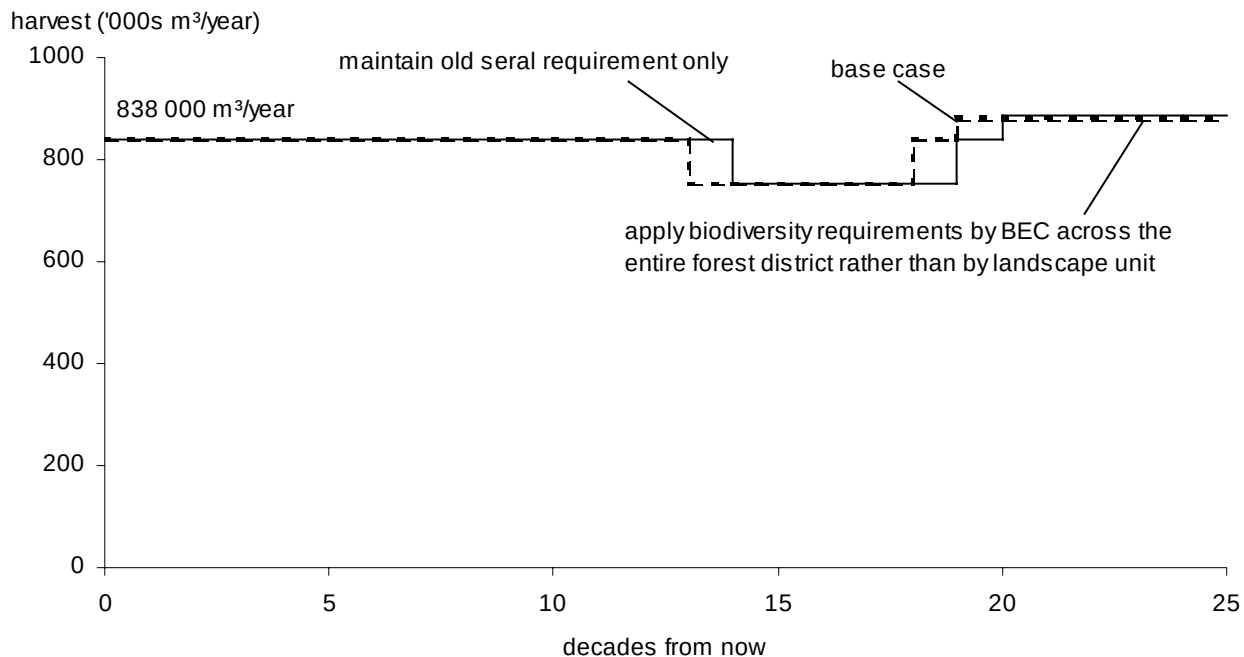


Figure 40. Harvest forecasts if landscape-level biodiversity requirements changed — Cranbrook TSA, 1999.

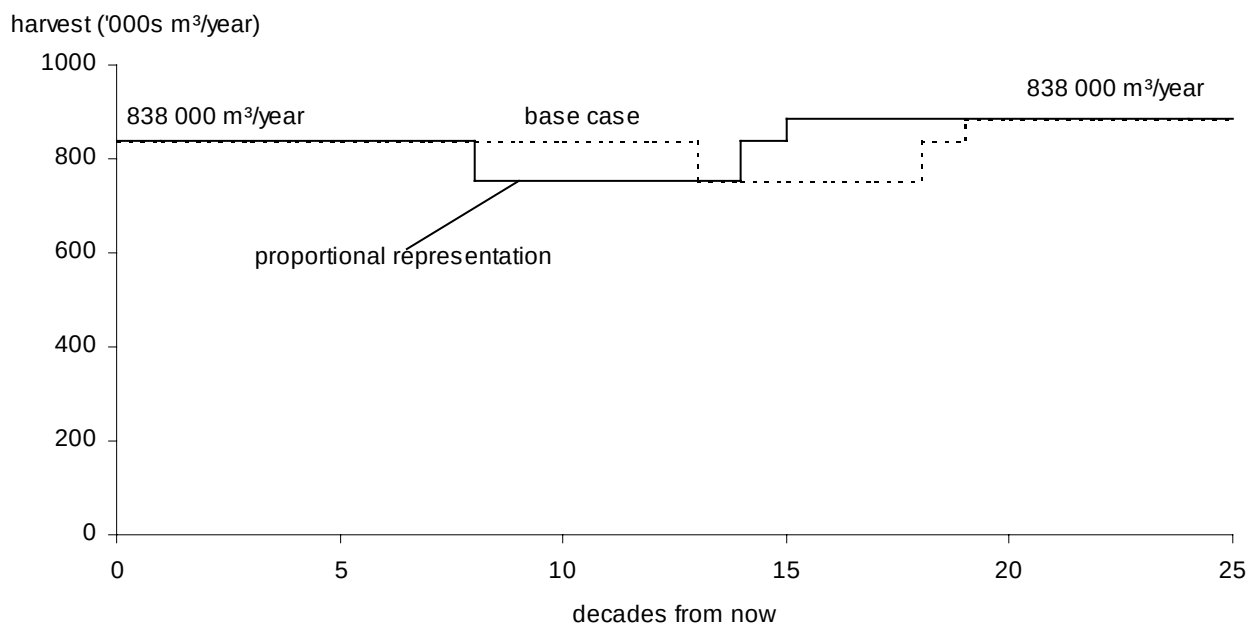


Figure 41. Harvest forecast if biodiversity requirements with proportional representation assumed — Cranbrook TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.3 Summary of sensitivity tests

Table 21 provides a summary of the sensitivity analyses described in Sections 5.1 and 5.2. Impacts

shown represent aggregate differences over the periods indicated.

Table 21. Summary of sensitivity tests

Factor tested	Change from base case	Period of impact (decades) (per cent)			
		1 – 2	3 – 10	11 – 20	21+
Size of timber harvesting land base	–5%	–	–7.5%	–1.7%	–5.4%
	+5%	–	–	+10.1%	+4.7%
	–10%	–	–15.5%	–7.1%	–10.2%
	+10%	+6.0	+ 6.0%	+14.5%	+ 8.7%
Volume estimates for existing natural stands (VDYP)	–10%	–	–16.7%	+3.2%	–
	+10%	+4.5%	+4.5%	+9.8%	–
Regenerated stand volume estimates	–10%	–	–5.0%	–4.2%	–11.1%
	+10%	–	–	+12.4%	+10.0%
Minimum harvestable ages	–10 years	–	–	+5.5%	–4.0%
	+ 10 years	–	–7.5%	–6.5%	–
	CMAI age	–5.0%	–10.0%	+11.5%	+1.8%
Green-up age	–3 years	–	–	+2.9%	+0.6%
	+3 years	–	–	+1.4%	–0.6%
Regeneration delay	–2 years	–	–	+5.2%	+0.3%
	+2 years	–	–1.9%	–	–0.2%
Unsalvaged losses estimate	–50%	–	–	+9.9%	+4.4%
	+50%	–	–13.1%	–7.0%	–4.3%
	% of inventory	–	–	+8.5%	+1.9%
Landscape-level biodiversity requirements	Old seral now	–	–7.5%	+7.6%	–0.5%
	No old or mature seral	–	–	+4.6%	–
	Add early seral	–	–2.5%	+1.6%	–
Adjacency restrictions	Remove	–	–	–	–0.2%
	All at 25% maximum	–	–	+1.7%	+0.2%
Accessibility of steep slopes	Include	–	–	+2.4%	+0.6%
Inventory audit results	–5.5% adjustment	–	–9.2%	+3.2%	–
Yields from high elevation sites	30% less	–	–5.0%	+2.9%	–3.1%
Amillaria losses	19 786 m ³ /year for next 70 years	–	–3.7%	+3.2%	–
Harvest priorities (harvest rules)	Oldest first	–	–5.0%	+4.7%	–2.3%
	Youngest first	–	–10.0%	–2.5%	–8.5%
	Random (none)	–	–7.5%	–1.1%	–6.1%
Species mix in annual harvest	Limit Fd & L to 18%	–	–8.7%	+9.7%	–
Residual volume (WTPs) within cutblocks	Reduce to 2.5%	–	–	+6.6%	+0.9%
	Increase to 7.9%	–	–6.2%	–3.6%	–4.0%
Landscape-level biodiversity requirements	BEC zone by district	–	–	–	–0.6%
	Old seral only	–	–	–0.6%	+0.5%
	Proportional rule	–	–2.5%	+3.2%	–
	BEO per KBLUP	–	–7.5%	1.6%	–0.3%

6 Summary and Conclusion of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current allowable harvest level in the Cranbrook TSA of 838 000 cubic metres per year can be maintained for up to 130 years without causing severe future timber disruptions if followed by a temporary future harvest level reduction. Based on current inventory and timber growth information, and assuming continuation of current forest management practices, harvests could be maintained at the current level for 130 years, if followed by a reduction of 10% between 131 and 180 years from now and a two decade climb to the long-term harvest level of 883 000 cubic metres per year.

The above results reflect current knowledge and information about forest inventory, growth and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees.

Uncertainty involving estimates in the size of the timber harvesting land base, estimates of timber volumes in existing stands and significant changes in minimum harvestable ages, have the largest potential effect on projected harvest levels over the next 250 years. Other areas of uncertainty that have a moderate to large effect ($> 2\%$) on timber supply either in the medium- or long-term, or both include: estimates of regenerated stand volume, unsalvaged losses, yields from high elevation sites, regeneration delay, residual volumes within cutblocks for stand-level biodiversity, uncertainty in the application of landscape-level biodiversity guidelines, scheduling stands for harvest, and controlling the contribution of Douglas-fir and larch to the annual harvest. Areas of uncertainty which have only a small (less than two per cent) impact on

medium timber supply include the age at which stands reach green-up conditions, and the maximum amount of disturbance allowed in the caribou and integrated resource management zones.

The forest inventory and management factors discussed above could affect timber supply over the next 10-100 years, but in all but one case (significant increase in minimum harvestable ages) uncertainties about these factors did not reduce timber supply over the next 20 years. None of the analysis results indicate that timber supply might need to drop below base case levels over the next 20 years to avoid creating severe timber supply disruptions in the future.

Over the long term — that is, during the period from 100 to 250 years from now — the size of the timber harvesting land base, volume estimates for regenerated stands, estimates of unsalvaged losses, estimates of residual volume within cutblocks, criteria for scheduling stands for harvest and landscape-level biodiversity requirements have moderate to large effects on timber supply (over five per cent impact between 101-200 years, or over five per cent impact beyond 200 years). Small to moderate changes in the age at which stands reach green-up conditions and the maximum amount of disturbance allowed in the caribou and integrated resource management zones have little to no effect on long-term timber supply.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, and the current management regime, timber harvests in the Cranbrook TSA can be maintained at the current allowable level for the next 130 years. Several factors related to the current forest inventory and management regime could affect timber supply over the next 10-100 years. No conclusive evidence was available prior to completion of this analysis to suggest that significant inaccuracies exist in the information used.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the Timber Supply Review. The socio-economic analysis compares the level of employment and economic activity currently supported by timber harvested from the Cranbrook TSA to the level of activity that could be expected given the timber supply projected in base case harvest forecast.

The socio-economic analysis uses the base case harvest forecast as an indication of timber supply levels but does not examine alternative management scenarios.

The socio-economic analysis includes:

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

7.1 Current socio-economic setting

7.1.1 Current population and demographic trends

The Cranbrook TSA is one of seven TSAs in the Nelson Forest Region and has a population of approximately 47,600 people (1996 census). The major communities are Cranbrook and Kimberley, with a combined population of nearly 25,000. Smaller communities include Fernie and Sparwood. Table 22 indicates that, from 1991 to 1996, the population of the TSA increased by 4% or less than one per cent annually. By 2001, the population of the area is projected to be an estimated 49,300, an increase of about 3.5% from 1996.

Table 22. Population statistics, Cranbrook TSA, 1991–2001

Communities	Population 1991 census	Population 1996 census	Population 2001 estimate ^a	Estimated per cent change 1996–2001
Cranbrook	16,447	18,131	18,962	4.6
Kimberley	6,531	6,738	6,646	–1.4
Fernie	5,012	4,877	5,045	3.4
Sparwood	4,211	3,982	4,179	5.0
Other communities	13,690	13,888	14,471	4.2
Cranbrook TSA	45,891	47,616	49,303	3.5

Source: 1991 and 1996 Census of Canada.

(a) Estimates are by BCSTAT, based on Local Health Area Population Projections.

7 Socio-Economic Analysis

7.1.2 Economic profile

From 1991 to 1996, the experienced labour force in the Cranbrook TSA increased by 5.8% to 24,785. In comparison, the experienced labour force for the province increased by almost 14% over the same period. The unemployment rate in the Cranbrook TSA was 11.9% in 1996, compared with 10.9% in 1991.

As Figure 42 illustrates, the major employment sectors in the Cranbrook TSA are forestry, other primary industries (mainly mining), tourism and the public sector (education, health, and federal, provincial and local public services). Figures from the 1996 census indicate that employment (direct,

indirect and induced) in the forest sector accounted for approximately 16% of employment in the TSA.

Tourism, which includes portions of several service sectors including accommodation services, retail trade and transportation, has demonstrated significant growth and investment in recent years. Almost 3,300 persons are employed in the Cranbrook TSA's tourism sector, catering to both tourist and business travellers. Approximately 400 businesses in the Cranbrook TSA service visitors' needs, including outdoor recreation facilities, tours and attractions, retail and service businesses, food and beverage facilities, and accommodations.

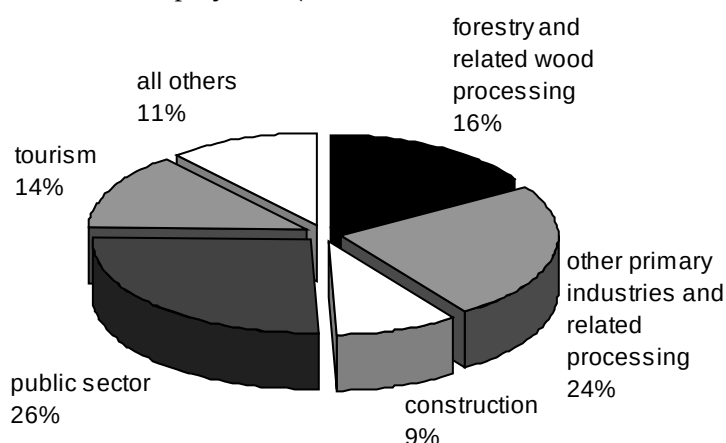


Figure 42. Estimates of total employment by sector, Cranbrook TSA, 1996.

Source: Ministry of Finance and Corporate Relations. The 1996 Forest District Tables. April, 1999.

Income, whether business or personal, is another indicator of a sector's contribution to the economy. Jobs in sectors with high income levels tend to support more employment per job than those in sectors with lower income levels. Statistics Canada labour force data, comparing average weekly earnings in different sectors of the economy, indicate that forestry is one of the highest paying sectors and, therefore, a major contributor to

the local and provincial economies. Mining is the only sector that has consistently paid higher wages than forestry. In 1998, the average weekly earnings (before income taxes) in the forest sector were approximately \$915, compared with \$1,116 for the mining sector. Other sectors' average weekly earnings were \$723 for the construction industry; \$254 for the accommodation, food and beverage services industries; and \$779 for the public sector.

7 Socio-Economic Analysis

Employment multipliers reflect the income effect: the greater the multiplier, the greater the impact that each job in the sector has on the economy. For example, estimates by the Ministry of Finance and Corporate Relations indicate that for every 100 full-time direct forestry jobs in the Cranbrook TSA, another 35 to 100 indirect and induced jobs* are supported, depending on the forestry activity (harvesting or timber processing).

In comparison, for every 100 full-time direct jobs in the tourism sector, an estimated additional eight to 18 indirect and induced jobs are supported. The differences are due to greater spending by forest sector businesses and their employees. Table 23 compares estimated employment, average weekly earnings and employment multipliers for selected sectors of the Cranbrook TSA's economy.

Table 23. Average weekly earnings and employment multipliers — Cranbrook TSA, 1998

Industry sector	Average weekly earnings (\$)	Employment multiplier ^a
Forestry and related	915	1.35–2.00
Mining and related	1,116	1.62–1.87
Construction	723	1.32–1.46
Tourism	254	1.08–1.18
Public sector	779	1.16–1.32

Sources: Statistics Canada. *Survey of Employment, Payroll and Hours*. 1998. Weekly earnings are before income taxes. Ministry of Finance and Corporate Relations. *The 1996 Forest District Tables*. April, 1999. Refers to 1996 Census of Canada data.

(a) Includes direct, indirect and induced jobs.

7.2 Cranbrook TSA forest industry

7.2.1 Current allowable annual cut

The current allowable annual cut (AAC) for the Cranbrook TSA is 850 000 cubic metres including 12 000 cubic metres issued to woodlot licences. The current AAC, which was determined in 1996, was 46 135 cubic metres lower than the previous

AAC. Forest licences account for about 87% of the apportioned volume in the TSA, and the Ministry of Forests' Small Business Forest Enterprise Program (SBFEP) accounts for about 10% of the apportioned volume. The remaining volume, about 2%, is apportioned to woodlot licences and the Forest Service Reserve. Table 24 indicates the current apportioned allowable annual cut by type of licence.

Indirect and induced jobs

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

7 Socio-Economic Analysis

Table 24. Allowable annual cut apportionment — Cranbrook TSA, 1996-present

Type of licence	Volume (m³)	Per cent (%)
Forest licences, replaceable	738 752	86.9
Timber sale licence (TSL) > 10 000 m³, replaceable	0	0.0
TSL < 10 000 m³, replaceable	5 672	0.7
Small Business Forest Enterprise Program (SBFEP)	88 458	10.4
Forest Service reserve	5 000	0.6
Woodlot licences	12 118	1.4
Total	850 000	100.0

Source: Ministry of Forests, Resource Tenures and Engineering Branch. 1996.

7.2.2 Cranbrook TSA harvest history

Actual harvest levels are important indicators of forestry activity in the Cranbrook TSA. While the AAC is the average maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Differences in annual harvest

levels are due to provisions for cut control,¹ which allow licensees to vary their harvest levels based on operating and market conditions. If the annual harvest level is less than the AAC, then economic activity is less than the TSA's full potential. Table 25 summarizes the volume of timber harvested in the Cranbrook TSA from 1994 to 1998.

Table 25. Volume billed, by type of licence — Cranbrook TSA, 1994–1998

Type of licence	(Cubic metres)					Average 1994–1998
	1994	1995	1996	1997	1998	
Forest licence	595 162	754 738	881 837	714 268	658 550	720 911
SBFEP	92 577	97 360	101 519	72 888	47 567 ^b	82 382
TSL	3 424	8 448	6 871	2 446	1 053 ^b	4 448
Other ^a	24 543	38 059	163 415	96 869	65 358 ^b	77 649
Total	715 706	898 605	1 153 642	886 471	772 528	885 390
Allowable annual cut	896 136	896 136	850 000	850 000	850 000	

Source: Ministry of Forests, Revenue Branch, Harvest Database.

(a) Other includes licence to cut's, right-of-way clearings, roads, trespasses and other miscellaneous harvests.

(b) Estimated.

¹ Cut control permits licensees to vary the volume between annual harvest and AAC by +/- 50% per year and by +/- 10% over a 5-year period. This variability gives licensees the flexibility to adapt to changing conditions, including changing market conditions.

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In addition to timber harvested from the TSA, there is an annual average of 239 011 cubic metres harvested from private lands and 5535 cubic metres from woodlots. These volumes are not included in the analysis discussed in this report.

7.2.3 Cranbrook TSA major licensees and processing facilities

The following section provides a short description of the Cranbrook TSA's major licensees, other smaller licensees and processing facilities. The employment figures reflect volumes harvested from the Cranbrook TSA only.

Crestbrook Forest Industries Ltd. (Crestbrook). Crestbrook has a replaceable forest licence to harvest 607 652 cubic metres per year, a decrease of about 33 000 cubic metres per year or

5% from the level established before 1996. Most of the harvest from this licence was processed at the company's lumber mills in Elko and Cranbrook; however, the lumber mill in Cranbrook closed in October, 1998. The remainder of the harvest is processed in the company's Canal Flats mill in the Invermere TSA. Table 26 shows that, based on 1996-1998 data, Crestbrook's average annual harvest from this licence supported an estimated 561-696 person-years of employment in harvesting, silviculture, timber processing and related activities. Nearly 90% of the workers associated with the harvesting and processing of timber from this licence reside in the Cranbrook TSA. In 2000, Crestbrook plans to establish a secondary wood processing plant at the company's former lumber mill site in Cranbrook.

Table 26. *Crestbrook annual average harvests and estimated employment, 1996–1998*

Allowable annual cut (AAC)	607 652 m ³
Annual average harvest: Forest licence (1996–1998)	638 022 m ³
1998 harvest	603 391 m ³
Estimated employment ^a (1996–1998)	Person-years
Harvesting and administration	212–239
Log transport	(included with harvesting)
Road construction and maintenance	21–23
Silviculture	34–36
Timber processing	294–398
Total	561–696

Source: Ministry of Forests, Revenue Branch, Harvest Database.

(a) Based on 1996–1998 average annual harvest of 638 022 cubic metres. Estimates of employment are derived from information supplied by the licensee and include employment associated with TSA timber that is processed outside the TSA.

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Galloway Lumber Co. Ltd. (Galloway). Galloway has a replaceable forest licence to harvest 131 100 cubic metres per year, a decrease of 6809 cubic metres per year, or 5% less than the level established before 1996. All the harvested timber from this licence is processed in the company's lumber mill in Galloway. Table 27 shows that, based on 1996 to 1998 data, Galloway's

average annual harvest from this licence supported an estimated 125–167 person-years of employment in harvesting, silviculture, timber processing and related activities. Approximately 85% of the workers associated with the harvesting and processing of the timber from this licence live within the Cranbrook TSA.

Table 27. Galloway annual average harvests and estimated employment, 1996–1998

Allowable annual cut	131 100 m ³
Annual average harvest (1996–1998)	142 880 m ³
1998 harvest	105 340 m ³
Estimated employment ^a (1996–1998)	Person-years
Harvesting and administration	31–51
Log transport	7–13
Road construction and maintenance	4–5
Silviculture	2–10
Timber processing	81–88
Total	125–167

Source: Ministry of Forests, Revenue Branch, Harvest Database.

(a) Based on 1996–1998 average annual harvest of 142 880 cubic metres. Estimates of employment are derived from information supplied by the licensee.

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McDonald Ranch and Lumber Ltd. (McDonald Ranch). McDonald Ranch has a replaceable timber sale licence to harvest 5596 cubic metres per year. Most of the harvest from this licence is traded for other timber which is then processed within the Cranbrook TSA at the company's lumber mill in Grasmere. Table 28

shows that, based on 1996 to 1998 data, McDonald Ranch's average annual harvest supported an estimated 9–14 of person-years of employment in harvesting, silviculture, timber processing and related activities. All the workers associated with harvesting and processing of the timber from this licence live in the Cranbrook TSA.

Table 28. McDonald Ranch annual average harvests and estimated employment, 1996–1998

Allowable annual cut	5 596 m ³
Annual average harvest (1996–1998)	3 296 m ³
1998 harvest	1 063 m ³
Estimated employment ^a (1996–1998)	Person-years
Harvesting and administration	2–4
Log transport	1–2
Road construction and maintenance	0.5
Silviculture	N/A
Timber processing	5–7
Total	9–14

Source: Ministry of Forests, Revenue Branch, Harvest Database

(a) Based on 1996–1998 average annual harvest of 3296 cubic metres. Estimates of employment are derived from information supplied by the licensee.

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Small Business Forest Enterprise Program (SBFEP). The volume apportioned to Cranbrook TSA's SBFEP is 88 458 cubic metres per year, or about 10% of the TSA's allowable annual cut. SBFEP harvest levels in recent years have averaged nearly 74 000 cubic metres per year, or about 8% of the total harvest in the TSA. Timber harvested under the SBFEP is processed both

within and outside the TSA. Table 29 shows that, based on averages of licensees and operators in the TSA, the volume harvested under the SBFEP supported an estimated 75 person-years of employment in harvesting, silviculture, timber processing and related activities. An estimated 60% of the timber harvested in the SBFEP is by registrants who reside within the Cranbrook TSA.

Table 29. Small Business Forest Enterprise Program annual average harvests and estimated employment, 1996–1998

Allowable annual cut	88 458 m ³
Annual average harvest (1996–1998)	73 991 m ³
1998 harvest	47 567 m ³
Estimated employment ^a (1996–1998)	Person-years
Harvesting and administration	26
Log transport	2
Road construction and maintenance	3
Silviculture	4
Timber processing	40
Total	75

Source: Ministry of Forests, Revenue Branch, Harvest Database.

(a) Based on 1996–1998 annual average harvest of 73 991 cubic metres. Estimates of employment are derived from industry averages of licensees and operators in the TSA and include employment associated with TSA timber that processed is outside the TSA.

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Cranbrook TSA timber supply and processing capacity. Most of the timber harvested in the Cranbrook TSA is processed within the TSA. Table 30 lists the timber processing facilities and their estimated annual capacities. Two lumber mills closed in 1998: Fab-Co Forest Products Ltd.'s lumber mill in Kimberley and Crestbrook Forest Industries Ltd.'s lumber mill in Cranbrook. The

remaining processing facilities in the TSA have an estimated annual processing capacity of more than 950 000 cubic metres. Between 1996 and 1998, harvests in the TSA averaged approximately 885 400 cubic metres per year. Additional timber supply for processing facilities in the TSA comes from nearby TSAs and private sources.

Table 30. Timber processing facilities and estimated annual capacities — Cranbrook TSA, 1998

Timber processing facilities	Type of product	Estimated annual capacity (000 m ³)
Bear Lumber Ltd.	Lumber	15.0
Canalog Wood Industries Ltd.	Log home	2.0
Carney Forest Products Ltd.	Pole	40.0
Crestbrook Forest Industries Ltd. (Elko)	Lumber	575.0
Galloway Lumber Co. Ltd.	Lumber	210.0
Grizzly Peak Log Homes Ltd. (formerly KBR Log Structures Ltd.)	Log home	1.0
J.R. Blackmore & Sons Ltd.	Post	15.0
Kootenay Wood Preservers Ltd.	Post	20.0
Loveless Logging Ltd.	Post	50.0
McDonald Ranch and Lumber Ltd.	Lumber	30.0
Total		958.0

Source: Ministry of Forests. Major Primary Timber Processing Facilities in British Columbia, 1998.

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7.2.4 Forest sector employment and employment coefficients

Harvesting and employment information is used to estimate employment coefficients which will be used to project future employment levels in the forest sector. For this purpose, the forest sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment such as log transportation, log salvage, log scaling, and harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilization and pruning*; and
- primary timber processing employment, such as manufacturing activities at lumber mills, veneer and plywood mills, shake and shingle mills and pulp and paper mills.

Harvesting and silviculture employment

The harvesting employment component of the forest industry is the most closely tied to the AAC and includes both company and contract loggers. Almost all the harvesting workforce resides in Cranbrook, Kimberley or other communities within the TSA. Harvesting activity in the Cranbrook TSA occurs throughout the year but mostly from June to March. Ground-based harvesting systems are the main type of harvesting methods used. In recent years, the volume of timber harvested by cable systems and other innovative means such as helicopter logging has increased.

Silviculture employment is perhaps the least tied to the current level of harvest, given that silviculture activities continue for 10 to 15 years following harvesting. Basic silviculture, which involves establishment of a free-growing stand, consists of surveys, site preparation, planting, brushing, cone collecting and some spacing.

Enhanced, or intensive silviculture includes spacing, fertilization and pruning. In the TSA, licensees are responsible for basic silviculture on areas harvested under major licences while the provincial government is responsible for enhanced silviculture, basic silviculture on areas harvested under the SBFEP and silviculture on backlog not satisfactorily restocked (NSR) areas.

The 1995 *Cranbrook Timber Supply Area Socio-Economic Analysis*, prepared for the previous timber supply review, identified approximately 335 person-years of direct employment in harvesting and silviculture, associated with an average annual harvest of about 896 000 cubic metres. The survey completed for the current timber supply review indicates that from 1996 to 1998, the average annual harvest of approximately 937 000 cubic metres supported an estimated 388 person-years of direct employment in harvesting and silviculture activities in the province.

Processing employment

Timber harvested from the Cranbrook TSA is processed mainly into lumber and wood chips. A small portion of the harvest is processed into various specialty products, such as flooring, panel products, log homes, shake and shingles, poles and posts at mills in the TSA and in neighbouring TSAs. Wood chips are shipped out of the TSA to pulp mills for further processing. Mills in the TSA also process timber harvested in other TSAs and from private sources.

The 1995 *Cranbrook Timber Supply Area Socio-Economic Analysis* estimated that the Cranbrook TSA timber harvest of approximately 896 000 cubic metres per year supported approximately 635 person-years in timber processing employment. The survey completed for the current timber supply review indicates that the average annual harvest was approximately 937 000 cubic metres and supported an estimated 500 person-years of timber processing employment in the province.

Pruning

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

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Ministry of Forests employment

The Cranbrook TSA is administered by the Cranbrook Forest District office in Cranbrook. Approximately 60 people work in the forest district office. District staff oversee the management of forestry-related activities on Crown land in the TSA. Employment in the Ministry of Forests is not included as part of direct employment in the forest sector because it is more related to administration and enforcement of statutory requirements than to the timber harvest levels and would not normally be affected by marginal changes in the timber supply. Ministry employees are, nevertheless, an important component of the total employment in the TSA and are accounted for in the government service component of the public sector.

Employment coefficients

Table 31 summarizes the employment supported by the 1996 to 1998 harvests in the Cranbrook TSA and the corresponding employment coefficients. These coefficients have been calculated at TSA and provincial levels to highlight the importance of the forestry sector within the Cranbrook TSA and to identify the contribution that the Cranbrook TSA's

forestry sector makes to the provincial economy. The two employment levels are defined as follows:

- 1) TSA employment and employment coefficients comprised of residents of the Cranbrook TSA who are employed in the forest sector within the Cranbrook TSA and whose jobs depend on the Cranbrook TSA timber supply; and
- 2) provincial employment and employment coefficients comprised of all forestry sector employment in the province that relies on the Cranbrook TSA timber supply, including both residents of the Cranbrook TSA and those who live elsewhere.

Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

For more detailed information regarding employment coefficients, see Appendix B, "Socio-Economic Analysis Background Information."

Table 31. Forest sector employment and employment coefficients — Cranbrook TSA

Activity	Within TSA		Province	
	Employment (person-years)	Employment coefficient (person-years per '000s m ³)	Employment (person-years)	Employment coefficient (person-years per '000s m ³)
Direct employment				
Harvesting	332	0.35	339	0.36
Silviculture	22	0.02	49	0.05
Timber processing	392	0.42	500	0.54
Total direct employment	746	0.79	888	0.95
Indirect/induced employment	400	0.43	839	0.91
Total	1,146	1.22	1,727	1.86

Notes:

1. Based on 1996–1998 average annual harvest of 937 547 cubic metres and related employment in the Cranbrook TSA. Employment estimates are reported in person-years (PY). Due to rounding, some totals may not equal the sum of their components.
2. 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 full-time employment and changing the definition of forestry sub-sectors. However, the relative impacts associated with a timber supply change should be similar.

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7.2.5 Forest sector employment income

In 1998, the average annual income of forestry employees was \$45,550 for those working in logging and forestry services; \$44,915 for those working in solid wood manufacturing; and \$52,250 for those working in pulp and paper mills. For those in indirect and induced employment (such as construction, business services, retail trade) the

estimated average annual income in 1998 was \$34,075. Based on 1996–1998 annual averages, the Cranbrook TSA's timber harvest supported approximately \$41 million in direct employment income and an additional \$28.6 million of indirect and induced employment income. Table 32 shows that the harvest supported an estimated total of \$69.5 million in employment income, or approximately \$74,100 per 1000 cubic metres harvested.

Table 32. Estimate of forest sector provincial employment income — Cranbrook TSA.

Employment component	Estimated person-years of employment	Estimated annual income per worker	Total employment income (1998 \$million)	Employment income per '000s m ³ (\$ per '000s m ³)
Direct employment				
Logging and forestry services	388	45,550	17.67	18,850
Solid wood processing	392	44,915	17.61	18,780
Pulp and paper processing	108	52,250	5.64	6,019
Subtotal (direct)	888		40.90	43,649
Indirect/induced employment	839	34,075	28.59	30,493
Total	1,727		69.49	74,142

Source: Statistics Canada. *Survey of Employment, Payroll and Hours*. 1998 data.

Note: Based on 1996–1998 average annual harvest of 937 547 cubic metres and related employment in the Cranbrook TSA. Employment estimates are reported in person-years (PY). Due to rounding, some totals may not equal the sum of their components.

7.2.6 Provincial government revenues

The provincial government receives taxes and revenues from the forest industry. The forest industry pays stumpage, royalties and/or rent to the provincial government for the right to harvest and use timber. The forest industry also pays operating taxes such as logging, corporate income, property, gasoline and sales taxes. As well, the provincial and federal governments receive revenues from forestry employees through income taxes.

From 1996 to 1998, the timber harvest in the Cranbrook TSA contributed approximately

\$15 million in stumpage and rent payments annually to the provincial government. Other taxes paid by the forest industry, such as logging, corporate income, property and sales taxes, contributed approximately \$8.1 million annually. In addition, the provincial government received approximately \$6.0 million annually in income taxes paid by forest sector employees. Table 33 summarizes the main sources of provincial revenues from the forest industry in the TSA. Altogether, the timber harvest in the Cranbrook TSA contributed an estimated \$29.2 million annually to provincial government revenues.

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Table 33. Estimate of average annual revenues — Cranbrook TSA

Provincial revenue sources	Estimated average annual revenues (\$million)	Average annual revenue (\$ per '000s m ³)
Stumpage and related revenues ^a	15.04	16,045
Forest industry taxes ^b	8.12	8,664
Employment income taxes ^c	6.01	6,336
Total	29.17	31,045

Note: Based on 1996–1998 average annual harvest of 937 547 cubic metres and related employment in the Cranbrook TSA. Due to rounding, some totals may not equal the sum of their components.

(a) Ministry of Forests, Revenue Branch.

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

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

7.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast is lower than the current level of 850 000 cubic metres by 12 000 cubic metres to account for the establishment of new woodlot licences since 1996. The base case harvest forecast is projected at 838 000 cubic metres per year for the next 13 decades. For decades 14 to 18, the base case forecast projects a decline in timber supply to 755 000 cubic metres per year. In decade 19, the harvest level in the base case forecast increases to 838 000 cubic metres per year and in decade 20 and the decades thereafter, to 883 000 cubic metres per year.

Once woodlot licences are issued, they become independent from the TSA for the purposes of the chief forester's AAC determination, as legislated under Section 8 of the *Forest Act*. Although the base case harvest level indicates a 12 000 cubic metre reduction, no associated socio-economic impact occurs for the total area consisting of the TSA and woodlot areas. Therefore, for the purposes of this review, the socio-economic analysis only examines the timber supply for the TSA.

The socio-economic analysis focuses on harvest level changes in the short- to medium-term (10 to 30 years) from now and considers:

- the implications for both the Cranbrook TSA and the province of alternative harvest levels;

- possible impacts on the communities within the TSA;
- log supply requirements of timber processing facilities within the Cranbrook TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forestry activity that harvests at the base case level could support, assuming that employment and income generated by the forestry sector in the provincial economy remain unchanged and that labour productivity in the industry does not change. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment, per cubic metre, remain constant and that the types and portions of wood products manufactured from the current level of harvest remain the same.

Employment impacts associated with future harvest levels are calculated using employment coefficients (person-years of employment per 1000 cubic metres). This method of calculating employment coefficients assumes that employment levels in the future can be predicted using current conditions of employment and the volume of timber harvested or processed. While this method can be reasonably accurate for short-term forecasts (within the next three to five years), employment coefficients 20 years from now may be very different due to changes in forest products market conditions, timber processing technologies, etc. The analysis provides an indication of the magnitude of impacts on employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

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

Employment and income impacts in the Cranbrook TSA

Using coefficients based on 1996 to 1998 annual averages, the base case harvest forecast of 838 000 cubic metres per year will support an estimated 904 to 1,025 person-years of employment (direct, indirect and induced) in the TSA.

Employment will tend to fluctuate around this level as companies respond to market changes and adjust harvesting activities under cut control regulations. Average annual employment income generated in the Cranbrook TSA is estimated to be between \$38.24 million and \$42.36 million.

Employment and employment income impacts in the province (including the Cranbrook TSA)

Provincial level employment and income impacts include all the activity supported by the Cranbrook TSA harvest, regardless of the location of processing facilities or the residences of workers. The base case harvest forecast of 838 000 cubic metres per year would support an estimated 1,301 to 1,545 person-years of employment in the province and generate an estimated \$53.86 million to \$62.15 million per year in employment 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 paid by workers whose livelihoods are derived from the industry by direct, indirect and induced employment. Under existing tax and stumpage regimes, the base case harvest forecast of 838 000 cubic metres per year would, if the entire volume is harvested and utilized, generate an estimated \$25.45 million to \$26.09 million (1998 dollar value) annually in provincial government revenues.

The estimated employment, employment income and provincial government revenues, in the TSA and in the province, are summarized in Table 34.

7.3.2 Community level impacts

The impacts of short- and long-term changes in timber supply will be much greater on an economy which depends on the local timber supply than on one which is more diversified. Compared with the economies of other TSAs, the economy of the Cranbrook TSA is relatively diversified, although still quite dependent on the forest sector. The base case harvest forecast suggests timber supply is quite stable, with 838 000 cubic metres per year being maintained for the next 13 decades, indicating the ability to maintain the existing level of forestry activity in the Cranbrook TSA.

7.3.3 Timber requirements of processing facilities in the Cranbrook TSA

From 1996 to 1998, harvests on Crown land in the Cranbrook TSA averaged approximately 937 500 cubic metres per year. Most of the timber from this harvest was processed within the TSA. Timber processing capacity in the Cranbrook TSA is estimated at nearly 1.0 million cubic metres per year. Additional timber supplies for the TSA's processing facilities came from nearby TSAs and private sources from within and outside the TSA.

7.3.4 Regional timber supply implications

The flow of timber across TSA boundaries means that communities in the Cranbrook TSA can be vulnerable to timber supply changes in other districts. Information from the previous timber supply reviews indicates that the timber supply in the south-east Kootenay region could decline by about 15% or almost 300 000 cubic metres within the next 20 years.¹ Since mills in the Cranbrook TSA depend on neighbouring management units and private sources for about 25% of their timber supply, future reductions in neighbouring timber supply areas could affect the timber supply available to these mills. This outlook may change as each successive timber supply review re-examines the timber supply in the region. The *Kootenay-Boundary Land Use Plan* may have further implications pertaining to timber supply for communities as the timber supply is adjusted to meet the objectives of the land use plan. How these processes may eventually impact the Cranbrook TSA will depend on the actual timber supply changes, the composition of the industry, and timber flows at the time.

1. These estimates are based on the most recent timber supply review base case forecasts for Kootenay Lake, Invermere and Cranbrook TSAs. The combined timber supply volume for these management units is currently 2.1 million cubic metres and the harvest level is forecast to be 1.8 million cubic metres by the year 2017.

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Table 34. Socio-economic impacts of implementing the base case harvest forecast — Cranbrook TSA, 1999

	At current AAC ^a	Base case harvest forecast Decades 1-4
Harvesting activity	('000s m ³)	('000s m ³)
Current timber supply	850	838
Harvest level (1996–1998 average)	937	
Difference from current AAC	+87	-12
Cranbrook Timber Supply Area		
Employment	(person-years)	(person-years)
Direct	677	667
Indirect/induced	363	358
Total	1,040	1,025
Range of employment gain or (loss)		(13 to 15)
Employment income	(\$ millions)	(\$ millions)
Direct	\$30.60	\$30.17
Indirect/induced	\$12.36	\$12.19
Total	\$42.96	\$42.36
Range of income gain or (loss)		(\$0.55 to \$0.61)
Province, including Cranbrook TSA^b		
Employment	(person-years)	(person-years)
Direct	806	794
Indirect/induced	761	750
Total	1,567	1,545
Range of employment gain or (loss)		(19 to 22)
Employment income	(\$ millions)	(\$ millions)
Direct	\$37.10	\$36.58
Indirect/induced	\$25.94	\$25.57
Total	\$63.04	\$62.15
Range of income gain or (loss)		(\$0.77 to \$0.89)
Provincial government revenues	(\$ millions)	(\$ millions)
Stumpage and related payments	\$13.64	\$13.45
Forest industry taxes	\$7.37	\$7.26
Employee income taxes	\$5.45	\$5.38
Total	\$26.46	\$26.09
Gain or (reduction) in revenues		(\$0.36 to -\$0.37)

(a) Estimates for current employment differ from those in Tables 31 and 32. Current employment figures in this table are based on the existing AAC of 850 000 cubic metres per year, while the figures in Tables 31 and 32 are based on the 1996–1998 average annual harvest volume of 937 547 cubic metres in the Cranbrook TSA. Due to rounding, some totals may not equal the sum of their components.

(b) Estimates of TSA employment and income impacts are included as part of the estimates of provincial employment and income impacts.

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7.4 Summary

Forestry and mining are the two major resource sectors in the Cranbrook TSA's economy. Major forest licence holders in the TSA include Crestbrook Forest Industries Ltd., Galloway Lumber Co. Ltd., and McDonald Ranch and Lumber Ltd. Together, they account for about 87% of the apportioned AAC in the TSA (including woodlots); the Ministry of Forests' Small Business Forest Enterprise Program accounts for approximately another 10%. Primary timber processing facilities include 4 lumber mills, 4 pole and post plants, and 2 log home builders, with an estimated annual processing capacity of 950 000 cubic metres.

The base case harvest forecast for the Cranbrook TSA projects timber supply of 838 000 cubic metres per year (woodlots excluded) for the next 13 decades. This is about 1.5% less than the current AAC of 850 000 cubic metres per year but does not constitute a reduction to the AAC

attributable to the Cranbrook district, since it simply accounts for woodlot licences issued since the last determination. The associated level of forestry activity would support an estimated 1,300 to 1,545 person-years of employment (includes direct, indirect and induced jobs) annually and estimated employment income of \$53.86 million to \$62.15 million per year in the province. Within the Cranbrook TSA, the volume from the base case harvest forecast would support an estimated 904 to 1,025 person-years of employment annually and generate an estimated \$38.24 million to \$42.36 million per year in employment income for the residents of the TSA. An estimated \$25.45 million to \$26.09 million per year in provincial government revenues would be generated.

In the coming years, new light industries may locate in the Cranbrook TSA and other sectors such as transportation, tourism and services may increase their relative contribution to the local economy, providing additional stability and diversification to the economy in the Cranbrook TSA.

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Base case forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	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.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Culmination age	The age at which a timber stand reaches its highest average growth rate, or mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Drainage	The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover 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).

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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.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber, at a particular time.
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 practices. 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 business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Integrated resource management	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The <i>Forest Practices Code Biodiversity Guidebook</i> provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

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Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Modification VQO	Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity (see Visual quality objective).
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.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since 1987 are classified as current NSR.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective).
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. If someone works full-time for 90 days, he or she accounts for 0.5 person-years.
Preservation VQO	Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity. (see Visual quality objective).

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Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
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.
Sensitivity analysis	Examines how uncertainty in data and management assumptions affect timber supply.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Threshold level	A mill's timber supply level which, when dropped below, will cause a mill to reduce the number of shifts or to stop production.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply area (TSA)	An integrated resource management unit established in accordance with <i>Section 7</i> of the <i>Forest Act</i> .
Timber supply	The amount of timber that is forecast to be available over a specified time period, under a particular management regime.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
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.
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.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

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 Cranbrook 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 1992 Ministry of Forests forest cover inventory for the Cranbrook TSA (based on 1988 photos and updated to December 31, 1996 for disturbances) and several additional non-standard inventories were used to determine the timber harvesting land base and to represent forest management activities. The data source and reliability of the information, including any irregularities in the data and assumptions used in deriving the information, and quality assurance measures taken for non-standard data are shown in Table A-1.

Table A-1. *Inventory information*

Data	Source	Vintage	Update	Source scale
Cranbrook TSA forest cover FC1 files	Ministry of Forests (MoF) standard inventory files	1992	1996/12/31	1:20,000
Provincial Park forest cover except for mapsheets 82F097, 82F098, 82F099	MoF standard inventory files	1992	1996/12/31	1:20,000
Provincial Park forest cover for mapsheets 82F097, 82F098, 82F099 only	KBLUP file — Regional non-standard inventory file	1956	05/97	1:50,000
FMER	MoF District non-standard inventory files	1998		1:20,000
Caribou habitat	KBLUP file — Regional non-standard inventory file	05/97		1:50,000
Ungulate winter range (other than caribou)	MoF District non-standard inventory files	1979	1998	1:20,000
Community watersheds and domestic watersheds	Defined by groups of planning cells	1997	N/A	1:20,000
Draft landscape unit boundaries	Defined by groups of planning cells.	1996	1997	1:20,000
Riparian management areas	Defined by GIS project by GeoSense consulting using Ministry of Environment, Lands and Parks (MELP) watershed atlas	1998		1:50,000
Visual landscape inventory	MoF standard landscape inventory files	1993	1998	1:50,000
Recreation inventory	MoF standard recreation inventory files	1993	1998	1:50,000
Draft biodiversity emphasis	Defined by planning cell as per KBLUP, MOF-MELP MOU, and FDP Instructions	10/96	1997	1:20,000
Slope, elevation, aspect	KBLUP file Regional non-standard inventory file created from NAD83 TRIM files (20 metre pixel resolution)	05/97		1:20,000
Kootenay-Boundary Land Use Plan (KBLUP) resource management zones	KBLUP file — Regional non-standard inventory file	05/97		1:50,000

A.2 Zone and Analysis Unit Definition

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

Management zones were defined to distinguish management emphasis within the draft Cranbrook Forest District landscape units. The Cranbrook Forest District wholly includes the Cranbrook TSA, and all or portions of Elk Lakes Provincial Park, Top of the World Provincial Park, Akamina Kishinena Provincial Park, Height-of-the-Rockies Provincial Park, Gilnockie Provincial Park and the Purcell Wilderness Conservancy. The Cranbrook TSA represents approximately 95% of the Cranbrook Forest District with most of the remaining area in provincial parks.

For this analysis, a management zone is an area within a landscape unit subject to the same combination of forest cover objectives. A management zone, for example, could be all the land in landscape unit two having a biogeoclimatic classification of Engelmann Spruce-Subalpine Fir — dry cold climate (ESSFdk) subject to caribou habitat and domestic watershed management guidelines.

Management zones are grouped in various ways for applying and tracking forest cover objectives. Forest cover objectives are the means by which some forest management requirements are modelled. One forest cover objective may wholly or partially overlap with another. In this analysis, such objectives were applied by landscape unit and biogeoclimatic zone and subzone/variant for the purpose of assessing *Biodiversity Guidebook* requirements. Forest cover objectives representing current forest management were also applied by resource emphasis area (REA) within each landscape unit.

The following groups were identified for the purpose of modelling *Biodiversity Guidebook* seral stage requirements and current forest management:

1. Biodiversity group — area grouped by landscape unit, biogeoclimatic classification to the variant level, and biodiversity-emphasis option (sensitivity analysis only). As such, there are 142 groups to which landscape-level biodiversity cover requirements are applied.
2. Caribou group — areas within the Cranbrook Forest District defined in the *Kootenay-Boundary Land Use Plan Implementation Strategy (1997)* as priority 1 and 2 caribou habitat and classified in the forest inventory as operable productive forest land having slopes less than 80%. Caribou areas were grouped by landscape unit and biogeoclimatic lines (ESSF versus ICH) resulting in 12 caribou groups. Caribou habitat area was derived from a non-standard GIS overlay.
3. Community and domestic watershed group — the Ministry of Environment, Lands and Parks (MELP) staff and Cranbrook Forest District staff identified important watershed areas using a planning cell list derived from the MELP watershed atlas. Planning cell areas are identified in the inventory file. Twenty-three groups were used to apply forest cover requirements by landscape unit and watershed type (community versus domestic). Community and domestic watersheds were defined for this analysis using the following planning cell list.

Community watershed

Planning cell E170, E165, E160, E090, E065, E070, E075, E080, E085,
 E030, T660, T655, C080, C010, C005, C008, G205, G182,
 G200, G187, G185, G190, G195, M220, S685, S690, S695
 S700, S705, S710, S715, S720, S725, K015, K020, K030,
 K035, K040, K041, K045

A.2 Zone and Analysis Unit Definition

Domestic watershed

Planning cell E175, E100, E095, E531, E040, E036, E035, E026, T415, T435, T505, T585, T595, T610, T650, T620, T645, T675, T677, T710, T700, T705, T670, T680, T690, T005, T035, T030, T025, T020, T015, T120, T125, T130, M200, M205, M210, M025, M085, M115, P005, C025, C027, T375, T370, T335, T345, T365, T360, T350, T340, T325, T320, T315, T310, T265, T270, T305, T275, T300, T295, T240, T280, T290, T235, T285, T230, T225, S680, T197, K100, K097, K065, K062, K060, K058, T210, K075, K070, K080, K090, K085, K092, K095

4. VQO visuals group — area grouped by landscape unit and visual quality objective(VQO). The 1993 recreation inventory for the Cranbrook Forest District was used to identify areas having VQOs. The VQO visuals group included areas coded as either 'P' or 'R' (retention), 'PR' (partial retention), or 'M' (modification). Forty-seven groups were created for applying forest cover requirements for VQOs.
5. Recreation management group — area grouped by landscape unit and recreation management rating. The recreation code in the 1993 recreation inventory for Cranbrook Forest District ranked recreation areas as follows:

recreation highest — management class = 1 and VQO = --;

recreation high — management class = 1 and feature significance = A or B and VQO = --;

recreation moderate — management class = 1 and feature significance = C and VQO = --.

Eighty-eight groups were created for applying forest cover requirements for recreation.

6. Ungulate winter range group — area grouped by landscape unit and ungulate winter range type. The Ministry of Environment, Lands and Parks and forest district staff identified ungulate winter range areas by landscape unit and biogeoclimatic subzone using habitat mapping updated to 1998. Seventy groups were used for applying ungulate winter range forest cover requirements. Different forest cover requirements are applied according to ungulate winter range type, and ungulate winter range type is based on the ungulate species present. Winter range type was defined using the following landscape unit and biogeoclimatic subzone combinations:

Type 1 LU1 (ICHmw2, ICHmk1), LU3 (ICHmw2), LU4 (ICHmw2), LU5 (ICHmw2, ICHmk1), LU6 (ICHmw2, ICHmk1), LU7 (ICHmw2, ICHmk1), LU8 (ICHmw2), LU9 (ICHmk1), LU10 (ICHmw2), LU11 (ICHmw2), LU21 (ESSFdk), LU22 (ESSFdk), LU23 (ESSFdk), LU27 (ESSFdk), LU28 (ICHmw2)

Type 2 LU1 (MSdk), LU4 (ICHmk1, MSdk), LU8 (ICHmk1, MSdk), LU10 (MSdk), LU11 (MSdk), LU15 (ICHmk1, MSdk), LU19 (MSdk), LU20 (MSdk), LU24 (ICHmk1, MSdk), LU25 (ICHmw2), LU26 (ICHmk1), LU28 (ICHmk1), LU30 (ICHmk1, MSdk), LU36 (MSdk), LU37 (MSdk), LU38 (MSdk)

Type 3 LU2 (MSdk), LU9 (MSdk), LU14 (MSdk), LU16 (MSdk), LU17 (MSdk), LU18 (MSdk), LU22 (MSdk), LU23 (ESSFdk, MSdk), LU27 (MSdk), LU31 (MSdk), LU32 (MSdk)

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Type 4 LU3 (ICHmk1), LU12 (MSdk), LU13 (MSdk),
 LU25(MSdk), LU26 (MSdk), LU28 (MSdk),
 LU29 (MSdk), LU33 (MSdk), LU34 (MSdk)

7. Integrated resource management zone (IRM) — all other non-NDT4 areas where harvesting operations are not constrained for specific resource management issues such as water, wildlife, recreation or visual sensitivity. IRM areas were divided by landscape unit boundaries and biogeoclimatic variants (ESSFwm, ICHmw2, ESSFdk, ICHmk1, MSdk) for a total of 97 IRM groups.
8. Fire Maintained Ecosystem Restoration (FMER – "managed forest", "open forest", "open range") — managed forest area (NDT4 code=47) was identified using a non-standard GIS overlay. Managed forest area is grouped by landscape unit and managed according to the *Kootenay-Boundary Land Use Plan Implementation Strategy FMER (NDT4) Guidelines*. Forest cover guidelines for the managed forest area of the NDT4 are assumed to be adequate to meet ungulate winter range requirements for this area. Twenty-four groups were used to model the FMER managed forest guidelines.

Fire maintained ecosystem management guidelines are also intended to encourage maintaining and increasing open forest conditions (NDT code=144) and open range conditions (NDT4 code=163). For modelling purposes, FMER open forest and FMER open range areas were assigned to analysis units having attributes reflecting partial cutting.

Table A-2. summarizes the area in each group — notwithstanding overlapping group areas.

A.2 Zone and Analysis Unit Definition

Table A-2. Crown forested land base and timber harvesting land base by resource emphasis group

Resource emphasis	Crown forested land base (hectares)	Timber harvesting land base (hectares)a	Per cent of timber harvesting land base ^a
Caribou habitat — ESSF	41 210.7	32 907.7	7.5
— ICH	3 965.1	3 168.6	0.7
Total caribou habitat	45 175.8	36 076.3	8.2
Water — community watershed	42 444.3	24 352.5	5.5
— domestic watershed	90 959.2	52 376.0	11.9
Total water	133 403.5	76 728.5	17.5
VQO visuals — retention	11 764.8	2 785.1	0.6
— partial retention	41 499.7	24 367.1	5.5
— modification	15 575.8	9 302.4	2.1
Total VQO visuals	68 840.3	36 454.6	8.3
Recreation management — highest	5 259.8	3 281.5	0.7
— high	16 144.5	8 154.8	1.9
— moderate	259 188.8	116 325.6	26.5
Total recreation management	280 593.1	127 761.9	29.1
Ungulate winter range — type 1	66 095.9	47 564.1	10.8
— type 2	33 455.1	23 691.1	5.4
— type 3	41 720.6	31 982.0	7.3
— type 4	9 495.2	4 088.2	0.9
Total ungulate winter range	150 766.8	107 325.4	24.4
IRM — ESSFwm	53 259.1	23 458.6	5.3
— ICHmw2	28 078.2	20 461.6	4.6
— ESSFdk	91 870.6	38 141.6	8.9
— ICHmk1	13 421.2	6 798.1	1.5
— MSdk	56 047.8	42 112.1	9.5
Total IRM	242 676.9	130 972.0	29.8
FMER — managed forest	41 722.4	36 441.0	8.3
— open forest	46 118.3	39 361.2	9.0
— open range	27 722.2	19 691.9	4.5
Total FMER (NTD4)	115 562.9	95 494.1	21.8

(a) Hectares and percentages are not additive because different group types may overlap.

A.2 Zone and Analysis Unit Definition

To simplify the analysis, individual forest stands were grouped into analysis units according to dominant tree species (inventory type group), silvicultural regime, elevation, slope, and timber growing capability (site index).

Table A-3. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-29. for existing natural stands and Tables A-30. And A-31. 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 zones and tracking multiple objectives (groupings)."

A.2 Zone and Analysis Unit Definition

Table A-3. Definition of analysis units

Analysis unit number	Leading species and site category ^a	Inventory type groups	Site index range (metres @ 50 years)	Elevation (metres)	Slope (%)	NTD4 code	Age at 1996/12/31
0111	PL(pure) – 1	28	> 19	< 1800	< 40	N/A	31+
0112	PL(pure) – 1s	28	> 19	< 1800	40+	N/A	31+
0121	PL(pure) – 2	28	14 to 19	< 1800	< 40	N/A	31+
0122	PL(pure) – 2s	28	14 to 19	< 1800	40+	N/A	31+
0131	PL(pure) – 3	28	10 to < 14	< 1800	< 40	N/A	31+
0132	PL(pure) – 3s	28	12 to < 14	< 1800	40+	N/A	31+
0161	PL,(pure) – 2m	28	10+	< 1800	< 40	N/A	< 31
0162	PL,(pure) – 2ms	28	12+	< 1800	40+	N/A	< 31
0211	PL,PA – 1	29-31,PA	> 19	< 1800	< 40	N/A	31+
0212	PL,PA – 1s	29-31,PA	> 19	< 1800	40+	N/A	31+
0221	PL,PA – 2	29-31,PA	14 to 19	< 1800	< 40	N/A	31+
0222	PL,PA – 2s	29-31,PA	14 to 19	< 1800	40+	N/A	31+
0231	PL,PA – 3	29-31,PA	10 to < 14	< 1800	< 40	N/A	31+
0232	PL,PA – 3s	29-31,PA	12 to < 14	< 1800	40+	N/A	31+
0261	PL,PA – 2m	29-31,PA	10+	< 1800	< 40	N/A	< 31
0262	PL,PA – 2ms	29-31,PA	12+	< 1800	40+	N/A	< 31
0298	PL – OF (FMER)	28-31	10+	< 1800	Any	144	31+
0311	S,B,PW,FD&S – 1	4,18-26,PW	> 19	< 1800	< 40	N/A	31+
0312	S,B,PW,FD&S – 1s	4,18-26,PW	> 19	< 1800	40+	N/A	31+
0321	S,B,PW,FD&S – 2	4,18-26,PW	14 to 19	< 1800	< 40	N/A	31+
0322	S,B,PW,FD&S – 2s	4,18-26,PW	14 to 19	< 1800	40+	N/A	31+
0331	S,B,PW,FD&S – 3	4,18-26,PW	8 to < 14	< 1800	< 40	N/A	31+
0332	S,B,PW,FD&S – 3s	4,18-26,PW	8 to < 14	< 1800	40+	N/A	31+
0361	S,B,PW,FD&S – 2y	4,18-26,PW	8+	< 1800	< 40	N/A	< 31
0362	S,B,PW,FD&S – 2ys	4,18-26,PW	8+	< 1800	40+	N/A	< 31
0411	L – 1	33-34	> 19	< 1800	< 40	N/A	31+
0412	L – 1s	33-34	> 19	< 1800	40+	N/A	31+
0421	L – 2	33-34	14 to 19	< 1800	< 40	N/A	31+
0422	L – 2s	33-34	14 to 19	< 1800	40+	N/A	31+
0431	L – 3	33-34	10 to < 14	< 1800	< 40	N/A	31+
0432	L – 3s	33-34	10 to < 14	< 1800	40+	N/A	31+
0461	L – 2y	33-34	10+	< 1800	Any	N/A	< 31
0498	L – OF (FMER)	33-34	10+	< 1800	Any	144	31+
0511	FD – 1	1,5,7,8	> 19	< 1800	< 40	N/A	31+
0512	FD – 1s	1,5,7,8	> 19	< 1800	40+	N/A	31+
0521	FD – 2	1,5,7,8	14 to 19	< 1800	< 40	N/A	31+
0522	FD – 2s	1,5,7,8	14 to 19	< 1800	40+	N/A	31+
0531	FD – 3	1,5,7,8	10 to < 14	< 1800	< 40	N/A	31+
0532	FD – 3s	1,5,7,8	13 to < 14	< 1800	40+	N/A	31+
0561	FD – 2y	1,5,7,8	10+	< 1800	Any	N/A	< 31
0598	FD – OF (FMER)	1,5,7,8	10+	< 1800	Any	144	31+

continued

(a) Site category codes: 1=good site; 2=medium site; 3=poor site; s=slopes $\geq 40\%$; e=elevation ≥ 1800 metres; m=managed stands < 31 years; y=natural stands < 31 years; OF=open forest.

A.2 Zone and Analysis Unit Definition

Table A-3. Definition of analysis units (concluded)

Analysis unit number	Leading species and site category ^a	Inventory type groups	Site index range (metres @ 50 years)	Elevation (metres)	Slope (%)	NTD4 code	Age at 1996/12/31
0620	PY,PY&FD,FD&PY – 2	6,32	14+	< 1800	Any	N/A	Any
0630	PY,PY&FD,FD&PY – 3	6,32	10 to < 14	< 1800	Any	N/A	Any
0698	PY,PY&FD,FD&PY – OF	6,32	10+	< 1800	Any	N/A	Any
0720	CW,H,FD&CW,FD&H – 2	2,3,9-17	10+	< 1800	Any	N/A	31+
0823	PL,PA – 2e	28-31	14+	1800+	Any	N/A	31+
0824	Not PL,PA – 2e	1-27,32-34	14+	1800+	Any	N/A	31+
0833	PL,PA – 3e	28-31	10 to < 14	1800+	Any	N/A	31+
0834	Not PL,PA – 3e	1-27,32-34	8 to < 14	1800+	Any	N/A	31+
0860	Any – 2ye	Any	10+	1800+	Any	N/A	< 31
0968	OF(FMER) < 31	Any	10+	< 1800	Any	144	< 31
0986	Backlog NSR < 420sph	Any	Any	Any	Any	N/A	Any
0987	Backlog NSR > 420sph	Any	Any	Any	Any	N/A	Any
0998	CW,H,B,S,PW – OF (FMER)	9-27	10+	< 1800	Any	N/A	Any
0999	Open Range (FMER)	Any	Any	< 1800	Any	163	Any

(a) Site category codes: 1=good site; 2=medium site; 3=poor site; s=slopes $\geq 40\%$; e=elevation ≥ 1800 metres; m=managed stands < 31 years; y=natural stands < 31 years; OF=open forest.

A.2 Zone and Analysis Unit Definition

Table A-4. describes some yield characteristics of the analysis units defined in Table A-3.

Table A-4. Description of analysis units

Analysis unit number	Leading species and site category ^a	Average site index (metres @ 50 years)	Maximum MAI (m ³ /hectare/year) Culmination age				Timber harvesting land base (hectares)
			VDYP	TIPSY	VDYP	TIPSY	
0111	PL(pure) – 1	21.0	3.455	4.863	80	70	16 607.3
0112	PL(pure) – 1s	20.7	3.471	4.743	80	69	1 467.2
0121	PL(pure) – 2	16.8	2.578	3.262	110	84	35 151.0
0122	PL(pure) – 2s	16.6	2.561	3.196	110	84	7 014.5
0131	PL(pure) – 3	12.6	1.770	1.938	130	122	10 353.1
0132	PL(pure) – 3s	13.2	1.788	2.113	130	82	1 636.5
0161	PL,(pure) – 2m	15.7	2.248	2.834	110	88	15 359.4
0162	PL,(pure) – 2ms	16.0	2.165	2.927	110	88	1 945.0
0211	PL,PA – 1	20.8	3.052	4.571	80	67	15 932.3
0212	PL,PA – 1s	20.9	3.109	4.614	70	67	2 824.9
0221	PL,PA – 2	16.7	2.237	3.080	100	82	33 413.1
0222	PL,PA – 2s	16.6	2.227	3.050	100	82	9 161.3
0231	PL,PA – 3	12.6	1.512	1.803	130	119	7 134.0
0232	PL,PA – 3	13.2	1.636	1.940	130	117	1 784.9
0261	PL,PA – 2m	15.7	1.934	2.713	100	87	15 996.8
0262	PL,PA – 2ms	15.9	2.085	2.762	100	87	1 556.9
0298	PL – OF (FMER)	15.4	1.942	1.343	110	140	2 831.1
0311	S,B,PW,FD&S – 1	21.8	3.138	4.930	90	75	6 963.0
0312	S,B,PW,FD&S – 1s	21.3	3.016	4.775	90	78	876.4
0321	S,B,PW,FD&S – 2	16.2	2.232	3.218	120	107	15 071.4
0322	S,B,PW,FD&S – 2s	16.1	2.176	3.198	110	107	4 321.2
0331	S,B,PW,FD&S – 3	11.4	1.431	2.015	150	152	13 876.9
0332	S,B,PW,FD&S – 3s	11.6	1.486	2.061	150	148	4 853.8
0361	S,B,PW,FD&S – 2y	14.9	1.982	2.885	110	107	18 059.4
0362	S,B,PW,FD&S – 2ys	15.2	2.044	2.947	110	107	3 385.2
0411	L – 1	20.9	2.630	3.933	130	88	10 434.2
0412	L – 1s	20.3	2.544	3.733	130	93	2 201.0
0421	L – 2	16.7	1.985	2.550	140	113	24 172.4
0422	L – 2s	16.7	1.963	2.550	140	113	6 483.8
0431	L – 3	12.5	1.282	1.413	140	145	5 101.4
0432	L – 3s	12.4	1.268	1.413	140	145	1 571.8
0461	L – 2y	15.7	1.785	2.404	140	113	3 651.8
0498	L – OF (FMER)	15.3	1.592	1.393	140	155	2 118.5
0511	FD – 1	20.8	2.625	3.976	110	95	5 069.7
0512	FD – 1s	21.7	2.944	4.336	110	90	881.9
0521	FD – 2	16.4	1.745	2.415	130	115	12 928.5
0522	FD – 2s	16.1	1.819	2.318	130	115	4 682.2
0531	FD – 3	12.5	0.988	1.304	150	141	6 797.1
0532	FD – 3s	13.5	1.232	1.558	140	130	1 622.3
0561	FD – 2y	15.4	1.620	2.097	130	115	3 790.0

(a) Site category codes: 1=good site; 2=medium site; 3=poor site; s=slopes $\geq 40\%$; e=elevation ≥ 1800 metres; m=managed stands < 31 years; y=natural stands < 31 years; OF=open forest.

continued

A.2 Zone and Analysis Unit Definition

Table A-4. Description of analysis units (concluded)

Analysis unit number	Leading species and site category ^a	Average site index (metres @ 50 years)	Maximum MAI (m ³ /hectare/year) Culmination age				Timber harvesting land base (hectares)
			VDYP	TIPSY	VDYP	TIPSY	
0598	FD – OF (FMER)	14.8	1.369	1.275	140	160	12 522.3
0620	PY,PY&FD,FD&PY – 2	18.2	1.862	3.046	120	104	3 752.0
0630	PY,PY&FD,FD&PY – 3	12.3	0.856	1.243	150	144	906.8
0698	PY,PY&FD,FD&PY – OF	15.1	1.314	1.344	130	155	13 710.1
0720	CW,H,FD&CW,FD&H – 2	15.1	2.093	2.792	130	124	3 415.2
0823	PL,PA – 2e	15.8	2.345	3.140	100	103	9 358.7
0824	Not PL,PA – 2e	15.5	2.112	3.055	110	107	2 655.5
0833	PL,PA – 3e	12.6	1.712	2.277	140	128	6 389.0
0834	Not PL,PA – 3e	10.8	1.372	1.847	160	152	8 286.0
0860	Any – 2ye	14.7	1.960	2.583	110	107	8 758.7
0968	OF(FMER) < 31	15.4	1.734	1.350	130	160	7 198.2
0986	Backlog NSR < 420sph	13.6	1.687	1.267	140	145	1 730.2
0987	Backlog NSR > 420sph	15.8	1.955	2.183	130	115	983.0
0998	CW,H,B,S,PW – OF (FMER)	16.4	1.893	1.625	130	160	782.2
0999	Open range (FMER)	11.9	0.905	0.905	140	140	19 659.1

(a) Site category codes: 1=good site; 2=medium site; 3=poor site; s=slopes $\geq 40\%$; e=elevation ≥ 1800 metres; m=managed stands < 31 years; y=natural stands < 31 years; OF=open forest.

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Cranbrook Forest District 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.

Table 2 in the main report lists the areas in each category of land. However, one area could have more than one characteristic that would identify it as falling outside of the timber harvesting land base: it could be both a park and not accessible, for example. The areas in Table 2 were derived by examining the characteristics of the land in a particular order; the areas could be different if the characteristics were examined in a different order. The discussion below follows the order used in compiling Table 2 in the main report.

A.3.1 Land not owned and administered by the province of British Columbia

Only British Columbia provincial Crown land contributes to the land base used to determine timber supply. Private lands (Crown granted lands) ownership code 40N and federal Crown lands (Indian Reserves and Dominion Government Blocks) ownership codes 52N and 54N do not contribute to the timber harvesting land base.

Table A-6. shows which land ownership classifications are not managed by the B.C. Forest Service for timber supply.

A.3.2 Exclusion of specific, geographically defined areas

The Flathead Town Site (private land) and recently issued woodlot licence areas that have not been incorporated into the forest inventory were not included in the timber harvesting land base. The following mapsheet and forest cover polygon listing was used to exclude this area from the timber harvesting land base. The numbers in parenthesis indicate the area, in hectares, to be excluded. The total number of hectares excluded from the timber harvesting land base in this category is 1534.9 hectares — 982.2 hectares for the Flathead town site and 552.7 hectares for issued woodlots.

Flathead Town Site (private land)

Mapsheet 82G037 — 108(21.7), 110(0.3), 133(1.9), 238(17.8), 272(0.8),
273(0.2), 274(14.3), 275(0.2), 276(1.6), 282(3.6),
283(2.7), 284(2.0), 285(0.4), 286(3.0), 288 (4.2),
312(2.1), 313 (0.1), 318(3.4), 319 (0.9), 323(19.0),
324(11.6), 325(4.8), 326(2.8), 327(22.0), 328(7.1),
329(23.2), 333(3.8), 414(0.1), 417(4.2), 439(3.3),
440(4.6), 442(3.4), 443(59.0), 444(6.4), 445(1.5),
446(3.0), 447(4.3), 448(13.5), 449(1.3), 450(10.4),
452(2.2), 453(0.1), 460(23.9), 461(6.9), 462(36.8),
463(10.8), 464(15.5), 465(4.2), 466(332.8),
467(6.2), 468(14.8), 469(3.2), 470(1.6), 471(4.0),
472(5.2), 473(1.8), 474(7.8), 475(2.6), 476(6.1),
477(7.3), 478(5.0), 479(11.3), 480(33.4), 481(55.9),
482(2.9), 483(5.2), 484(19.0), 485(4.4), 487(1.4),
488(0.8), 494(6.7), 495(1.6), 496(0.5), 614(4.0),
615(2.9), 616(8.6), 617(0.8), 618(3.2), 624(0.5),
638(1.9), 727(1.4), 828(1.5), 829(10.9), 830 (2.5),
831(2.0), 836(11.0)

A.3 Definition of the Timber Harvesting Land Base

Issued woodlots

Mapsheet 82G043 — 84(1.0), 95(1.9), 97(13.4), 102(9.6), 103(23.0),
104(11.0), 105(23.9), 112(40.2), 113(31.6),
114(16.3), 117(3.8), 451(3.5), 483(7.8), 484(7.0),
489(2.2), 490(1.7), 491(8.3), 492(10.4), 494(3.0),
495(4.8), 496(7.4), 497(7.8), 498(12.6), 499(4.3),
506(2.2), 620(2.9), 621(1.9), 676(2.2), 682(2.2),
683(3.5), 684(1.7), 685(98.3), 686(3.9), 687(1.3),
689(3.9)

Mapsheet 82G053 — 592(19.5)

Mapsheet 82G086 — 32(1.8), 36(4.4), 37(8.0), 38(27.4), 39(10.6), 40(2.7),
41(0.9), 42(4.4), 43(0.9), 44(14.1), 49(2.7)

Mapsheet 82G096 — 155(1.3), 283(2.7), 284(2.7), 285(3.5), 286(8.8),
290(3.5), 291(14.6), 292(13.7), 294(1.8), 295(4.4),
298(3.5), 301(0.9), 302(4.4), 308(2.7), 309(0.9),
310(4.4), 311(3.5), 312(4.4), 327(4.0), 369(0.9),
370(1.8), 374(1.8), 375(0.4), 379(2.2), 381(0.4),
382(1.8), 383(31.8), 386(8.8), 386(0.4)

A.3.3 Non-forest and non-productive forest land

Non-forest and non-productive forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) — areas do not contribute to timber harvesting. These categories include areas such as sparse alpine forest, ice, swamps, water, and rock. Table A-5. describes the non-forest and non-productive forest removed from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-5. *Non-forest and non-productive area*

Basic class code	Description	Area removed (hectares)
02	Alpine	191 754.1
03	Rock	15 563.8
06	Gravel pit	6.0
09	Clay bank	293.0
10	Alpine forest with species	68 812.4
11	Non-productive brush	11 090.7
12	Non-productive forest	39 001.0
13	Non-productive burn	16 409.4
15	Lake	9 683.6
18	Gravel bar	40.7
25	River	5 375.2
35	Swamp	2 986.5
42	Clearing	1 559.3
54	Urban	7 417.5
62	Meadow	629.3
63	Open range	17 967.7
00	Non-typed areas	170.2
Total		388 760.4

A.3.4 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5 — 3816.8 hectares) were not included in the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

A.3.5 Provincial land not administered by the B.C. Forest Service for AAC determination purposes

The ownership (OWNER and OWNER_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 and various special use permit areas. Forest in ownerships 62-C (forest management unit), 69-C (forest reserves), and portions of 61-C (UREP) are available for timber harvesting.

Apart from ownerships 40-N, 52-N, 54-N, and 77-N and non-commercial brush types, the productive forest portion of land within the Cranbrook Forest District is considered part of the Crown forested land base and may contribute to old growth and wildlife tree retention targets.

Table A-6. details which land ownership classifications are not managed by the B.C. Forest Service for timber supply.

Table A-6. Ownership classification for the Cranbrook Forest District

Ownership classification	Total area within Cranbrook Forest District (hectares)	Land not managed for timber supply within the Cranbrook Forest District (hectares)
Area within the Cranbrook TSA		
40-N Private	195 424.8	195 424.8
52-N Indian reserve	12 202.6	12 202.6
54-N Dominion block	20 215.8	20 215.8
60-N Ecological reserve	56.1	56.1
61-C UREP	1 722.4	0.0
61-N UREP	291.3	291.3
62-C	1 112 659.3	0.0
62-N	747.7	747.7
63-N Park, class A	718.1	718.1
65-N Park, class C	25.8	25.8
67-N Park reserve	328.7	328.7
69-C Miscellaneous reserves	51 796.2	0.0
69-N Miscellaneous reserves	1 848.8	1 848.8
75-N Christmas tree permit	5 860.1	5 860.1
77-N Woodlot licence	6 256.0	6 256.0
99-N Miscellaneous leases	81.8	81.8
Total Cranbrook TSA	1 410 235.5	244 057.6
Area outside of Cranbrook TSA		
40-N Private	2.2	2.2
63-N Park, class A	48 947.6	48 947.6
67-N Park reserve	23 897.9	23 897.9
Total area outside of Cranbrook TSA	72 847.7	72 847.7
Total Cranbrook Forest District area	1 483 083.2	389 753.0

A.3 Definition of the Timber Harvesting Land Base

A.3.6 Existing unclassified roads, trails and landings

Many roads, trails and landings constructed for forest access and harvesting are not large enough to be classified on the inventory file. Cranbrook Forest District staff estimated that unclassified permanent roads and other infrastructure features occupy 10 860.6 hectares of land that would otherwise be included in the timber harvesting land base. Land occupied by these features was calculated using a geographic information system linear overlay procedure to identify the length of each feature running through otherwise productive forest, and then multiplying these lengths by average right-of-way width for the feature. The area deducted for each feature was calculated using the information shown in Table A-7.

Table A-7. *Right-of-way information for existing classified roads, resource access trails and other infrastructure features*

Feature	Length (metres)	Right-of-way width (metres)	Reduction area (hectares)
Highway	61 740	40.0	246.9
Secondary road	2 138 646	15.9	3 400.5
Logging road	7 262 578	8.5	6 173.1
Trail	1 386 713	3.0	416.0
Railway	33 246	33.8	112.0
Power line	62 863	49.0	308.0
Pipeline	66 260	30.8	204.1
Total			10 860.6

A.3 Definition of the Timber Harvesting Land Base

Trails and landings within blocks with forest cover less than 31 years old are assumed to reduce productivity, and will be represented as timber yield reduction applied to volume curves (for stands < 31 years). A factor of 0.9053 was applied to these volume curves based on the information in Table A-8.

Table A-8. *Estimates of non-classified existing roads, trails and landings*

Roads trails and landings category	Productivity reduction on previously harvested sites (per cent)
Skid trails (including old historic trails), and other detrimental disturbance on the net area to reforest	5.76
Landings	3.71
Total	9.47

Existing trails include old historic trails that were used in harvesting operations earlier in this century (that are not re-used for subsequent harvesting operations and continue to be unproductive) which amounted to 0.43% of the area harvested. These existing trails were added to the trails from current harvesting operations. Trails from current harvesting operations were estimated for conventional harvesting and cable harvesting based on advice from the Regional Pedologist for four time periods when different standards applied. There was a clear trend of decreasing area occupied by trails for each subsequent time period. The actual loss of productivity associated with the area occupied by trails was determined to be 30% (based on the assumption that 50% of logging occurs during summer and 50% occurs in winter, and that average productivity loss in winter logging is 20% and average productivity loss in summer logging is 40%). This productivity loss factor has been incorporated into the final productivity reduction percentages listed above in Table A-8.

Area in existing landings from current harvesting operations was estimated for conventional harvesting and cable harvesting based on advice from the Regional Pedologist for four time periods when different standards applied. There was a clear trend of decreasing area occupied by landings for each subsequent time period. The area occupied by landings was assumed to be non-productive. It was assumed that all existing and future landings constructed during right-of-way clearing would eventually be used for harvesting of cutblocks and therefore no additional netdown for right-of-way landings was made.

A.3.7 Estimated area in riparian reserves and riparian management zones

To account for protection of riparian and stream values within the Cranbrook TSA, 34 147.2 hectares were excluded from the timber harvesting land base. Table A-9. describes the information used to estimate the riparian area reduction.

A.3 Definition of the Timber Harvesting Land Base

Table A-9. *Riparian management areas*

Riparian class	Length (metres)	Reserve zone width (metres)	Management zone width (metres)	Retention in management zone (%)	Total riparian reduction area width (metres)	Reduction area (hectares)
S1	202 150	50	20	50	60	2 425.8
S2	2 160 350	30	20	50	40	17 282.8
S3	1 928 467	20	20	50	30	11 570.8
S4	18 188	0	30	25	8	29.1
S5	1 443 438	0	30	25	8	2 309.5
W	123 000	10	20	25	15	184.5
L	172 350	10	20	50	20	344.7
Total						34 147.2

Riparian management area (RMA) classifications for the Cranbrook TSA were done using a methodology developed by the Ministry of Environment, Lands, and Parks and the Ministry of Forests at Nelson for this timber supply analysis. GIS layers and inputs such as the watershed atlas stream network, watershed atlas lake and wetland polygons, community watershed polygons and the Forest Renewal British Columbia (FRBC) fish inventory provided the base line information for determining riparian management area classifications. Field sampling was done to check some of the assumptions used in the GIS model. Details of this classification procedure are described in a report produced by Nanuq Consulting Ltd. (May 1997) available in the Nelson Forest Region office. Riparian area exclusions were performed on specific geographic areas based on the information discussed above.

The total riparian area reserve is made up of the reserve zone plus the management zone multiplied by the retention. For example:

Reserve zone	30 metres
Management zone	20 metres
Retention in management zone	50%
Implied reserve in management zone	$(20 * 0.5) = 10$ metres
Total riparian area reserve	40 metres
(reserve zone 30 metres plus implied reserve in management zone of 10 metres)	

The total riparian area reserve is then multiplied by stream length for the total reduction area. For streams, the riparian area reserve is also multiplied by two to account for riparian management on each side of the stream.

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as sensitive soils, avalanches and regeneration difficulties. Environmental sensitivity is designated as high or moderate depending on the degree of sensitivity or value for other resources. The high ESA class (E1) is applied where very high environmental sensitivity or value for other resources precludes timber harvesting. The moderate ESA class (E2) is given to areas where significant sensitivity or value for other resources may result in conditions or restrictions being applied to timber harvesting. Portions of areas classified as environmentally sensitive were excluded from the timber harvesting land base using the percentages shown in Table A-10.

Table A-10. Per cent of area considered unavailable for timber harvesting due to environmental sensitivity

ESA class	ESA description	% area reduction	Reduction area (hectares)
E1a	Areas having severe snow chutes or avalanche problems.	100	127.1
E1h	Areas having very high water values and extreme sensitivity to harvesting.	100	58.1
E1s	Areas having extremely fragile or unstable soils.	100	93 573.1
E2s within community watersheds and domestic watersheds	Areas having significantly fragile or unstable soils.	50	1 553.8
E1p outside NDT4	Areas having severe regeneration problems caused by biotic factors.	100	17 229.2
Total			112 541.3

A.3 Definition of the Timber Harvesting Land Base

Area-based reductions for ESAs were based upon professional judgment and an assessment of historic and planned harvesting activities on ESA areas. Where reasonable, deductions were stated as 100 or 0% of specific areas to enable them to be spatially explicit. One-half of soil E2 areas in community and domestic watersheds were deducted to reflect the fact that the FPC is more restrictive on Class IV terrain hazard areas within community and domestic watersheds. Difficult to regenerate E1 area (E1p) within the NDT 4 is not deducted because these areas are assumed to be harvestable for conversion to open range. All the NDT 4 E1p areas are assumed to be targeted for conversion to open range and are contained in the FMER open range analysis unit. Most E2 soil areas outside of community and domestic watersheds, and difficult to regenerate E2 (E2p) sites can be harvested with due care to soils and recognition of possible regeneration problems, so these areas were not explicitly removed from the timber harvesting land base. Areas identified as being sensitive for recreational concerns, visual quality concerns, and wildlife concerns are addressed through management zones with specific forest cover constraints (see Section A.4.4, "Forest cover requirements").

A.3.9 Sites with low timber growing potential

Sites may have low timber growing potential because of inherent site factors (nutrient availability, limiting climatic conditions, excessive or insufficient moisture, etc.). Typically, these stands are intermixed with other stands within the forested land base. The forest inventory rates growing potential of stands using a site index (height at 50 years breast height age). Stands with a site index less than that indicated in Table A-11. are excluded from the timber harvesting land base due to low timber growing potential.

Table A-11. Description of sites with low timber growing potential

Species	Inventory type groups	Site index (m @ 50 years)	Slope (%)	Reduction (%)	Reduction area (hectares)
PI leading	28-31	< 10	< 40	100	4 270.8
PI leading	28-31	< 12	40+	100	11 038.4
F leading except FS	1-3, 5-8	< 10	< 40	100	2 230.9
F leading except FS	1-3, 5-8	< 13	40+	100	6 049.9
L, C, H, Py, Pa deciduous leading and F leading except FS	9-17, 27 where Pa leading, 32-42	< 10	All	100	2 277.8
S leading, B leading, Pw leading, FS	4, 18-26, 27 where Pw leading	< 8	All	100	12 628.4
Total					38 496.2

A.3 Definition of the Timber Harvesting Land Base

A.3.10 Specific excluded forest types

Some forest types are excluded to reflect that they are not available for timber harvesting due to decadence, non-merchantable characteristics, regeneration problems due to harsh climatic conditions at high elevation, or high significance for other environmental resource values. The forest types or areas referred to in Table A-12. are excluded entirely from the timber harvesting land base.

Table A-12. Description of specific excluded forest types

Description	Type group	Species	Age	Comments	Reduction area (hectares)
Old cedar- and hemlock stands	9-17	C, CF, CH, H, HF, HC, HB, HS, Hdecid	> 200	High degree of decay; important for biodiversity	2 136.3
Old balsam-leading stands	18, 19, 20	B, BH, BS	> 200	High degree of decay; important for biodiversity	5 586.0
Deciduous stands	35-42	Deciduous	Any	Not currently utilized; important for wildlife	8 150.0
High elevation "parkland" forest	ESSFdk-p	Any	Any	High elevation sites; sensitive and important for wildlife and biodiversity	12 706.6
High elevation "parkland" forest	ESSFwm-p	Any	Any	High elevation sites; sensitive and important for wildlife and biodiversity	56.3
Total					28 635.2

A.3 Definition of the Timber Harvesting Land Base

A.3.11 Inoperable areas

Operability codes found in the inventory file are used to describe the presence or absence of physical barriers or limitations to harvesting and the merchantability of stands. Inoperable areas are defined as areas unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining operability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil instability, elevation and timber quality. Operability can change over time as a function of new harvesting technologies and changing economics.

Table A-13. Description of inoperable areas

Inventory description	Code	Reduction per cent (%)	Reduction area (hectares)
Inoperable	Operability I	100	82 784.7
Not typed	Operability N or blank	100	604.3
Operable	Operability A	0	0.0
Slopes greater than 70% where species other than lodgepole pine are the leading species	As per TRIM file data and FIP file where SPCS is not PI	100	2 576.8
Slopes greater than 65% where lodgepole pine is the leading species	As per TRIM file data and FIP file where SPCS is PI	100	2 725.5
			88 691.3

A.3.12 Problem forest types

Problem forest types occur within the operable land base and occupy sites that have the potential to produce merchantable timber but are not currently utilized due to marginal merchantability. The stand types identified as problem forest types will in most cases include some merchantable and some unmerchantable stands in varying proportions. Each problem forest type must be evaluated separately to determine the proportion that should be excluded from the timber harvesting land base. Table A-14. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-14. Problem forest types criteria

Problem forest type number	Type group	Species	Age (years)	Height (metres)	Per cent (%) excluded	Reduction area (hectares)
1	28-31	PI leading	> 40	< 10.5	80	540.6
2	28-31	PI, PIF, PIS, PIDecid	> 40 to 60	10.5-19.4	35	10 432.0
3	28-31	PI, PIF, PIS, PIDecid	> 60 to 80	10.5-19.4	18	7 518.4
4	28-31	PI, PIF, PIS, PIDecid	> 80	10.5-19.4	29	2 930.2
5	6, 32	FdPy, FPI, Fdecid, Py leading	> 80	10.5-19.4	6	269.2
Total						21 690.4

A portion of problem forest types 2, 3, 4 in Table A-14. stay in the timber harvesting land base but require an extended rotation to achieve merchantability. The percentage of these stand types assigned to extended rotation analysis unit is as follows: inventory type groups 28-31, age class 3 / height class 2: 10%; age class 4 / height class 2 - 24%, and age class 5+ /height class 2 - 57%. Minimum harvestable ages for these analysis units were extended to reflect the longer period of time required for these stands to meet minimum product objectives, and volume estimates were reduced to reflect the lower volume projected at the extended minimum harvestable age. These analysis units are part of the timber harvesting land base and have an adjustment factor applied to the volume curve to account for the reduced productivity.

Based upon a statistically-designed inventory, a portion of the FPL, FPY, FL, Fdecid, Py forest types previously identified as problem forest types in the 1995 timber supply review have been added back to the timber harvesting land base, except for those stands included in problem forest type 5 noted in Table A-14. These stands, portions of inventory type groups 5 - 8 and 32, were assigned to extended rotation analysis units using the following percentages: age class 3 / height class 2 — 12%; age class 4 /height class 2 — 11%; and age classes 5+ / height class 2 — 12%.

Table A-15. describes the timber harvesting land base area reassigned to extended rotation analysis units based on the above percentages. A summary of the statistically designed inventory (*Cranbrook Forest District Problem Forest Type Summary Report*, 1999) was used for developing the adjustment factor shown in Table A-15.

A.3 Definition of the Timber Harvesting Land Base

Table A-15. *Extended rotation analysis units*

Existing analysis unit number	Description	Area reassigned to problem forest type (hectares)	Problem forest type analysis unit number	Adjustment factor	Extension to minimum harvestable age (years)
0121	PL (pure) – 2	3 771.9	5121	0.45	20
0122	PL (pure) – 2s	757.6	5122	0.45	20
0131	PL (pure) – 3	1 970.8	5131	0.45	20
0132	PL (pure) – 3s	321.8	5132	0.45	20
0221	PL, PA – 2	2 634.3	5221	0.45	20
0222	PL, PA – 2s	651.9	5222	0.45	20
0231	PL, PA – 3	1 512.3	5231	0.45	20
0232	PL, PA – 3s	259.2	5232	0.45	20
0298	PL – OF	495.8	5298	0.45	20
0521	FD – 2	387.4	5521	0.45	20
0522	FD – 2s	167.6	5522	0.45	20
0531	FD – 3	199.6	5531	0.45	20
0598	FD – OF	270.4	5598	0.45	20
0620	PY, PY & FD, FD & PY – 2	144.6	5620	0.45	20
0698	PY, PY & FD, FD & PY – OF	501.0	5698	0.45	20
0823	PL, PA – 2e	478.1	5823	0.45	20
0833	PL, PA – 3e	1 020.7	5833	0.45	20
0999	FMER open range	556.0	5999	0.45	20
Total		16 101.0			

A.3 Definition of the Timber Harvesting Land Base

A.3.13 Future roads, trails and landings

Future roads, trails and landings are assumed to reduce productivity, and are represented as a one-time area reduction applied to future stands on areas currently covered by stands older than 30 years. Table A-16. shows the productivity reduction for each category.

Table A-16. *Estimates of productivity losses due to future roads, trails and landings*

Roads, trails and landing category	Productivity reduction (%)
Roads	3.70
Skid trails (including old historic trails), and other detrimental disturbance on the net area to reforest	1.93
Landings	2.30
Total	7.93

Future road requirements were estimated by stratifying the timber harvesting land base into slope classes applicable to various harvest methods and determining the proportion of the area where each type of harvesting method would likely occur. For each of the harvest methods, on average road width of 20 metres was divided by estimated average road spacing for the applicable harvest method to determine the estimated proportion of the area occupied by future roads. A weighted average road requirement for each harvest method was calculated.

Future bladed trails are assumed to be fully rehabilitated and restored to 100% productivity. The losses attributed to trails are productivity losses due to dispersed detrimental soil disturbance (typically concentrated in unbladed skid trails) which is estimated to be approximately 1.93%.

Future in-block landing requirements were based on the Regional Pedologist's estimate of current practice, and an assumption that a similar level of productivity loss would occur in the future.

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.

In the Cranbrook TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-17.

Table A-17. Utilization levels

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

A.4.2 Minimum harvestable age by analysis unit

Minimum harvestable age defines the earliest age at which a stand may be harvested, not the age at which harvesting must occur. For this analysis, minimum harvestable ages were defined by the following criteria: minimum volume per hectare, minimum piece size, and the age at which 95% of the culmination of the mean annual increment (CMAI) is achieved for all other analysis units. In a few cases involving stands on poorer sites, professional judgment was used to lower the minimum harvestable age obtained by the above criteria. For example, if the minimum diameter was the most limiting factor and it was projected to be reached well beyond the age of 95% of CMAI, or it was projected never to be achieved, then the age at 95% of CMAI was used to define the minimum harvestable age. These criteria apply to existing natural and managed second-growth stands, and future regenerated stands.

A.4 Forest Management Assumptions

Table A-18. Minimum harvestable age criteria

Analysis unit	Leading species and site category	Criteria ^a				Minimum harvestable age	
		Minimum volume (m³/ha)	Minimum average DBH (cm)	Age at 95% maximum MAI			
				VDYP ^b	TIPSY ^b	Existing stands	Future stands
0111	PL(pure) – 1	100	20	60	55	60	55
0112	PL(pure) – 1s	150	25	60	57	105	80
0121	PL(pure) – 2	100	20	80	70	80	70
0122	PL(pure) – 2s	150	25	80	72	130	123
0131	PL(pure) – 3	100	20	110	94	110	105
0132	PL(pure) – 3s	150	25	100	91	175	175
0161	PL(pure) – 2m	100	20	80	77	103	103
0162	PL(pure) – 2ms	150	25	90	77	123	123
0211	PL,PA – 1	100	20	60	52	60	52
0212	PL,PA – 1s	150	25	60	52	95	83
0221	PL,PA – 2	100	20	80	70	80	75
0222	PL,PA – 2s	150	25	80	67	120	120
0231	PL,PA – 3	100	20	100	84	100	100
0232	PL,PA – 3s	150	25	100	82	155	155
0261	PL,PA – 2m	100	20	80	76	101	101
0262	PL,PA – 2ms	150	25	70	75	120	120
0298	PL – OF	100	20	80	105	80	105
0311	S,B,PW,FD&S – 1	120	25	80	66	80	66
0312	S,B,PW,FD&S – 1s	180	28	80	71	80	80
0321	S,B,PW,FD&S – 2	120	25	90	91	90	91
0322	S,B,PW,FD&S – 2s	180	28	90	92	90	92
0331	S,B,PW,FD&S – 3	120	25	120	127	120	127
0332	S,B,PW,FD&S – 3s	180	28	120	127	120	127
0361	S,B,PW,FD&S – 2y	120	25	90	91	90	91
0362	S,B,PW,FD&S – 2ys	180	28	90	92	90	92
0411	L – 1	100	25	100	73	100	73
0412	L – 1s	180	28	100	80	100	90
0421	L – 2	100	25	120	88	120	88
0422	L – 2s	180	28	110	88	120	100
0431	L – 3	100	25	130	123	130	123
0432	L – 3s	180	28	130	123	135	135
0461	L – 2y	100	25	120	88	120	88
0498	L – OF	100	28	120	125	120	125
0511	FD – 1	100	25	90	77	90	77
0512	FD – 1s	180	28	90	70	90	90
0521	FD – 2	100	25	110	88	110	88
0522	FD – 2s	180	28	110	82	110	100

(a) Shading indicates limiting criterion, often the most limiting criterion.

(b) See Table A-4., "Description of analysis units."

continued

A.4 Forest Management Assumptions

Table A-18. Minimum harvestable age criteria (concluded)

Analysis unit	Leading species and site category	Criteria ^a				Minimum harvestable age	
		Minimum volume (m ³ /ha)	Minimum average DBH (cm)	Age at 95% maximum MAI			
				VDYP ^b	TIPSY ^b	Existing stands	Future stands
0531	FD – 3	100	25	120	118	120	118
0532	FD – 3s	180	28	120	108	145	145
0561	FD – 2y	100	25	110	88	110	88
0598	FD – OF	100	25	110	125	110	125
0620	PY,PY&FD,FD&PY – 2	100	25	100	84	100	96
0630	PY,PY&FD,FD&PY – 3	100	25	120	120	135	120
0698	PY,PY&FD,FD&PY – OF	100	25	110	125	130	125
0720	CW,H,FD&CW,FD&H – 2	150	28	100	104	115	115
0823	PL,PA – 2e	150	25	80	91	120	105
0824	Not PL,PA – 2e	180	25	90	92	120	106
0833	PL,PA – 3e	150	25	100	111	165	140
0834	Not PL,PA – 3e	180	25	120	132	150	150
0860	Any – 2ye	200	25	90	92	120	106
0968	OF(FMER) < 31	100	25	100	120	100	120
0986	Backlog NSR < 420sph	150	25	110	125	125	125
0987	Backlog NSR > 420sph	150	25	100	100	100	100
0998	CW,H,B,S,PW – OF	100	25	100	120	130	120
0999	FMER Open Range	100	20	120	120	140	999

(a) Shading indicates limiting criterion, often the most limiting criterion.

(b) See Table A-4., "Description of analysis units."

A.4.3 Harvest profile

The harvest profile describes any characteristics desired from the timber harvest; for example, the proportion of the total harvest made up of a particular tree species. No harvest profile requirements were applied in the Cranbrook TSA analysis.

A.4 Forest Management Assumptions

A.4.4 Forest cover requirements

This analysis did not involve an explicitly spatial evaluation of timber supply. However, the timber supply model used (FSSIM Version 3.0) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition, or the minimum required area of old-age forest. Since site specific adjacency guidelines and forest level cover requirements are linked, use of forest cover guidelines can approximate the effect of adjacency guidelines as well as broader forest level goals. The forest cover requirements applied in this analysis approximate current forest management practices.

A growth-yield model, Site Tools v3.0, B.C. Ministry of Forests, Research Branch, 1998a, was used to estimate when trees will reach a top height of two metres (integrated resource management zones, FMER managed forest zones), three metres (caribou zones, recreation moderate zones), four metres (recreation high zones), six metres (VQO zones, recreation highest zones) and nine metres (community and domestic watershed zones). While recognizing that the TSA land base will support a range of growth rates, average green-up ages based on forest stand type (analysis unit) distribution throughout the zone type were used to simplify the analysis. These green-up ages do not include regeneration delay; the delays are dealt with separately in the simulation model.

Table A-19. specifies the forest cover requirements for the Cranbrook TSA. Except for the integrated resource management zone, caribou habitat zone, and the FMER managed forest zone, the cover requirements apply to the total Crown forest area. In the integrated resource management zone and the FMER managed forest zone they apply to the timber harvesting land base. In caribou habitat zones, cover requirements apply to the 'suitable forested area', which includes the timber harvesting land base and all other operable forest area with slopes less than 80%.

A.4 Forest Management Assumptions

Table A-19. Resource emphasis area forest cover requirements

Zone type	Forest cover objective				
	Green-up height (metres)	Green-up age (years)	Maximum area less than green-up age (%)	Minimum older age (years)	Minimum area greater than older age (%)
Caribou ESSF < 80% slope	3	21	25	140 250	30 10
Caribou ICH < 80% slope	3	19	25	140 250	40 10
Community watershed	9	34	25	N/A	N/A
Domestic watershed	9	34	30	N/A	N/A
VQO — retention	6	23	5	N/A	N/A
VQO — partial retention	6	25	15	N/A	N/A
VQO — modification	6	25	25	N/A	N/A
Recreation highest	6	25	5	N/A	N/A
Recreation high	4	21	15	N/A	N/A
Recreation moderate	3	17	25	N/A	N/A
Ungulate winter range type 1	N/A	N/A	N/A	121	50
Ungulate winter range type 2	N/A	N/A	N/A	101	30
Ungulate winter range type 3	N/A	N/A	N/A	82	40
Ungulate winter range type 4	N/A	N/A	N/A	101	40
IRM — ESSFwm	2	16	33	N/A	N/A
IRM — ICHmw2	2	17	33	N/A	N/A
IRM — ESSFdk	2	14	33	N/A	N/A
IRM — ICHmk1	2	13	33	N/A	N/A
IRM — MSdk	2	13	40	N/A	N/A
FMER (NDT4) managed forest	2	14	33	N/A	N/A

A.4 Forest Management Assumptions

A.4.5 Biodiversity

Landscape-level biodiversity

Biodiversity seral stage distribution guidelines were modelled using information from the *Forest Practices Code Biodiversity Guidebook*. As indicated in the memorandum of understanding between MoF and MELP and the forest district manager's forest development plan instructions, biodiversity emphasis for each landscape unit that was drafted in the *Kootenay-Boundary Land Use Plan Implementation Strategy* is being operationally applied. However, because the *Kootenay-Boundary Land Use Plan Implementation Strategy* biodiversity emphasis and landscape units have not been formalized through the legal landscape unit establishment process, the timber supply analysis base case incorporates forest cover requirements that do not prejudge the outcome of this legal process. For the base case, a single weighted forest cover requirement for each of the old plus mature-seral stage and the old-seral stage was developed based on the anticipated distribution of 45% low-, 45% intermediate- and 10% high-emphasis for each landscape unit.

These weighted forest cover requirements were determined in accordance with the memorandum from the director of the Ministry of Forests, Timber Supply Branch regarding incorporating biodiversity and landscape units in the Timber Supply Review, dated December 1, 1997.

The *Forest Practices Code Biodiversity Guidebook* describes the following forest cover requirements for each natural disturbance type (NDT) and emphasis as shown in Table A-20.

A.4 Forest Management Assumptions

Table A-20. *Landscape level biodiversity: biodiversity guidebook distribution objectives for each seral stage by emphasis option, for the NDTs in the Cranbrook Forest District*

Biogeoclimatic unit	NDT	Biodiversity emphasis	Mature and old-seral stage		Old-seral stage			Minimum age (years)
			Minimum retention area (%)	Minimum age (years)	Minimum retention area(%)			
					Now	71 years	141 years	
ESSFwm	2	Low	14	120	3	6	9	250
ESSFwm	2	Medium	28	120	9	9	9	250
ESSFwm	2	High	42	120	13	13	13	250
ESSFdk	3	Low	14	120	4.7	9.3	14	140
ESSFdk	3	Medium	23	120	14	14	14	140
ESSFdk	3	High	34	120	21	21	21	140
ICHmw2	2	Low	15	100	3	6	9	250
ICHmw2	2	Medium	31	100	9	9	9	250
ICHmw2	2	High	46	100	13	13	13	250
ICHmk1	3	Low	14	100	4.7	9.3	14	140
ICHmk1	3	Medium	23	100	14	14	14	140
ICHmk1	3	High	34	100	21	21	21	140
MSdk	3	Low	14	100	4.7	9.3	14	140
MSdk	3	Medium	26	100	14	14	14	140
MSdk	3	High	39	100	21	21	21	140
IDFdm2	4	Low	17	100	4.3	8.7	13	250
IDFdm2	4	Medium	34	100	13	13	13	250
IDFdm2	4	High	51	100	19	19	19	250
PPdh2	4	Low	17	100	4.3	8.7	13	250
PPdh2	4	Medium	34	100	13	13	13	250
PPdh2	4	High	51	100	19	19	19	250

As specified in the aforementioned letter, early-seral requirements were not applied. Furthermore, old-forest requirements for low emphasis landscape-level biodiversity were designed to be met by the end of three rotations of 70 years each, with one-third of the percentage required over the first 70 years, two-thirds of the requirements applied from 71 – 141 years from the present, and the full requirement applied from 141 years onward. The full requirement is applied at the beginning of the third rotation to ensure that it will be fully achieved by the end of that rotation.

A.4 Forest Management Assumptions

Table A-21. Calculation of low-emphasis biodiversity option older forest cover requirements

Time (years)	Old-seral cover requirements, low emphasis
0	Guidebook % * 0.33
70	Guidebook % * 0.66
140 +	Guidebook % * 1.0

For example, to calculate the older forest cover requirements applied over time to the low-biodiversity emphasis ESSFwm portions of the Cranbrook Forest District, the following calculation was used:

Time 0: old forest % = $9\% * 0.33 = 2.97$

Time 70: old forest % = $9\% * 0.67 = 6.03$

Time 140: old forest % = $9\% * 1.00 = 9.00$

Thus, in the analysis, the old-forest requirements increase over time. However, it is important to note that this increase in older forest cover requirements only applies to low-emphasis biodiversity areas. In the absence of designated landscape units, each landscape unit proposed for the Cranbrook TSA was modelled as if 45% of the area has a low-biodiversity emphasis, 45% a medium-biodiversity emphasis, and 10% a high-biodiversity emphasis. Thus, the low-emphasis biodiversity requirements for each NDT and biogeoclimatic zone variant determined according to the above calculation were weighted according to the 45%-45%-10% distribution by emphasis as follows:

Older forest requirement = $(0.45 * \text{low emphasis older forest requirement})$
 $+ (0.45 * \text{medium emphasis requirement}) + (0.10 * \text{high emphasis requirement})$

For example, over time, the old-forest cover requirements for ESSFwm would be calculated as follows:

Time 0: old forest % = $(9\% * 0.45) * 0.33$
 $+ 9\% * 0.45$
 $+ 13\% * 0.10$
 6.69%

Time 70: old forest % = $(9\% * 0.45) * 0.67$
 $+ 9\% * 0.45$
 $+ 13\% * 0.10$
 8.06%

Time 140: old forest % = $(9\% * 0.45) * 1.00$
 $+ 9\% * 0.45$
 $+ 13\% * 0.10$
 9.40%

A.4 Forest Management Assumptions

The following table outlines the resulting forest cover requirements applied in the analysis to account for landscape-level biodiversity.

Table A-22. Forest cover requirements applied for landscape-level biodiversity

Biogeoclimatic unit	NDT	Mature and old-seral stage		Old-seral stage			
		Minimum retention area (%)	Minimum age (years)	Minimum retention area (%)			Minimum age (years)
				Now	71 years	141 years	
ESSFdk	3	20.1	120	10.5	12.6	14.7	140
ESSFwm	2	23.1	120	6.7	8.0	9.4	250
ICH-mk1	3	20.1	100	10.5	12.6	14.7	140
ICH-mw2/(1)	2	25.3	100	6.7	8.0	9.4	250
IDF-dm2	4	28.1	100	9.7	11.6	13.6	250
MS—dk	3	21.9	100	10.5	12.6	14.7	140
PP-dh2	4	28.1	100	9.7	11.6	13.6	250

A.4 Forest Management Assumptions

Stand-level biodiversity

Both wildlife trees (WTs) and wildlife tree patches (WTPs) are used to provide structure to retain stand-level biodiversity, as described in the FPC *Biodiversity Guidebook*. Current management direction is based on Table 20a of the guidebook. Recognizing the contribution of forest outside the timber harvesting land base (e.g., riparian areas, non-merchantable stand types) to stand-level biodiversity, it is estimated that WTs and WTPs will reduce timber yield from cutblocks by 3.9% in areas not being managed for open forest and open range. In areas being managed for open forest and open range, timber yield from cutblocks was reduced by 32.7% and 18.3% respectively to account for wildlife trees, wildlife tree patches and the timber left standing to meet *KBLUP-IS Guidelines*. To represent retention of WTs and WTPs, timber yield projections for both existing and future stands were reduced by the reduction percentages shown in Table A-23.

Table A-23. *Residual volume retention in cutblocks*

Analysis unit	Description	Residual area in the timber harvesting land base in patches > 2 hectares net of riparian reserves (%)	Residual individual tree volume and patches < 2 hectares in the timber harvesting land base net of riparian reserves (%)	Total timber yield reduction (%)
0298, 0498, 0598, 0698, 0968, 0998	Open forest all species	2.3	30.4	32.7
0999	Open range	0.0	18.3	18.3
All other analysis units	All other analysis units	1.6	2.3	3.9

According to the *Biodiversity Guidebook*, WTPs larger than two hectares could contribute to seral-stage requirements (landscape-level biodiversity). However, in order to reduce the complexity of this analysis, these larger patches were combined with the patches smaller than two hectares thus eliminating their potential contribution to landscape-level biodiversity. This results in landscape-level biodiversity requirements for the base case that are slightly more stringent than the recommended requirements.

A.4 Forest Management Assumptions

A.4.6 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 (endemic losses) are assumed to be 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 captured in yield estimates. Table A-24. summarizes the estimate used in this analysis for unsalvaged losses on the timber harvesting land base of the Cranbrook TSA.

Table A-24. *Unsalvaged losses*

Cause of loss	Unsalvaged loss (m ³ /year)
Mountain pine beetle	43 561
Douglas-fir bark beetle	251
Balsam bark beetle	337
Catastrophic blowdown / snowdown in mature stands	11 748
Non-catastrophic in-block blowdown / snowdown	4 048
Non-catastrophic blowdown / snowdown immediately adjacent to logged stands	3 893
Non-catastrophic blowdown / snowdown immediately adjacent to roads	5 569
Oil, gas and mineral exploration	50
Coal mine spoil failures	50
Wildfires	7 384
Red-belt damage	350
Total	77 241

A.4 Forest Management Assumptions

Information about unsalvaged losses was collected from forest district staff, forest health overview flight maps, Forest Insect Disease Surveys (FIDS), wildfire maps, industry and Small Business Forest Enterprise Program (SBFEP) forest development plan maps and wildfire reports from the protection fire reporting system. As many years of reliable data as possible were used to determine the extent of total losses due to each causal agent. Where possible, the most current performance of the forest licensees and SBFEP in regards to salvaging these losses was then applied against the average historical losses to estimate the future losses to be applied. Local knowledge, estimates and professional judgment from MoF staff are a key part of the estimates of unsalvaged losses. In addition it is recognized that volume projections from VDYP do not likely account for many types of unsalvaged losses (*Measurement of Pest Killed Timber*; Henningman, 1997). Future forest composition and age class distribution and improved future access were considered when developing estimates.

A.4.7 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 Cranbrook TSA. Table A-25. outlines the regeneration regime for each analysis unit, and specifies the expected regeneration delay following harvesting, based on immature plantation history (ISIS), Nelson Forest Region free-growing stocking standards, and the knowledge of silviculture staff in the forest region and district.

A.4 Forest Management Assumptions

Table A-25. Regeneration assumptions for existing natural stands

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs		Method		Species		Density	
				1	2	Type	%	Code	%	Initial	Target
0111	PI, S, B, F	21.0	3	15	7	Plant	60	PI	83	4500	1600
0121		16.8						S	7		
0131		12.6						B	7		
0112		20.7						F	3		
0122		16.6									
0132		13.2									
0111	PI, S, B, F	21.0	2	15	7	Natural	40	PI	83	4500	1600
0121		16.8						S	7		
0131		12.6						B	7		
0112		20.7						F	3		
0122		16.6									
0132		13.2									
0211	PI, S, B, F	20.8	3	15	7	Plant	47	PI	83	4822	1600
0221		16.7						S	7		
0231		12.6						B	7		
0212		20.9						F	3		
0222		16.6									
0232		13.2									
0211	PI, S, B, F	20.8	2	15	7	Natural	53	PI	83	4822	1600
0221		16.7						S	7		
0231		12.6						B	7		
0212		20.9						F	3		
0222		16.6									
0232		13.2									
0298	Open forest with PI leading	15.4	-50	15	7	Natural	100	PI	50	4910	250
								F	30		
								L	10		
								Py	10		
0311	S, B, PI, L	21.8	3	15	7	Plant	80	S	50	4983	1200
0321		16.2						B	20		
0331		11.4						PI	17		
0361		14.9						L	13		
0312		21.3									
0322		16.1									
0332		11.6									
0362		15.2									
0311	S, B, PI, L	21.8	2	15	7	Natural	20	S	50	4983	1200
0321		16.2						B	20		
0331		11.4						PI	17		
0312		21.3						L	13		
0322		16.1									
0332		11.6									

continued

A.4 Forest Management Assumptions

Table A-25. Regeneration assumptions for existing natural stands

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs		Method		Species		Density	
				1	2	Type	%	Code	%	Initial	Target
0411	PI, F, L, S	20.9	3	15	7	Plant	50	PI	40	4383	1500
0421		16.7						F	30		
0431		12.5						L	20		
0461		15.7						S	10		
0412		20.3									
0422		16.7									
0432		12.4									
0411	PI, F, L, S	20.9	2	15	7	Natural	50	PI	40	4383	1500
0421		16.7						F	30		
0431		12.5						L	20		
0412		20.3						S	10		
0422		16.7									
0432		12.4									
0511	F, PI, L	20.8	3	15	7	Plant	40	F	57	4910	1200
0521		16.4						PI	40		
0531		12.5						L	3		
0561		15.4									
0512		21.7									
0522		16.1									
0532	F, PI, L	13.5	3	15	7	Plant	60	F	57	4910	1200
0511		20.8						PI	40		
0521		16.4						L	3		
0531		12.5									
0512		21.7									
0522		16.1									
0532	Open forest with fir leading	13.5	-50	15	7	Natural	100	F	70	4910	250
0511		20.8									
0521		16.4									
0531		12.5									
0512		21.7									
0522		16.1									
0532	Open forest with Py, Py&F or F&Py	13.5	-50	15	7	Natural	100	Py	10	4910	250
0511		20.8									
0521		16.4									
0531		12.5									
0512		21.7									
0522		16.1									
0620	F, PI, Py	18.2		15	7	Plant	20	F	50	4079	1200
0630		12.3						PI	40		
0620	F, PI, Py	18.2		15	7	Natural	80	Py	10	4079	1200
0630		12.3						F	50		
0620	F, PI, Py	18.2		15	7	Natural	80	PI	40	4079	1200
0630		12.3						Py	10		
0698	Open forest with Py, Py&F or F&Py	15.1	-50	15	7	Natural	100	Py	50	4910	250
								F	40		
								PI	10		

continued

A.4 Forest Management Assumptions

Table A-25. Regeneration assumptions for existing natural stands (concluded)

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs		Method		Species		Density	
				1	2	Type	%	Code	%	Initial	Target
0720	S, L, H, C	15.1	3	15	7	Plant	60	S L H C	60 20 10 10	2742	1400
0720	S, L, H, C	15.1	2	15	7	Plant	40	S L H C	60 20 10 10	2742	1400
0823	PI, S, B	15.8	3	15	7	Plant	80	PI	45	5256	1400
0824		15.5						S	40		
0833		12.6						B	15		
0834		10.8									
0823	PI, S, B	15.8	2	15	7	Natural	20	PI	45	5256	1400
0824		15.5						S	40		
0833		12.6						B	15		
0834		10.8									
0986	Backlog NSR < 420 stems/ha	13.6	9	15	7	Plant	100	PI	50	210	1000
								S	50		
0987	Backlog NSR > 420 stems/ha	15.8	9	15	7	Plant	100	PI	50	560	1000
								S	50		
0998	Open forest with leading species other than PI, F, L, Py or deciduous	16.4	-50	15	7	Natural	100	F	70	4910	250
								L	10		
								PI	10		
0999	FMER open range	11.9	N/A	N/A	N/A	N/A	N/A	Py	10	2455	20
								F	70		
								Py L	20 10		

A.4 Forest Management Assumptions

Regeneration delay is the average time between the completion of harvesting and the time need to establish at least the minimum required well spaced stems per hectare, less the age of the stock that will form next stand. Planting stock on average is assumed to be one year old and this age is factored into the regeneration delay.

The following operational adjustment factor (OAF) values are assigned:

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 7% (an increasing reduction, to represent losses such as disease and decay that increase with age).

Table A-26. identifies stands of existing immature forest where stand management has occurred. These stands were assigned to managed stand yield curves at the beginning of the planning horizon. Table A-27. identifies the regeneration assumptions for these stands.

Table A-26. *Immature plantation history*

Analysis unit	Species description	Age	Per cent (%) of area managed — first rotation
0161, 0162	PI (pure)	≤ 30	30
0261, 0262	PI (leading)	≤ 30	50

A.4 Forest Management Assumptions

Table A-27. *Regeneration assumptions for managed stands less than 31 years old*

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs		Method		Species		Density	
				1	2	Type	%	Code	%	Initial	Target
0161 0162	PI, S, B, F	15.7 16.0	3	15	7	Plant	60	PI S B F	83 7 7 3	4500	1600
0161 0162	PI, S, B, F	15.7 16.0	2	15	7	Natural	40	PI S B F	83 7 7 3	4500	1600
0261 0262	PI, L, Py, F	15.7 15.9	3	15	7	Plant	47	PI S B F	83 7 7 3	4822	1600
0261 0262	PI, L, Py, F	15.7 15.9	2	15	7	Natural	53	PI S B F	83 7 7 3	4822	1600

A.4 Forest Management Assumptions

A.4.8 Not satisfactorily restocked (NSR) areas

Land coded as not satisfactory restocked (TYPID_PRJ = 4 or 9) in the inventory file is included in the timber harvesting land base. A total of 29 542.7 hectares of timber harvesting land base is coded as not satisfactorily restocked (NSR). Not satisfactorily restocked (NSR) areas consist of current NSR and backlog NSR. Current NSR refers to areas that were logged or disturbed after October 1, 1987 and for which there are legal reforestation obligations. Current NSR areas are accounted for in regeneration delay assumptions. Backlog NSR refers to areas that were logged or disturbed before October 1, 1987, and for which there are no legally required reforestation obligations. Operable backlog NSR areas (2690 hectares) were put into separate analysis units having volume curves reflecting low stocking levels. The ISIS database was used to identify the amount and stocking levels of the backlog NSR area, as indicated in Table A-28.

Table A-28. *Not satisfactorily restocked (NSR) areas*

Analysis unit	Stocking level	Total backlog database (hectares)	Inoperable backlog NSR (hectares)	Restocked in 1-9 years from now (hectares)
0986	< 420	3 455	1 727	1 728
0987	420 sph and < 700 sph	1 925	963	962
Total		5 380	2 690	2 690

A.4.9 Rehabilitation of problem forest types, and non-commercial cover areas

Rehabilitation of non-commercial cover occurs on a very small portion of the Cranbrook TSA land base. Due to the small area treated, these activities are not included in the analysis.

A.5 Volume Estimates for Existing Natural Stands

The variable density yield prediction (VDYP) model, version 6.5a 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-29. shows the volume estimates by analysis unit for existing natural stands.

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number					
	0111	0112	0121	0122	0131	0132
	PL(pure) – 1	PL(pure) – 1s	PL(pure) – 2	PL(pure) – 2s	PL(pure) – 3	PL(pure) – 3s
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	40	39	6	5	0	0
40	101	101	50	48	6	7
50	155	155	94	92	33	41
60	201	202	133	131	64	73
70	241	242	169	167	92	102
80	276	278	200	198	118	129
90	310	311	230	228	143	155
100	340	342	258	256	167	179
110	369	371	284	282	189	201
120	395	397	308	306	210	223
130	420	422	331	329	230	243
140	436	438	346	344	244	257
150	448	450	357	355	255	268
160	456	458	365	363	263	276
170	460	462	370	368	268	281
180	460	463	371	369	270	283
190	457	459	369	367	269	282
200	459	461	371	369	271	284
210	461	463	373	371	274	287
220	464	466	376	374	277	290
230	466	469	378	377	279	292
240	469	471	381	379	282	295
250	471	474	383	381	284	297
260	474	476	385	383	286	299
270	476	478	387	385	288	301
280	478	480	389	387	289	302
290	480	482	390	389	291	304
300	482	484	392	390	292	305
310	484	486	393	392	293	306
320	485	487	395	393	294	307
330	487	488	396	394	295	308
340	488	489	396	395	296	309
350	489	490	397	395	296	309

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number						
	0211	0212	0221	0222	0231	0232	0298
	PL,PA – 1	PL,PA – 1s	PL,PA – 2	PL,PA – 2s	PL,PA – 3	PL,PA – 3s	PL – OF
10	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0
30	36	38	6	6	1	1	1
40	90	93	44	43	6	8	28
50	137	141	82	82	30	38	62
60	178	182	117	116	57	67	94
70	213	218	147	147	82	93	122
80	244	249	175	174	104	117	147
90	273	277	200	200	125	139	171
100	299	303	224	223	145	159	193
110	323	326	245	244	163	178	214
120	345	348	265	264	180	196	233
130	365	368	284	283	197	213	251
140	380	383	298	296	209	225	264
150	390	393	308	306	218	235	273
160	397	400	315	313	225	242	280
170	400	403	318	317	229	246	285
180	401	405	320	319	231	249	287
190	399	404	319	319	232	250	287
200	401	406	321	321	235	252	289
210	403	408	324	324	238	255	292
220	406	411	326	326	240	258	294
230	408	413	328	329	243	261	297
240	410	416	330	331	245	263	299
250	413	418	333	333	247	266	302
260	414	420	334	335	249	267	303
270	416	421	336	336	250	269	305
280	417	423	337	338	252	270	306
290	419	424	338	339	253	271	307
300	420	426	340	340	254	272	308
310	421	427	341	341	255	273	309
320	423	428	342	342	256	274	310
330	424	429	342	343	257	275	311
340	424	430	343	344	257	276	311
350	425	431	344	344	258	276	312

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number					
	0311	0312	0321	0322	0331	0332
	S,B,PW,	S,B,PW	S,B,PW,	S,B,PW,	S,B,PW,	S,B,PW,
	FD&S – 1	FD&S – 1s	FD&S – 2	FD&S – 2s	FD&S – 3	FD&S – 3s
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	2	3	1	1	0	0
40	36	33	11	12	1	1
50	98	93	39	44	7	8
60	154	147	82	84	20	25
70	203	195	122	123	44	51
80	246	236	159	158	70	78
90	282	271	191	188	95	103
100	314	301	219	215	119	127
110	341	327	245	239	140	149
120	364	349	268	261	160	168
130	386	369	290	282	180	188
140	404	387	310	301	198	206
150	419	402	327	317	214	223
160	431	415	342	332	229	238
170	441	425	355	345	242	252
180	450	435	367	357	254	264
190	457	443	377	369	266	276
200	465	450	387	379	276	287
210	471	458	397	389	286	298
220	478	464	406	398	296	308
230	483	470	414	407	305	317
240	488	476	422	415	313	326
250	493	481	429	423	321	335
260	495	483	432	425	325	338
270	497	485	435	427	328	341
280	499	487	437	429	331	344
290	500	488	439	431	334	347
300	501	490	441	433	336	349
310	503	491	443	434	338	351
320	504	492	445	435	340	353
330	504	493	446	436	342	355
340	505	493	447	437	344	357
350	506	494	448	438	346	358

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number						
	0411	0412	0421	0422	0431	0432	0498
	L – 1	L – 1s	L – 2	L – 2s	L – 3	L – 3s	L – OF
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	5	3	0	0	0	0	0
40	34	31	8	8	0	0	1
50	70	66	32	31	2	2	16
60	108	102	61	60	15	13	39
70	146	139	91	90	35	33	64
80	182	175	121	120	57	54	89
90	218	210	151	149	80	77	114
100	252	243	180	178	102	99	139
110	285	274	207	205	123	120	162
120	314	304	233	230	143	141	184
130	342	331	257	254	162	160	205
140	364	354	278	275	180	177	223
150	378	367	291	288	191	189	235
160	387	376	299	296	198	196	242
170	391	380	303	300	203	200	246
180	392	382	305	302	205	202	248
190	392	382	306	303	206	204	249
200	394	384	307	304	208	205	251
210	395	386	309	306	209	207	253
220	397	387	311	308	211	208	254
230	398	388	312	309	212	210	255
240	399	390	313	310	213	211	257
250	400	391	314	311	214	212	258
260	401	391	314	311	214	212	258
270	401	392	315	312	214	212	258
280	401	392	315	312	214	212	258
290	402	392	315	312	214	212	258
300	402	392	315	312	214	212	258
310	402	393	315	312	214	212	258
320	403	393	315	312	214	212	258
330	403	393	315	312	214	211	258
340	403	393	315	312	214	211	258
350	403	393	315	312	214	211	257

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number						
	0511	0512	0521	0522	0531	0532	0598
	FD – 1	FD – 1s	FD – 2	FD – 2s	FD – 3	FD – 3s	FD – OF
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	6	11	0	0	0	0	0
40	43	54	12	10	0	0	4
50	81	98	37	37	5	9	20
60	119	141	63	65	18	30	41
70	156	183	89	92	35	50	63
80	192	222	115	119	51	70	84
90	226	259	140	145	67	89	104
100	259	293	163	170	83	108	124
110	289	324	186	195	99	126	143
120	315	350	207	216	113	143	161
130	338	375	227	236	126	158	177
140	358	396	244	254	138	172	192
150	375	413	258	268	148	184	204
160	389	428	270	280	157	194	215
170	401	440	279	290	164	203	224
180	412	450	287	299	171	211	232
190	422	460	295	307	177	218	240
200	431	470	303	316	183	226	248
210	440	479	310	324	189	233	256
220	449	488	317	331	195	240	263
230	457	496	323	338	200	247	269
240	465	504	330	345	206	254	276
250	473	512	335	352	211	260	282
260	473	512	336	352	211	260	282
270	473	512	336	352	211	260	282
280	473	512	336	353	211	261	282
290	473	512	337	353	211	261	283
300	474	512	337	353	211	261	283
310	474	512	337	353	211	261	283
320	474	512	337	353	212	261	283
330	474	511	337	353	212	261	283
340	473	511	337	353	212	261	283
350	473	510	337	353	212	261	283

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare)

Age	Volume table number and analysis unit number					
	0620	0630	0698	0720	0998	0999
	PY,PY&FD,	PY,PY&FD,	PY,PY&FD,	CW,H,FD&CW,	CW,H,B,S	FMER
	FD&PY – 2	FD&PY – 3	FD&PY – OF	FD&H – 2	PW – OF	Open range
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	2	0	0	1	0	0
40	21	0	7	15	4	1
50	49	5	25	42	27	6
60	77	18	46	78	61	18
70	105	33	67	115	96	34
80	132	47	87	149	128	49
90	157	61	106	178	157	64
100	181	75	125	205	183	79
110	204	88	142	229	206	92
120	223	99	157	250	227	105
130	241	110	171	272	246	116
140	257	120	183	292	262	127
150	271	128	194	310	276	136
160	284	136	204	326	287	143
170	294	143	212	340	296	150
180	304	149	220	353	305	156
190	312	155	227	365	312	162
200	320	160	234	377	319	167
210	328	166	240	388	326	172
220	335	170	246	400	332	177
230	341	175	251	411	337	181
240	347	179	255	422	342	185
250	352	183	260	432	347	189
260	353	183	260	434	349	190
270	354	183	261	436	351	190
280	354	184	261	438	353	190
290	355	184	262	440	355	191
300	355	184	262	442	356	191
310	356	184	262	443	357	191
320	356	184	262	444	358	191
330	356	184	262	446	359	191
340	356	184	262	447	360	191
350	356	184	262	448	361	191

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-29. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

Age	Volume table number and analysis unit number					
	0823	0824	0833	0834	0002	0003
	PL,PA – 2e	Not PL, PA – 2e	PL,PA – 3e	Not PL, PA – 3e	Not timber harvesting land base, non-productive	Not timber harvesting land base, productive
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	5	1	1	0	0	0
40	40	16	7	1	0	2
50	82	46	35	8	0	10
60	119	84	66	20	3	36
70	152	123	94	40	18	60
80	182	156	119	63	49	82
90	209	184	143	87	78	103
100	234	210	165	110	106	121
110	258	232	185	131	134	139
120	279	252	204	150	160	155
130	300	274	223	169	185	171
140	315	294	236	187	207	183
150	326	311	246	204	226	193
160	334	328	254	219	242	201
170	339	343	260	233	255	206
180	341	356	262	246	267	210
190	340	369	263	258	278	212
200	342	381	266	270	288	216
210	345	393	269	280	298	220
220	348	404	272	291	307	223
230	351	414	275	301	316	227
240	354	424	278	310	324	230
250	356	433	280	319	331	233
260	358	436	282	322	335	234
270	360	438	284	325	338	236
280	362	440	286	328	341	237
290	363	442	287	331	344	238
300	365	444	289	334	346	239
310	366	445	290	336	349	239
320	367	447	291	339	351	239
330	368	448	291	341	353	239
340	369	449	292	343	355	239
350	369	451	293	344	356	239

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (WindowsTM 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 stands less than 30 years old and for future managed stands. The area-weighted site index for each analysis unit along with the regeneration assumptions in Table A-4. were used as inputs to TIPSY. Table A-26. in Section A.4.7, "Basic silviculture and regeneration assumptions" documents which stands were assumed to be managed in the analysis.

Table A-30. displays the volume tables for existing managed stands. These volume tables are generated from TIPSY for ages where TIPSY data exists, and estimated for ages beyond the TIPSY data set. Volumes are assumed to remain constant after 300 years of age. Table A-31. displays the volume tables for future managed stands.

These volume tables are based on the information displayed in Table A-4., including site index, operational adjustment factors, regeneration method and establishment density.

A.6 Volume Estimates for Regenerated Stands

Table A-30. Timber volume tables for existing managed stands (cubic metres/hectare)

Age	Volume table number and analysis unit number					
	0161	0162	0261	0262	0986	0987
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	10	0	11	13	0	1
40	45	0	48	50	2	12
50	97	12	101	104	10	38
60	142	49	142	145	26	72
70	181	103	177	181	44	109
80	222	149	214	219	64	146
90	255	189	244	249	84	179
100	281	232	268	272	104	212
110	303	263	288	292	123	239
120	320	290	305	309	144	262
130	334	311	320	324	162	282
140	344	328	331	335	177	298
150	353	341	341	345	190	312
160	361	351	350	353	201	324
170	367	360	358	362	211	336
180	373	368	365	367	219	345
190	375	375	368	370	228	354
200	377	378	371	374	234	362
210	379	381	374	376	240	369
220	380	383	376	379	246	374
230	381	385	378	382	251	378
240	382	386	380	384	256	381
250	382	387	382	385	260	384
260	383	388	383	384	264	387
270	381	388	382	382	268	387
280	377	386	379	380	270	386
290	374	383	377	379	271	385
300	373	381	376	378	271	385
310	373	379	376	378	271	385
320	373	378	376	378	271	385
330	373	378	376	378	271	385
340	373	378	376	378	271	385
350	373	378	376	378	271	385

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)						
	1211 (0211)	1212 (0212)	1221 (0221)	1222 (0222)	1231 (0231)	1232 (0232)	1298 (0298)
10	0	0	0	0	0	0	0
20	4	4	0	0	0	0	0
30	65	67	23	22	2	3	2
40	144	146	69	68	18	24	14
50	212	215	124	122	45	52	32
60	273	276	166	164	79	90	51
70	320	323	208	205	111	121	69
80	358	361	246	244	136	148	89
90	390	392	275	272	158	170	109
100	413	416	299	296	176	191	127
110	433	436	320	317	197	213	143
120	449	452	338	335	216	233	159
130	463	466	352	349	232	247	174
140	468	466	364	361	244	259	188
150	468	466	376	373	255	270	201
160	468	466	384	381	264	279	211
170	468	466	390	387	272	286	221
180	468	466	395	392	278	293	231
190	468	466	400	397	284	300	240
200	468	466	404	402	289	305	247
210	468	466	408	405	294	310	253
220	468	466	408	407	298	313	259
230	468	466	409	407	302	314	265
240	468	466	409	407	305	316	269
250	468	466	410	407	305	318	274
260	468	466	410	407	306	319	277
270	468	466	410	407	306	320	280
280	468	466	411	407	307	321	283
290	468	466	411	408	307	322	285
300	468	466	411	408	307	323	286
310	468	466	411	408	307	323	286
320	468	466	411	408	307	323	286
330	468	466	411	408	307	323	286
340	468	466	411	408	307	323	286
350	468	466	411	408	307	323	286

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)					
	1311 (0311)	1312 (0312)	1321 (0312)	1322 (0322)	1331 (0331)	1332 (0332)
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	15	12	1	1	0	0
40	85	76	11	11	1	1
50	178	167	54	52	5	5
60	262	247	113	110	18	21
70	339	324	173	170	48	51
80	394	382	226	223	85	90
90	435	423	276	272	123	129
100	468	456	320	317	160	166
110	494	483	354	352	192	199
120	494	504	381	378	222	229
130	494	504	401	399	253	260
140	494	504	419	417	281	288
150	494	504	434	431	302	309
160	494	504	447	445	322	327
170	494	504	456	454	336	342
180	494	504	464	462	349	355
190	494	504	472	469	360	365
200	494	504	474	473	369	374
210	494	504	475	474	376	381
220	494	504	476	475	384	388
230	494	504	476	475	389	394
240	494	504	475	474	394	399
250	494	504	472	472	399	402
260	494	504	470	469	400	404
270	494	504	468	467	402	406
280	494	504	466	465	404	408
290	494	504	463	462	406	410
300	494	504	462	461	406	411
310	494	504	462	461	406	411
320	494	504	462	461	406	411
330	494	504	462	461	406	411
340	494	504	462	461	406	411
350	494	504	462	461	406	411

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)						
	1411 (0411)	1412 (0412)	1421 (0421)	1422 (0422)	1431 (0431)	1432 (0432)	1498 (0498)
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	16	12	2	2	0	0	0
40	65	56	17	17	2	2	3
50	133	119	51	51	8	8	16
60	204	188	94	94	21	21	37
70	262	245	140	140	43	43	57
80	313	294	185	185	67	67	79
90	354	336	222	222	92	92	100
100	390	371	253	253	115	115	119
110	421	401	281	281	139	139	139
120	446	427	306	306	162	162	157
130	467	447	325	325	182	182	176
140	467	465	343	343	198	198	193
150	467	481	359	359	212	212	209
160	467	481	372	372	224	224	222
170	467	481	384	384	235	235	236
180	467	481	394	394	244	244	249
190	467	481	403	403	252	252	260
200	467	481	410	410	260	260	270
210	467	481	416	416	267	267	279
220	467	481	419	419	273	273	288
230	467	481	423	423	279	279	295
240	467	481	426	426	284	284	303
250	467	481	429	429	286	286	307
260	467	481	430	430	289	289	312
270	467	481	432	432	291	291	316
280	467	481	434	434	293	293	320
290	467	481	435	435	295	295	323
300	467	481	432	436	296	296	326
310	467	481	432	436	296	296	326
320	467	481	432	436	296	296	326
330	467	481	432	436	296	296	326
340	467	481	432	436	296	296	326
350	467	481	432	436	296	296	326

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)						
	1511 (0511)	1512 (0512)	1521 (0521)	1522 (0522)	1531 (0531)	1532 (0532)	1598 (0598)
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	21	28	2	2	0	0	0
40	74	88	19	16	1	3	1
50	142	164	53	49	9	15	12
60	207	232	93	86	23	39	32
70	263	292	136	127	45	65	51
80	315	344	176	168	68	91	69
90	358	390	209	200	90	116	90
100	397	431	238	228	110	143	108
110	431	465	266	254	132	167	126
120	459	465	290	278	152	186	143
130	459	465	310	299	169	203	159
140	459	465	328	316	183	217	176
150	459	465	345	332	195	230	191
160	459	465	359	347	206	243	204
170	459	465	372	360	216	255	216
180	459	465	383	371	224	265	227
190	459	465	394	381	233	274	238
200	459	465	402	390	240	281	248
210	459	465	409	397	247	287	257
220	459	465	414	403	254	293	265
230	459	465	419	407	260	298	272
240	459	465	423	411	263	303	278
250	459	465	426	414	266	307	284
260	459	465	430	417	269	311	290
270	459	465	433	419	272	315	295
280	459	465	436	422	274	319	298
290	459	465	439	424	277	320	301
300	459	465	440	426	278	321	303
310	459	465	440	426	278	321	303
320	459	465	440	426	278	321	303
330	459	465	440	426	278	321	303
340	459	465	440	426	278	321	303
350	459	465	440	426	278	321	303

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)					
	1620 (0620)	1630 (0630)	1698 (0698)	1720 (0720)	1998 (0998)	1999 (0999)
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	6	0	0	0	0	0
40	37	1	2	1	5	1
50	84	7	14	13	24	6
60	138	18	35	56	47	18
70	189	40	55	111	70	34
80	231	62	75	166	95	49
90	269	83	96	215	118	64
100	305	103	115	260	141	79
110	334	123	133	301	164	92
120	360	142	151	335	187	105
130	384	160	169	361	207	116
140	404	174	187	384	225	127
150	422	186	201	403	243	136
160	436	197	215	420	260	143
170	448	207	227	434	275	150
180	460	216	240	446	288	156
190	471	224	251	456	300	162
200	471	231	262	463	312	167
210	471	238	270	469	320	172
220	471	244	278	476	328	177
230	471	250	286	480	335	181
240	471	255	293	482	342	185
250	471	259	299	484	348	189
260	471	261	303	485	353	190
270	471	263	307	487	358	190
280	471	265	311	488	362	190
290	471	267	314	487	366	191
300	471	269	317	486	370	191
310	471	269	317	486	370	191
320	471	269	317	486	370	191
330	471	269	317	486	370	191
340	471	269	317	486	370	191
350	471	269	317	486	370	191

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare)

Age	Volume table number (present analysis unit number)				
	1823 (0823)	1824 (0824)	1833 (0833)	1834 (0834)	1860 (0860)
10	0	0	0	0	0
20	0	0	0	0	0
30	3	2	0	0	1
40	20	18	4	1	11
50	66	61	17	6	42
60	122	114	50	19	83
70	179	171	90	47	129
80	230	221	131	80	173
90	273	263	170	114	214
100	314	305	206	147	251
110	345	336	239	176	283
120	368	360	269	203	310
130	386	379	296	230	331
140	401	394	317	256	349
150	413	407	333	277	363
160	423	417	346	294	375
170	431	425	358	308	385
180	437	431	367	320	394
190	442	436	375	330	401
200	446	440	381	338	405
210	447	443	385	344	410
220	447	443	390	349	414
230	445	443	393	355	414
240	445	441	396	359	414
250	443	440	398	362	415
260	440	437	400	365	415
270	437	434	401	368	415
280	434	431	401	369	414
290	431	428	400	369	410
300	430	427	399	369	410
310	430	427	399	369	410
320	430	427	399	369	410
330	430	427	399	369	410
340	430	427	399	369	410
350	430	427	399	369	410

continued

A.6 Volume Estimates for Regenerated Stands

Table A-31. Timber volume tables for future managed stands (cubic metres/hectare) (concluded)

Age	Volume table number (present analysis unit number)				
	1361 (0361)	1362 (0362)	1461 (0461)	1561 (0561)	1968 (0968)
10	0	0	0	0	0
20	0	0	0	0	0
30	1	1	1	1	0
40	7	7	13	12	14
50	33	37	44	39	42
60	83	89	83	72	70
70	138	145	126	107	97
80	189	196	170	145	122
90	234	242	206	178	145
100	279	287	237	206	167
110	316	324	264	230	188
120	346	353	289	252	207
130	370	376	309	272	225
140	388	394	327	290	240
150	403	410	342	304	251
160	417	422	355	318	260
170	428	434	366	331	266
180	438	443	377	342	271
190	445	450	385	352	275
200	451	456	393	360	280
210	457	462	399	367	285
220	460	462	403	373	290
230	459	463	407	379	294
240	460	463	411	384	299
250	460	463	414	388	303
260	460	462	415	391	304
270	459	459	417	393	305
280	455	455	418	394	306
290	451	452	418	395	306
300	450	452	419	396	307
310	450	452	419	396	308
320	450	452	419	396	308
330	450	452	419	396	309
340	450	452	419	396	309
350	450	452	419	396	309

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

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

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

B.2 Economic Impact Analysis Methodology

Data sources

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

Person-year of employment

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

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

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

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

Employment — harvesting

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

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

Two estimates of direct employment in harvesting were calculated:

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

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

B.2 Economic Impact Analysis Methodology

Employment — silviculture

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

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

Employment — timber processing

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

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

Indirect and induced employment estimates

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

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

B.2 Economic Impact Analysis Methodology

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

Table B-1. *Employment multipliers — Cranbrook TSA*

Forest sub-sector	Cranbrook TSA migration multiplier	Cranbrook TSA no-migration multiplier	Provincial (Interior) migration multiplier	Provincial (Interior) no-migration multiplier
Harvesting	1.51	1.35	2.14	1.80
Solid wood processing	1.56	1.36	2.29	1.93
Plywood	1.56	1.36	1.93	1.64
Pulp	2.00	1.73	3.02	2.48

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

Ministry of Finance and Corporate Relations. *A Provincial Impact Estimation Procedure for the British Columbia Forest Sector*. 1996.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forest sector workers in 1998 were:

\$45,550 for those working in logging and forestry services;

\$44,915 for those working in solid wood manufacturing; and

\$52,250 for those working in pulp and paper mills

and approximately \$34,075 for those in indirect and induced occupations. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

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

B.2 Economic Impact Analysis Methodology

Provincial government revenues

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

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

Sources of revenue	Annual average revenue (1998 millions)	Revenue per '000s m ³ (\$ per '000s m ³)
Stumpage and related payments ^a	15.04	16,045
Forest industry taxes ^a	8.12	8,664
Employee income tax ^c	6.01	6,336
Total	29.17	31,045

Note: Based on 1996–1998 average annual harvest of 937 547 cubic metres.

Sources:

(a) Ministry of Forests, Revenue Branch.

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

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