

**Kalum
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. (The first two documents are the information report and the data package.) 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 (BCFS) has examined the availability of timber in the Kalum 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 Kalum TSA consists a total of about 540 000 hectares of land within the Skeena, Kitimat, Kitsumkalum, and Nass River drainages. About 98 000 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 hemlock tree species, although there are also significant areas dominated by balsam, cedar, spruce, pine and cottonwood species. There are also smaller areas where the leading species are larch, aspen and birch. Hemlock, spruce, and balsam are the tree species most commonly used by the forest industry in the area.

Recently the BCFS reviewed site productivity of coastal western hemlock sites. The results showed that on average, the site productivity of areas currently growing western hemlock over 140 years old in the Coastal Western Hemlock biogeoclimatic zone is significantly underestimated (by 10 meters at 50 years of age, or 74%). Those results were incorporated in the base case.

The results of this timber supply analysis suggest that the current harvest level of 464 000 cubic metres per year in the Kalum TSA can be maintained for another three decades, followed by a decline over two decades to 387 000 cubic metres per year. Timber supply remains at this level for another eight decades, until rising to the long-term harvest level of 431 500 cubic meters per year in decade 12.

The above results 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 showed that these uncertainties can affect timber supply to varying degrees.

These sensitivity analyses suggest that within the range of uncertainty examined in this analysis, short-term timber supply (over the next 20 years) in the Kalum TSA is stable. Uncertainty generally affected the timing of the transition to the long-term harvest level which begins from 10 to 50 years from now depending on the variables examined, and in some cases affected the long-term harvest level.

Uncertainty about site productivity, timber volumes in existing stands, timber volumes in regenerated stands, and the size of the timber harvesting land base each have a significant effect on projected harvests. Also, large changes in minimum harvestable ages have a significant effect on projected mid-term timber supply.

Uncertainty regarding estimates of site productivity for regenerated stands could significantly change the mid-and long-term timber supply. If old-growth site index (OGSI) adjustments are made to all eligible stands, the long-term harvest level increases to 489 000 metres per year, 13.3% higher than in the base case, and mid-term supply increases substantially. Conversely, if the adjustment overestimate actual stand performance, long-term supplies would drop substantially relative to the base case.

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 only one decade; if existing stand volumes were 10% higher then the initial harvest level could be maintained five decades. The long-term harvest level is virtually unaffected by changes in existing stand volume estimates.

Uncertainty about regenerated stand volume estimates has no impact on the length of time the initial harvest level can be maintained, but has an effect on long-term timber supply approximately proportional to the change in volume estimates.

Executive Summary

Uncertainty in the size of the timber harvesting land base proportionally affects timber supply. If the size of the timber harvesting land base is overestimated by 10%, the initial harvest level projected in the base case can be maintained for only one decade. Conversely, if the size of the timber harvesting land base is underestimated by the same amount, the medium term harvest level of 387 000 cubic meters per year projected in the base case could rise by 12% to 433 000 cubic meters per year. The land base change implied in the Nisga'a Final Agreement requires either earlier harvest level reductions or larger declines further into the future, while the additional land base available for helicopter logging provides the potential for timber supply to rise in the mid- and long-terms.

Assigning minimum harvestable ages based on the age of maximum timber productivity, rather than the mix of volume, tree height and diameter used in the base case, resulted in an average increase in harvested ages of 16 years over the long term. The increase in minimum harvestable ages reduced mid-term timber supply, requiring a decline from the current AAC after only one decade, while increasing the long-term level by 2.8%, due to harvests occurring closer to the age of maximum average growth.

Factors with moderate effects on timber supply include estimates of green-up age, the age at which old-forest characteristics are achieved, and requirements for the management of visually sensitive areas. Even though visually sensitive areas cover a relatively small portion of the timber harvesting land base, the forest cover requirements applied to these areas in the base case frequently limit timber supply throughout the planning horizon. Thus, increasing or decreasing those requirements affects timber availability in the mid-and long term.

Uncertainty about the allowable disturbance in integrated resource management areas, the application of forest cover requirements for landscape-level biodiversity (including early, and mature plus old seral requirements, and the provincial average biodiversity requirement for old seral forests 45% low, 45% intermediate, 10% high

emphasis) all have a small effect on projected harvests. Changes in these factors change the amount of time the initial harvest level can be maintained by one decade at the most, and have slight or no effects on the long-term harvest level.

The socio-economic analysis for the Kalum TSA indicates that the current AAC of 464 000 cubic metres can support a provincial total of approximately 440 person-years of direct forestry employment. Residents of the Kalum TSA account for approximately 80% of this direct employment. Direct forestry activity in the TSA supports a further 460 person-years of indirect and induced employment across the province.

The base case harvest forecast for the next 30 years is 464 000 cubic metres per year. As shown in the timber supply analysis report, by the fourth decade, the harvest level is projected to decline to 423 000 cubic metres per year — 9% less than the current AAC. This level of activity would support a provincial total of 400 person-years of direct employment and a further 420 person-years of indirect and induced employment. By the fifth decade, the harvest level is projected to decline to 387 000 cubic metres and would reduce provincial employment, based on timber harvested in the area, to 365 person-years of direct and 384 person-years of indirect and induced employment.

The current AAC provides the provincial government with average revenues of about \$10 million per year. Under the base case harvest forecast, the projected harvest level reduction in the fourth decade would reduce annual revenues by \$0.9 million. In the fifth decade, annual revenues could decline by a further \$0.8 million to \$8.4 million.

In conclusion, this analysis indicates that using current inventory and growth and yield information, timber harvests in the Kalum TSA can be maintained at the current allowable level for the next 30 years with the reductions forecast for the medium term. 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 for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

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

Timber supply area (TSA)

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

Allowable annual cut (AAC)

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

1 Description of the Kalum Timber Supply Area

The Kalum Timber Supply Area (TSA) lies within the Prince Rupert Forest Region and is administered from the Kalum Forest District office in Terrace. The Kalum TSA comprises a total 539 319 hectares. Major rivers in the area include the Kitimat, Kalum, Lower Nass, and southern Skeena.

Terrace, Thornhill, and Kitimat are the major population centres within the Kalum TSA. Nass Camp is a logging community in the Lower Nass area with a fluctuating population which peaks during the pine mushroom season. Other communities and subdivisions are scattered throughout the Kalum TSA.

Most timber harvested in Kalum is transported to mills in the area. Two large sawmills are situated in Terrace, and a pulp mill is located in Kitimat. Chips from the sawmills are also sent to a pulp mill in Port Edward, near Prince Rupert. A cedar pole mill, a few small custom-cut sawmills that operate periodically, and a cedar shake and shingle mill are located in the Terrace area. A very small portion of harvested timber is shipped to the lower mainland or to mills in adjacent TSAs.

A land and resource management planning (LRMP) process is ongoing in the Kalum TSA. Representatives of the provincial and local governments, aboriginal peoples, and the public are developing a land use and management plan that will account for the diverse values in the area.

The current allowable annual cut for the Kalum TSA is 464 000 cubic meters as determined by the chief forester, effective January 1996. The 1996 determination was a reduction of approximately 3% from the previous level of 480 000 cubic metres.

The TSA includes the Nisga'a Memorial Lava Bed Provincial Park, the Lakelse Lake Provincial

Park, the Exchamsiks River Provincial Park, the Hai Lake Park and the Gitnadoix River Recreation Area.

1.1 The environment

The Kalum TSA has a variety of terrain, ranging from the valley bottoms of the Skeena, Kitimat, Nass, Lakelse and Kitsumkalum Rivers through rolling lower slopes and steep upper slopes, to the alpine meadows of Sleeping Beauty Mountain. Four biogeoclimatic zones occur in the timber supply area.

The Coastal Western Hemlock Zone, considered the most productive forest ecosystem in Canada because of its high rainfall and mild climate, occupies low-to-middle elevations, primarily west of the Coast Mountains. In the Kalum TSA, it dominates the large, wide valley region that extends north from Douglas Channel at Kitimat. Western hemlock is the most abundant tree species; western redcedar, Sitka spruce, red alder and black cottonwood also occur, depending on local conditions and the history of stand disturbance.

The Interior Cedar-Hemlock Zone is located in the Nass River basin and parts of the Skeena mountains, at elevations from 100 to 1,000 metres. This zone is characterized by cool, wet winters and warm, dry summers. While it is similar to the CWH zone, the ICH has significantly lower precipitation. The ICH is also characterized by the highest diversity of tree species of any zone in the province, including western hemlock, western redcedar, yellow cedar, Engelmann spruce, white spruce, various spruce hybrids, subalpine fir, lodgepole pine, trembling aspen and paper birch.

1 Description of the Kalum Timber Supply Area

The Mountain Hemlock Zone, located at middle to high elevations, is characterized by short, cool summers and long, cool winters, with heavy snow cover for several months. Mountain hemlock, amabilis fir (balsam), and yellow cedar are the most common tree species. Forests are not continuous in the Mountain Hemlock Zone, and are largely confined to lower elevations of the zone. At higher elevations, the forest thins out into parkland, with trees in isolated clumps.

The Alpine Tundra Zone is located at higher elevations (i.e., above 1,650 metres). The harsh alpine climate is cold, windy and snowy, with low growing-season temperatures. This zone is often dominated by stunted vegetation, most commonly subalpine fir and mountain hemlock. Plants in this zone typically grow close to the ground and are often separated by bare soil or rock.

The Kalum TSA contains an abundance of terrestrial and marine wildlife, ranging from moose, grizzly bear and black bear, to sea mammals and marine birds. The fish stocks in the area represent an important ecosystem component, as many wildlife species in the area are highly dependent on these

stocks for food. Of particular importance are the Skeena, Nass, Tseax and Kitimat Rivers, some of which support provincially significant fish populations. Fish species include Dolly Varden char, coastal cutthroat trout, eulachon, and salmon species. As well, estuaries, floodplains and islands associated with these rivers are areas of important biodiversity, providing habitat for a wide variety of birds and other species. Two ecological reserves are situated in the Kalum TSA.

Table 1 lists the majority of at risk or regionally significant species that may be found in the Kalum TSA.

Current forest management practices follow the standards and legislation set out by the Forest Practices Code. Consequently the protection of wildlife and the environment will primarily be managed through the Code. In addition, a Land and Resource Management Plan is currently being developed for the Kalum TSA. Once the plan's recommendations regarding future management of public forest lands have been approved by government and implemented, they will be considered in future timber supply reviews.

Table 1. *Vulnerable, endangered, threatened and regionally significant species¹, Kalum TSA, 1999*

Endangered/Threatened (Red-Listed)	Vulnerable (Blue-Listed)	Regionally Significant (Yellow-Listed)
marbled murrelet Swainson's hawk American peregrine falcon	short-eared owl trumpeter swan gyrfalcon tailed frog (coastal pop.) bull trout wolverine (<i>luscus</i>) fisher grizzly bear	bald eagle

(1) B.C. Conservation Data Centre, November 1998

1 Description of the Kalum Timber Supply Area

1.2 First Nations

The Kalum TSA is within the traditional territories of a number of First Nations represented by six tribal organizations: Nisga'a, Tsimshian, Haisla, Carrier Sekani, Wet'suwet'en and Gitksan. The aboriginal communities of Gitlakdami, Gitwinksihlkw, Kitsumkalum, Kitselas and Kitamaat Village are within the TSA boundaries.

The Nisga'a Tribal Council has negotiated a comprehensive land claim which covers a portion of the Kalum TSA. The treaty has been approved by the Nisga'a Nation and is yet to be ratified by the provincial and federal governments. The uncertainty about the effect of the treaty on timber supply in the Kalum TSA was examined in a sensitivity analysis (Section 5.11). The Carrier Sekani, Tsimshian and Haisla Nations are in the process of treaty negotiations. The Gitksan and the Province are conducting bilateral negotiations under a September 15, 1998 Reconciliation Agreement.

All of the First Nations have expressed concerns about timber harvesting in areas with high cultural and economic values, particularly in the valley bottoms. Inventories to identify sites of potential archaeological significance have been completed. If impact assessments and traditional-use surveys are completed prior to completion of this timber supply

review, this information will be considered by the chief forester.

The AAC that will be determined by the chief forester in this timber supply review should not in any way be construed as limiting the Crown's obligations regarding aboriginal rights, as determined by recent decisions of the Supreme Court of Canada. As much as possible, the chief forester will consider aboriginal rights as part of his mandate under *Section 8* of the *Forest Act* and, in addition, these rights will be respected in the administration of the AAC (i.e., in planning harvesting activity).

First Nations communities in the TSA have expressed a desire to gain greater access to the employment opportunities afforded by forestry, particularly silviculture and harvesting activities. Currently, participation in forestry varies by community. First Nations have also expressed concern about the impacts of logging activity, such as damage to traplines, loss of hunting areas, and increased access to traditional fishing stations which can affect economic opportunities for First Nation people. First Nations also wish to maintain or increase opportunities for other forest-based activities, such as pine mushroom harvesting and tourism (guiding and adventure tourism).

1 Description of the Kalum Timber Supply Area

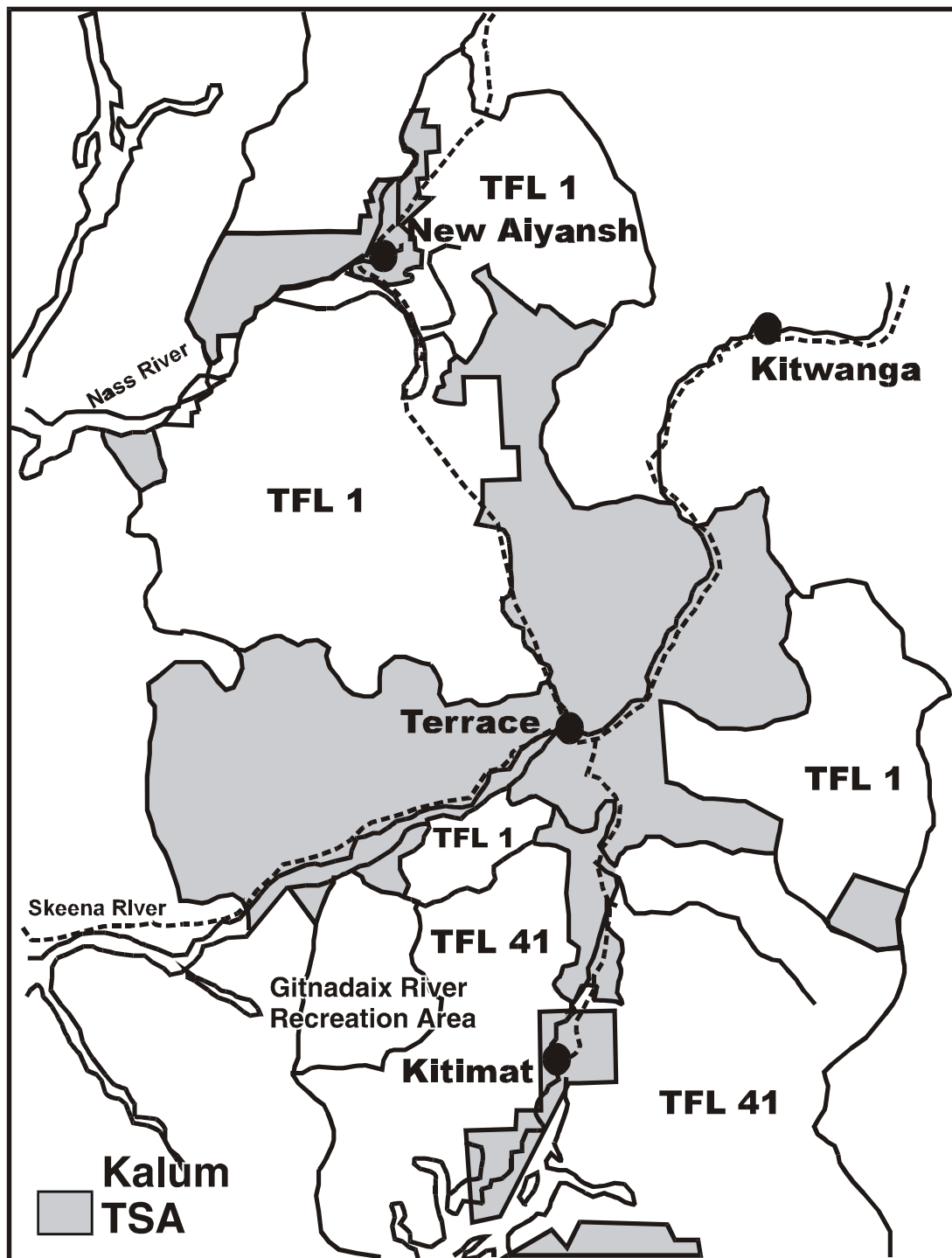


Figure 1. Map of the Kalum Timber Supply Area

2 Information Preparation for the Timber Supply Analysis

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

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1997 by the B.C. Ministry of Forests Resources Inventory Branch. This file contains a considerable amount of information on the forest land in the Kalum TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other notable characteristics such as environmental sensitivity and physical accessibility (operability). Stand characteristics such as tree height, stocking* and age have been projected to 1997. Except for a few mapsheets shared with adjacent forest districts, the inventory file has been updated to account for timber harvesting up to 1997 for the Kalum TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, and areas in power lines, highways,

or town sites. A description of these areas specific to the Kalum TSA is provided below. These types of areas do not contribute to the timber supply of the Kalum TSA. Before assessing timber supply these non-contributing areas are identified and separated from the land base which represents the timber harvesting land base*. In this classification process, each specific area (e.g., stand of trees) is assigned either to the timber harvesting, or to the non-contributing land base (in some cases a stand may be divided, with part assigned to the harvesting land base and part to the non-contributing area). There is no double accounting of area; for example, the area of a forest stand that falls within a park, and is also on hazardous terrain, is assigned only once to the non-contributing land base.

Identifying areas as not contributing to timber supply does not mean the area is also removed from the Kalum TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

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

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

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

- non-Crown areas — areas not managed directly by the B.C. Forest Service.
- non-productive areas — areas not occupied by productive forest cover (e.g. rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (e.g. presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- Humphrys reversion — a portion of the Humphrys landscape unit is being transferred to Tree Farm Licence 41.
- land where deciduous tree species (except cottonwood) are dominant.
- problem forest types — areas covered by timber stands that are physically operable and have adequate productivity, but are not currently utilized or have marginal merchantability.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- existing roads, trails and landings — areas that have been removed from timber production due to access development and harvesting to date.
- environmentally sensitive areas* — portions of the areas considered unavailable for harvesting because of environmental sensitivity.
- riparian management area — area otherwise available for timber production that was assumed to be unavailable for harvesting to provide protection for riparian* and stream ecosystems.
- wildlife tree areas — portions of the areas reserved for wildlife habitat.
- inaccessible areas — Exchamsiks landscape unit.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, “Description of Data Inputs and Assumptions for the Timber Supply Analysis.” Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base.

Inoperable areas

Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Operability

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.

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.

Riparian area

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

2 Information Preparation for the Timber Supply Analysis

Table 2. Timber harvesting land base for the Kalum TSA, 1999.

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	539 319	100.0	
Not managed directly by the B.C. Forest Service	36 213	6.7	
Non-productive	305 698	56.7	
Total productive forest managed by the Forest Service (Crown forest)	197 408	36.6	100.0
Reductions to Crown forest:			
Non-commercial cover (brush)	503	0.1	0.3
Inoperable	70 897	13.1	35.9
Humphrys reversion (to TFL)	906	0.2	0.5
Aspen, birch, alder	4 041	0.7	2.0
Problem forest types	7 090	1.3	3.6
Low timber productivity	808	0.1	0.4
Existing roads	3 815	0.7	1.9
Environmentally sensitive	4 836	0.9	2.5
Riparian management area	4 625	0.9	2.3
Wildlife tree area	1 359	0.3	0.7
Exchamsiks	272	0.1	0.1
Total current reductions^a	99 152	18.4	50.2
Current timber harvesting land base (includes 6 493 hectares not satisfactorily restocked (NSR)* land) ^b	98 256	18.2	49.8
Future reductions			
Future roads	4 076	0.7	2.1
Long-term timber harvesting land base	94 180	17.5	47.7

(a) Reductions were performed in the order listed in the table.

(b) NSR includes: current NSR and backlog 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 represents both the total Kalum TSA area, and the productive forest land base. The total area chart (left) shows that almost two thirds of the total land base is not managed by the B.C. Forest Service, or classified as non-forest or non-productive forest (i.e. having no or very few trees). The productive forest chart details the categories of forest land and shows that about 36% of the productive forest land in the TSA is considered to be unavailable for harvesting due to physical or

economical inoperability at this time. An additional 6% is identified as non-merchantable (low timber productivity, problem forest types, and non-commercial cover). Approximately 2% of the productive forest is unavailable for harvesting due to existing roads and 5.5% of the productive forest is excluded from timber harvesting due to wildlife trees, riparian management areas, and ESAs. About 50% of the productive forest is considered available for timber harvesting (including NSR).

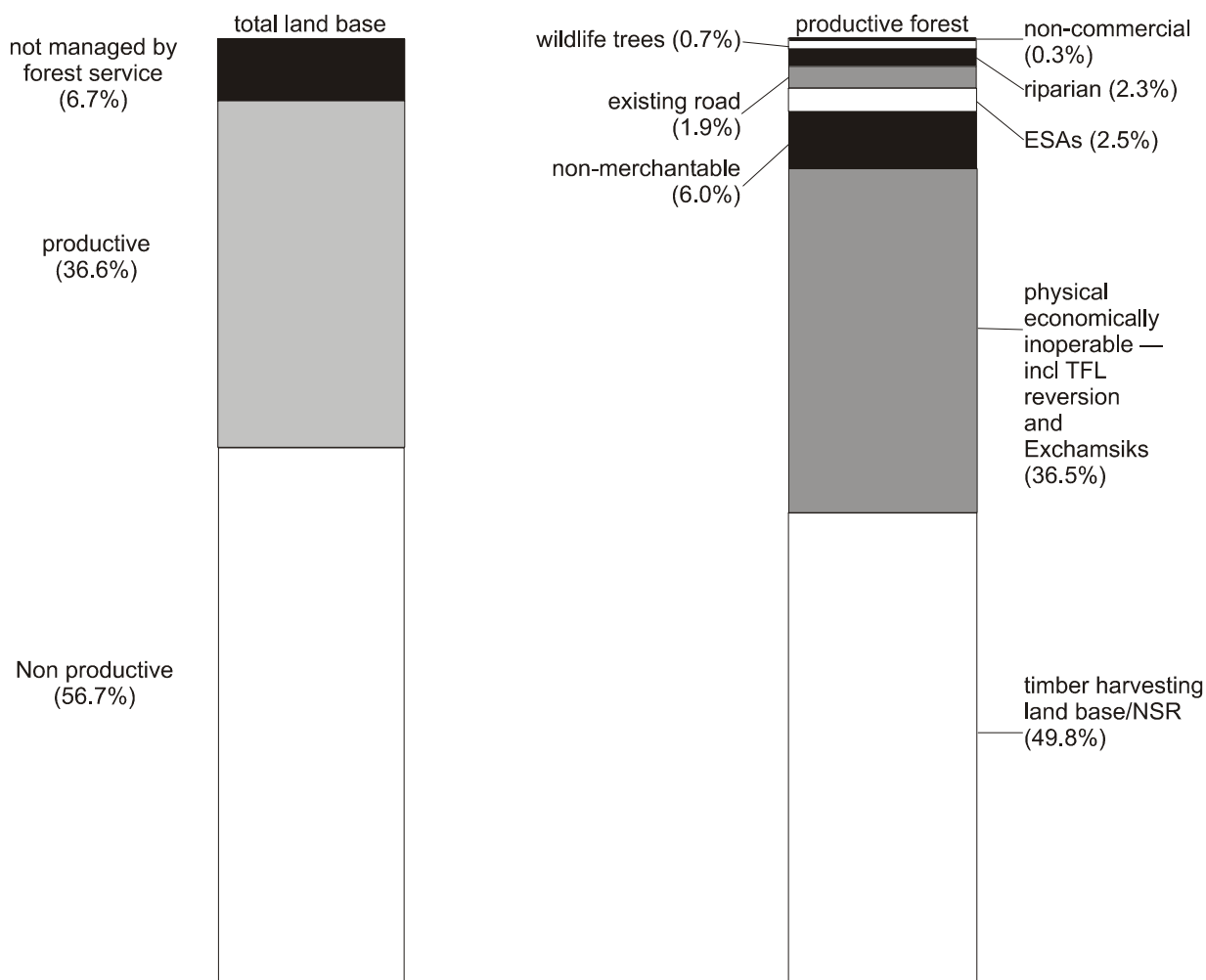


Figure 2. Composition of the total and productive forest land bases — Kalum TSA, 1999

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Hemlock species dominate in stands on about 76% of the area within the timber harvesting land base, with balsam dominating in 8%, spruce in 6%, lodgepole pine in 5%, cottonwood in 4% and cedar in 1%. After harvest, most stands are expected to be regenerated by planting to hemlock or pine, depending on site conditions. Natural regeneration of hemlock, balsam, and deciduous species is also expected to contribute to stand composition in the future. Spruce-dominated ecosystems are often susceptible to spruce leader weevil and will be regenerated to hemlock after harvest.

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 46% of stands in the timber harvesting land base are at or above the minimum harvestable age. There is significant variation around this proportion for each of the species groupings: 51% of hemlock stands, 39% of balsam stands, 22% of cottonwood stands, 22% of spruce stands, 12% of lodgepole pine stands and 49% of cedar are currently older than the minimum harvestable ages. In the Kalum TSA, it would appear that harvesting has occurred in all species groups.

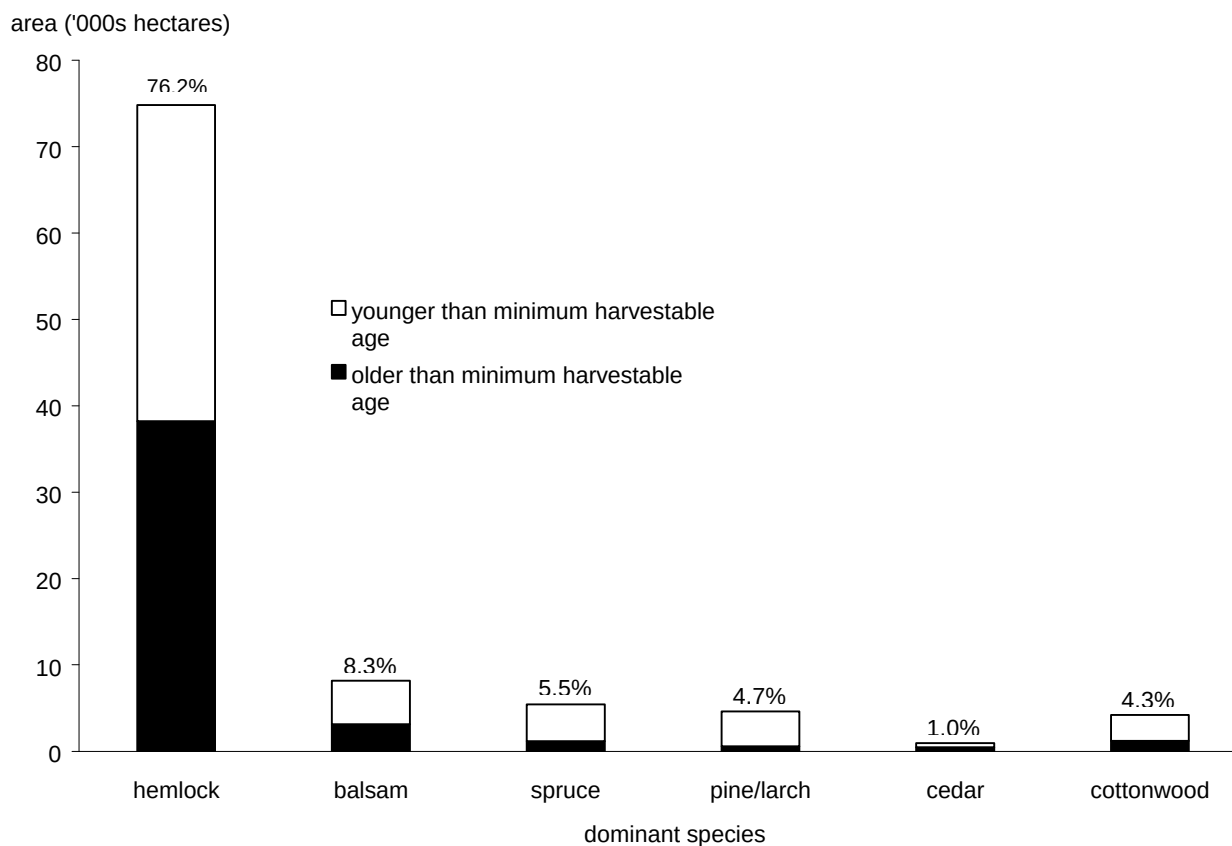


Figure 3. Area by dominant species — Kalum TSA timber harvesting land base, 1999

2 Information Preparation for the Timber Supply Analysis

Figure 4 provides an overview of the distribution of site productivity within the harvesting land base, and the relative amount of area in each class that is older than the minimum harvestable age. Three quarters (75%) of the sites in the timber harvesting land base are classified as having good or medium productivity (site index greater than or equal 13 at age 50 years), and 25% have poor productivity (site index less than 13 meters at age 50 years). Sites classified as having low productivity are excluded

from the timber harvesting land base. The proportion of area older than minimum harvestable age in each site class indicates that harvesting has concentrated more on good and medium productivity sites than on poor sites. However, a relatively large proportion of stands in each site class is currently old enough to be harvested, and the composition by site class and age does not appear to present a significant issue for timber supply in the short term.

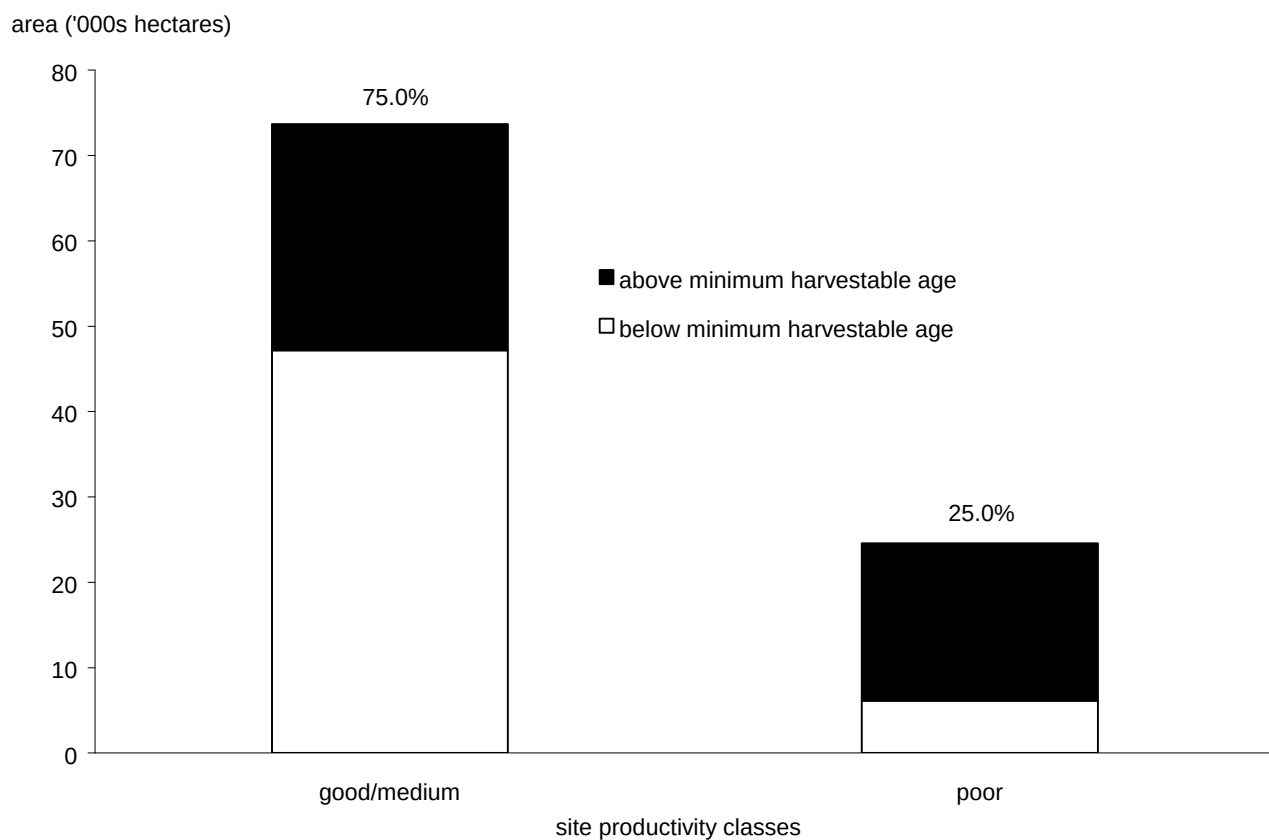


Figure 4. Area by site productivity class — Kalum TSA timber harvesting land base, 1999

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age composition of forested stands in the Kalum TSA. Within the timber harvesting land base, a substantial portion (32%) of stands are older than 250 years. About 27% of stands are 20 years or younger, 29% are between 21

and 100 years old, and 12% are between 101 and 250 years of age. Almost 46% of the stands in the timber harvesting land base are at or above their minimum harvestable age.

area ('000s hectares)

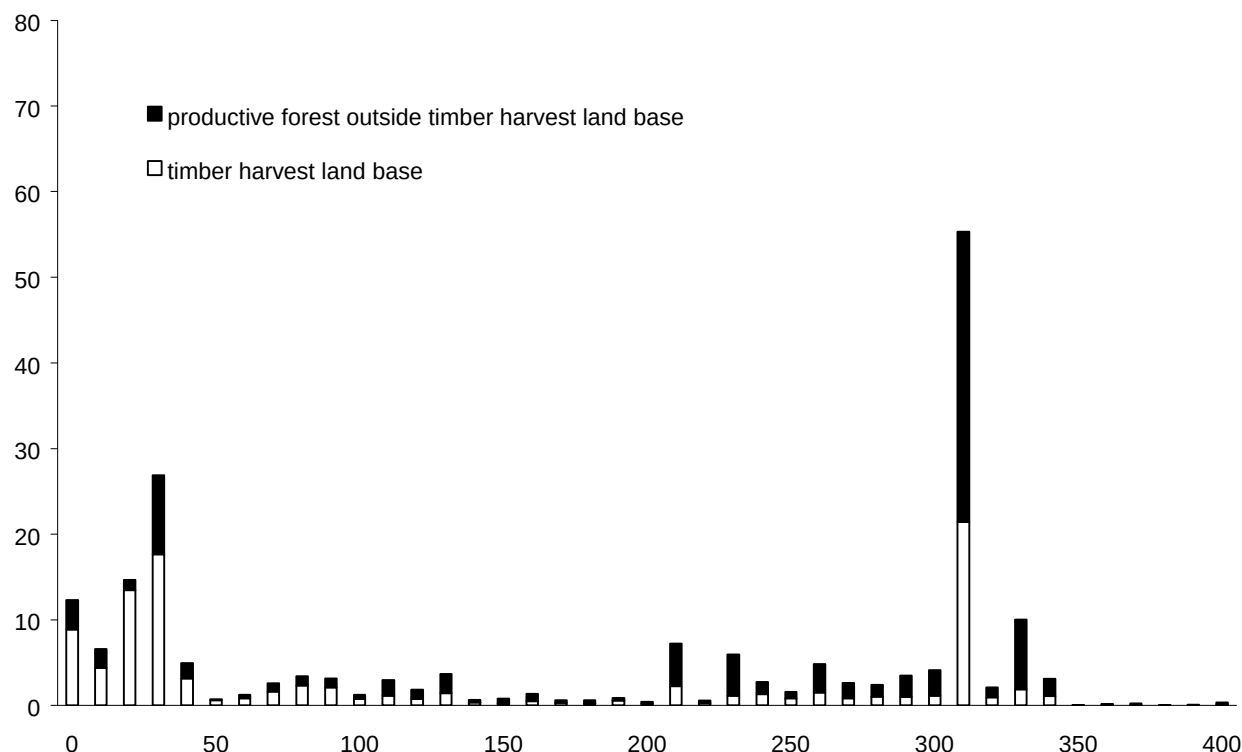


Figure 5. Current age class composition of productive forest land base — Kalum TSA, 1999

The age-class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. In the case of the Kalum TSA, a very significant portion of the total land base is covered by these stands which, although they do not contribute to the timber supply, can affect how much harvesting can be conducted and the pattern of the harvesting by providing stand conditions that help achieve old-forest and biodiversity objectives. About 58% of these 'inoperable' stands are older than

250 years. The 'inoperable' stands here include non-merchantable stands, deciduous stands, and riparian and wildlife reserves. Only 8% of inoperable stands are 20 years or younger, 13% are between 21 and 100 years old, and 20% are between 101 and 250 years of age. Most of the requirements for old-forest attributes within the Kalum TSA are met by the area covered by inoperable stands older than 250 years.

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 (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 meters 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 Kalum 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 coniferous stands and for both existing and managed deciduous stands. The Table Interpolation Program

for Stand Yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for coniferous managed stands. Managed stands were defined as all stands harvested over the last 20 years, 70% of the stands harvested between 21 - 30 years ago, 30% of the stands harvested between 31 - 40 years ago, and those that will be harvested in the future.

Volume estimation and prediction are subject to a fair amount of uncertainty due to uncertainty in inventories which form the basis for estimating site productivity and applying growth and yield models, 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 25.1 million cubic metres. About 23.5 million cubic metres, or 94%, of the total are currently merchantable; that is, older than minimum harvestable age.

Volume estimate (yield projections)

Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.

2 Information Preparation for the Timber Supply Analysis

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. Forest management practices in Kalum TSA follow the Forest Practice Code, regulations, and guidelines. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Kalum Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. Most areas in the Kalum TSA are harvested using a clearcut harvesting* system and area restocked by planting or natural

regeneration. Helicopter logging is practiced on a small proportion of the land base.

- Intensive silviculture — juvenile spacing*, commercial thinning*, and pruning* are practiced in Kalum TSA. Most stands are juvenile spaced, which ensures young trees are well distributed to maximize growth. Current management includes commercial thinning, whereby some trees of merchantable size are removed to increase growing space for the remaining trees. The thinning program is represented in the analysis and is carried out according to criteria listed in Appendix A, “Description of Data Inputs and Assumptions.” Trees on some good sites are pruned (have their lower branches removed) to improve timber quality.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Clearcut harvesting

A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.

Juvenile spacing

A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased (see Commercial thinning).

Commercial thinning

A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts (see also, Juvenile spacing). It is carried out to improve the health and growth rate of the remaining crop trees.

Pruning

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

2 Information Preparation for the Timber Supply Analysis

- Forest health and unsalvaged losses* — timber losses to fire damage and windthrow are expected to average 9500 cubic metres per year.
- Utilization levels — maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species are specified in cutting permits (see Appendix A).
- Maintenance of wildlife habitat — grizzly bear, fisher, and northern goshawk occur in the Kalum TSA. Each of these species requires specific habitat types. Most of the habitat needs of these species are expected to be achieved through forest cover retention for landscape – level biodiversity, and other forest area excluded from the timber harvesting land base. Wildlife trees are another source of wildlife habitat. In general 75% of requirements for wildlife trees are met from the land outside of timber harvesting land base. An additional 1359 hectares were excluded from the timber harvesting land base to meet the objectives for wildlife trees.
- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits. About 24 449 hectares (25%) of the timber harvesting land base are being managed for visual quality. Guidelines are stated in terms of the maximum proportion of an area that may be less than five metres tall (the visual green-up). The proportion depends on the specific visual quality objective (VQO)* and the visual sensitivity*. Areas managed for visual quality fall into three categories: 1) about 2262 hectares are in the retention*/preservation* class where visible evidence of timber harvesting must be minimal; 2) about 7 976 hectares are in the partial retention* class where harvesting may be noticeable, but not dominant; and 3) about 14 210 hectares are in the modification* class where harvesting may be visually dominant, but must blend with the natural landscape. Appendix A, "Description of Data Inputs and Assumptions" contains a detailed description of the specific objectives that apply to these categories.

Unsalvaged losses

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

Visual quality objective (VQO)

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

Visual sensitivity

A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.

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).

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).

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

- **Cutblock adjacency*** and **green-up*** — in the Kalum TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (3 meters in height for integrated forest management areas and five meters in height for visual quality management areas), before adjacent stands may be harvested. In the analysis a requirement that a maximum of 35% of the general IRM zone may be below green-up is used to approximate the effects of cutblock adjacency restrictions. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.
- **Minimum harvestable ages** — these ages are an estimate of the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set at the age at which stands reach minimum volume, minimum height, and minimum diameter criteria. The minimum harvestable age defines the youngest age at

which a specific type of stand is expected to become harvestable. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives* (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets.

- **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 Kalum TSA, for each ecosystem type and biogeoclimatic variant, a proportion of the forested area in each landscape unit must be covered by forest older than 250 years. The proportion depends on the level of emphasis placed on biodiversity for a landscape unit, as well as the level of stand disturbance naturally occurring in each ecosystem.

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.

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).

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.

2 Information Preparation for the Timber Supply Analysis

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

Some of the practices and objectives discussed in the previous paragraphs apply in all or most areas (e.g., minimum harvestable ages, wildlife trees, landscape-level biodiversity, riparian reserves). Some of the objectives or management emphases can be delineated in more geographically specific areas. These include: visual quality management, IRM, community watersheds, and Thunderbird special management area.

The following forest management emphases occur within the Kalum TSA.

- General integrated resource management where cutblock adjacency objectives apply;
- Thunderbird special management area: reservation of a minimum of 12% of the

productive forest area in stands above 140 years old.

- Community watersheds: maximum 30% of the productive forest area below five metres.
- Landscape-level biodiversity: retention of a minimum proportion of the land base in each landscape unit in old forest.
- Visual quality management: maximum disturbance levels depend on the visual quality class.

To facilitate analysis of the different management regimes associated with these emphases, the Kalum TSA was divided into management zones.

Figure 6 displays the composition of the timber harvesting land base according to management emphasis (or management zone).

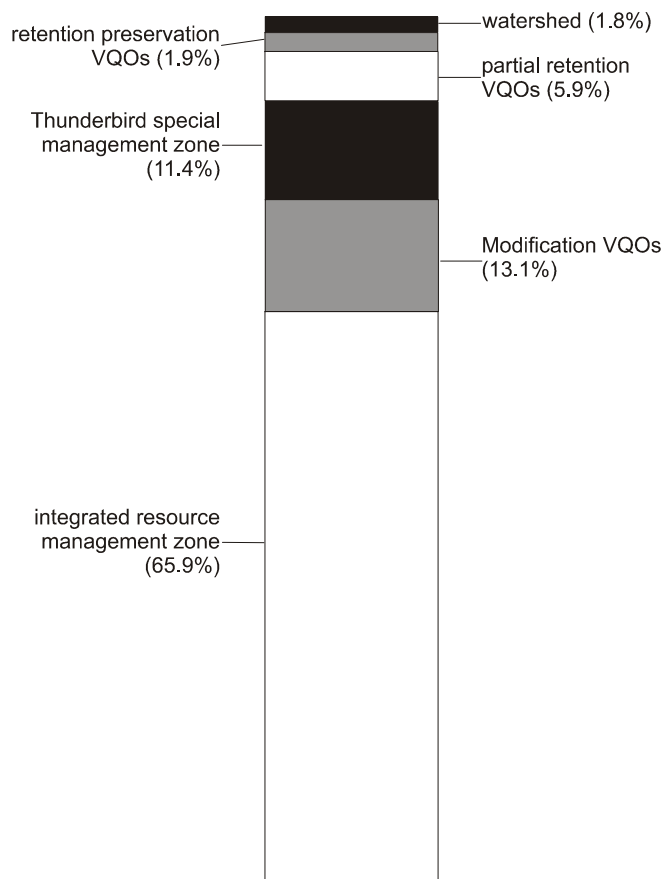


Figure 6. Forest management zones — Kalum TSA timber harvesting land base, 1999

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Kalum 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 Kalum TSA. The base case harvest forecast uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." Because forest management is inherently a long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 5, "Timber Supply Sensitivity Analyses." It is important to remember that the base case provides only a part of the timber supply picture for the Kalum TSA, and should not be viewed in isolation of the sensitivity analysis.

4.1 Base case harvest forecast

Figure 7 shows the base case harvest forecast* for the Kalum TSA. The forecast indicates that harvests can be maintained at current allowable annual harvest level of 464 000 cubic metres for another three decades before declining to 387 000 cubic meters by decade five. The harvest forecast remains at this lower level until decade 12 when it rises to the sustainable long-term harvest level of 431 500 cubic meters per year. This rise to the long-term level in decade 12 coincides with the time when harvests are forecast to come almost entirely from regenerated stands. This long-term harvest level is maintained for the remainder of the analysis horizon.

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.

4 Results

Unsalvaged losses to natural forces such as insects, fire, windthrow, small mammals, and disease are estimated to be 9500 cubic metres per year, and

have been subtracted from all harvest forecasts shown in this report.

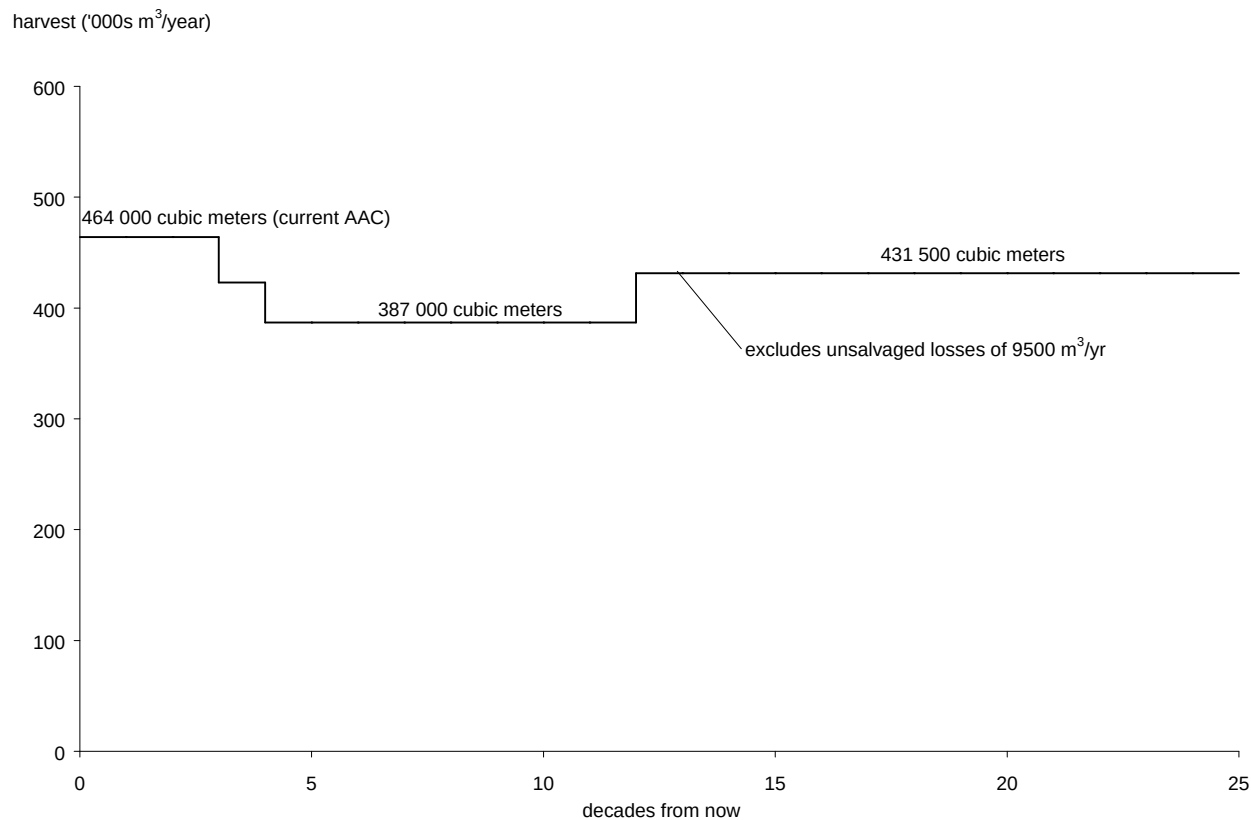


Figure 7. Base case harvest forecast — Kalum timber supply area, 1999

4 Results

Several criteria were used to define the base case harvest forecast. The first was to maintain the current harvest level for the Kalum TSA (464 000 cubic metres per year) for as long as possible while avoiding substantial timber supply disruptions in the future. The long-term harvest level was defined as the harvest rate that is close to the maximum productivity, and maintains the total timber growing stock* at an even level, on average, so that harvesting could continue at that level in perpetuity (see Figure 8). 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 rapidly over the next five decades as the available existing mature stands on the timber harvesting land base are harvested and replaced with younger stands. The merchantable stock of managed stands increases rapidly until decade 10 when it comprises most of the total merchantable stock. From decade 4 to decade 11, most of the managed stands are harvested near their minimum harvestable age. Once harvesting occurs predominantly in younger managed stands, the growing stock stabilizes at approximately 22 million cubic metres.

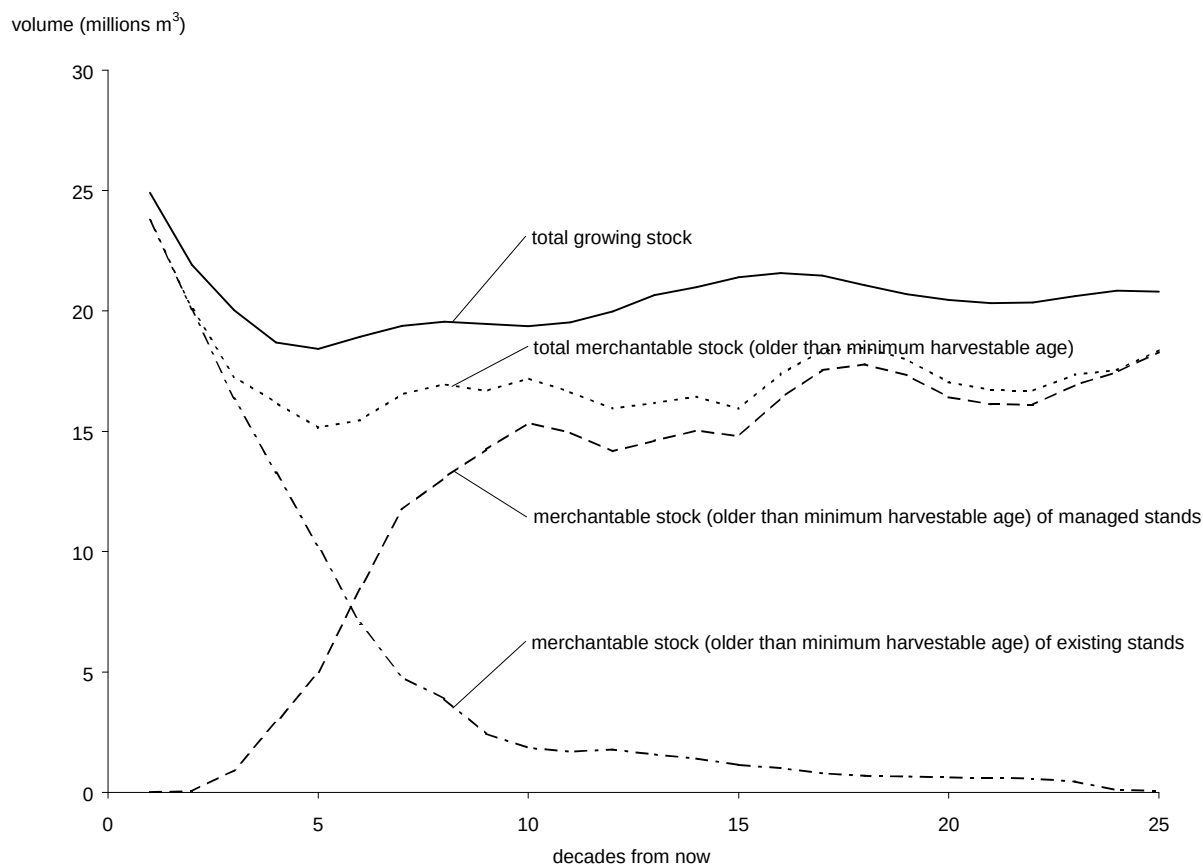


Figure 8. Changes in timber growing stock over time — Kalum TSA base case, 1999

Growing stock

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

4 Results

In defining the base case, another criterion was to manage the transition from the current harvest level to the long-term harvest level, which coincides with the transition from harvesting existing stands to harvesting regenerated, managed stands. Drops of 8.8% before decade four and 8.5% before decade five were necessary to ensure that timber supplies were not disrupted in the future. As shown in Figure 8, the amount of merchantable timber is at a minimum of approximately 15 million cubic metres in decade 5, and this relative shortage of stands old enough to harvest affects the transition to the long-term harvest level. These basic criteria were applied when generating all harvest forecasts in this report.

Other harvest flow patterns are possible, for example with different lengths of time at the current level, different rates of decline, and a different initial harvest level. Some alternatives are described in Section 5.1, "Alternative harvest flows over time".

Stand management, such as planting and spacing, allows for higher harvests in the long-term than if future stands were expected to grow at the same rate as did existing stands.

The average growth rate at minimum harvestable ages from managed stands is about 4.7 cubic metres per hectare per year, about 68% higher than the 2.8 cubic metres per hectare per year for existing stands. This volume increase is expected in managed

stands because stocking levels will be controlled to ensure full site occupancy while avoiding over-stocking and competition among trees. The full benefit of improved management will not occur until most second-growth stands become available for harvesting, in from 90 - 100 years from now.

However, the long-term harvest level is slightly below the maximum productive capacity of the timber harvesting land base partly because of forest cover requirements* for visual quality and adjacency, and also because areas are not necessarily harvested at the point of maximum productivity, since it is difficult to schedule areas for harvest at a particular age when there is also an objective of maintaining a fairly even harvest flow over time. If dramatic fluctuations in harvests were acceptable, stands could be harvested at their minimum harvestable age, or even at the age of maximum productivity.

For the most part, forest cover requirements do not limit the mid- or long-term harvest level, since by 12 decades from now, forested stands outside the timber harvesting land base are projected to be in a condition to meet most of the requirements for older forests and wildlife habitat in the long-term. Thus, only very small areas of the timber harvesting land base have to be reserved for these purposes. Harvest levels are limited mainly by the amount of timber of a harvestable age and by the maximum amount of disturbance allowed in the VQO zones.

Forest cover requirements

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

4 Results

4.2 Area, average volume, and average age harvested

Figure 9 shows how the annual area harvested would change over the next 250 years if the base case harvest forecast was followed.

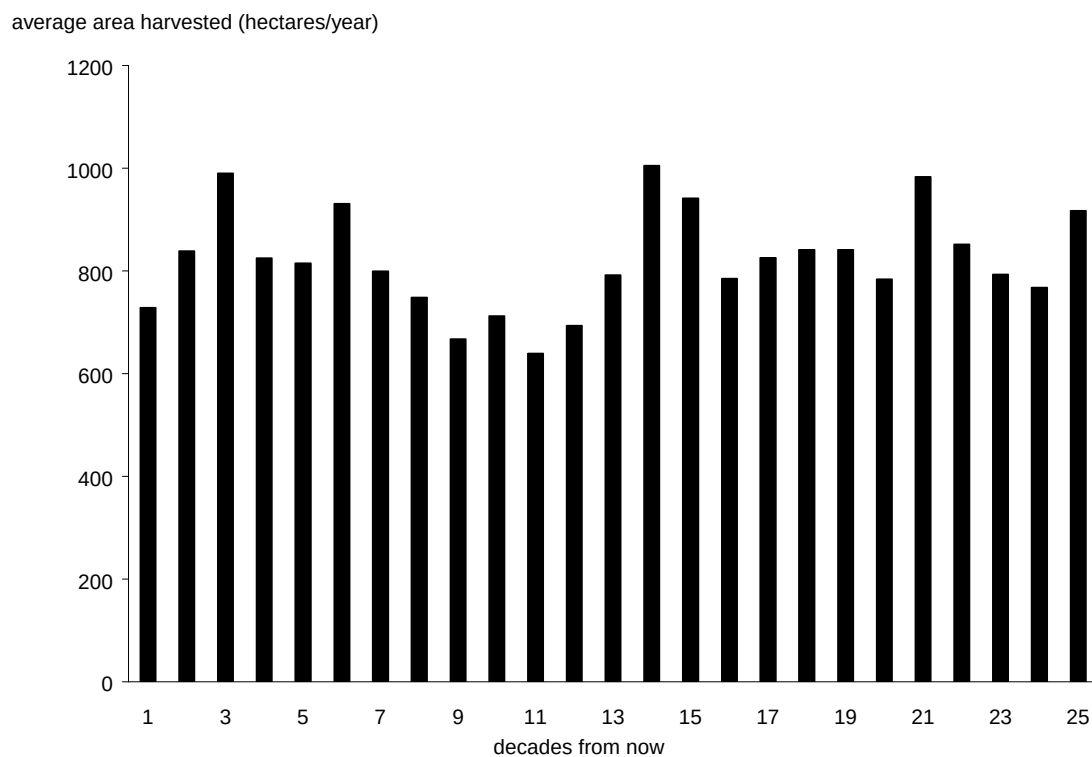


Figure 9. Area harvested over time — Kalum TSA base case, 1999

4 Results

Figure 10 shows changes in the average timber volume per hectare harvested over the same period. These graphs display a fluctuating pattern of peaks and troughs. The highest average harvest volume per hectare of 650 cubic meters in decade one reflects that during decade one most of the harvest is forecast to come from high volume old growth stands (age greater than 300 years). This volume per hectare is slightly higher than that of the inventory audit average volume of 550 cubic meters which applies to stands above 60 years of age. The peak in area harvested in decade 3 is partially due to the harvest of short rotation spruce stands and commercially-thinned stands. Average volume per hectare harvested is high when area harvested is low, and low when area harvested is high. This relationship is expected since the annual timber harvest is constant

at 387 000 cubic meters per year from decade 5 to 12 and at 431 500 cubic metres per year for the long-term. The pattern occurs because after most existing stands are harvested by decade five, the first managed stands to become available for harvesting will be primarily on good and medium quality growing sites which have proportionately higher volumes than poor sites. This means that from decade 7 to decade 12 when the harvest occurs mostly from good and medium site managed stands, the average volume per hectare harvested will be high and the corresponding area that must be harvested will be low. When poor site managed stands become available for harvesting, which first occurs about 140 years from now, more area must be harvested annually than on better sites to reach the same harvest target.

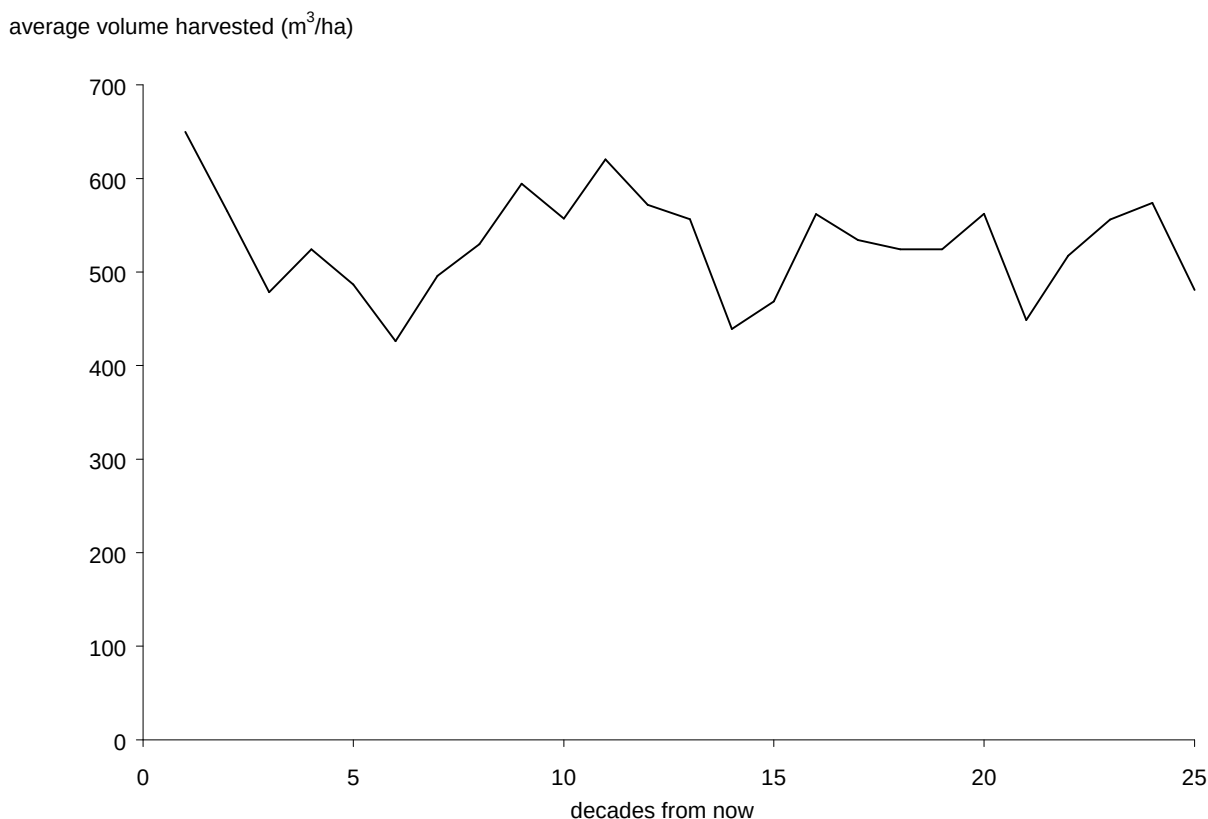


Figure 10. Average volume per hectare harvested over time — Kalum TSA base case, 1999

Figure 11 tracks the change in average stand age harvested for the base case harvest forecast. Over the next 60 years, most harvesting occurs in existing old stands and a small portion from the short rotation spruce and commercial thinning. During this time period, few stands are harvested at the minimum harvestable age since there is an abundance of older

stands available for harvest, and because older stands are given priority for harvest in the analysis. From decade seven onward, most of the stands harvested are regenerated stands. The average harvested age from decade seven to decade 25 fluctuates slightly, averaging about 110 years over the long-term.

4 Results

average age harvested (years)

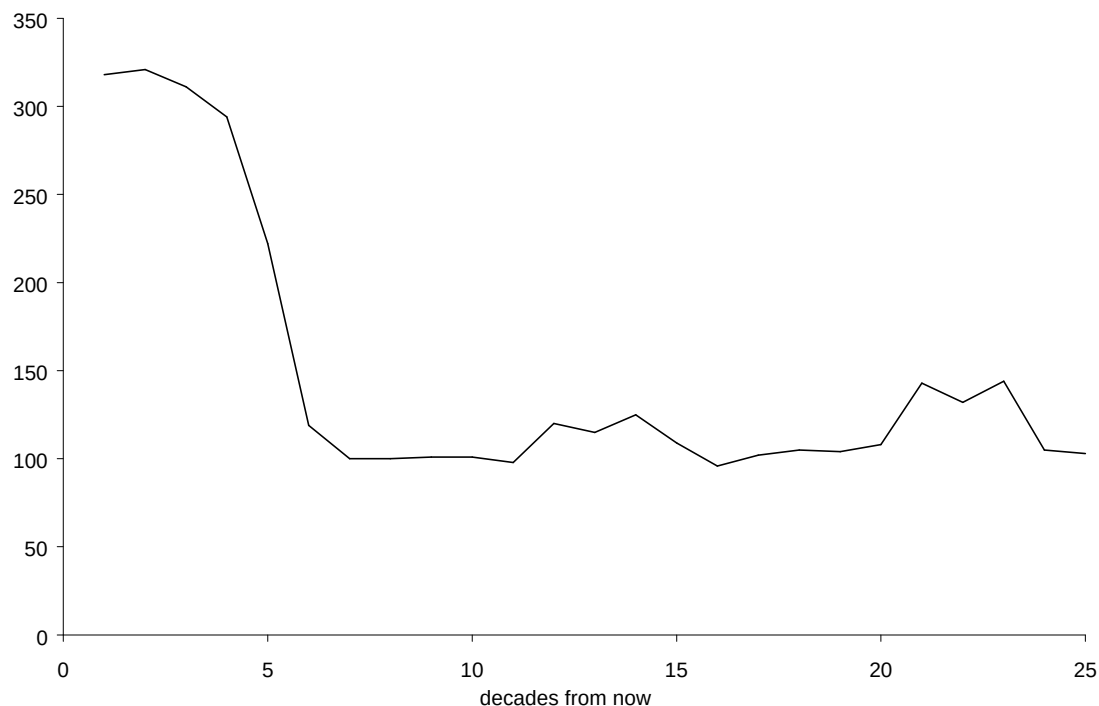


Figure 11. Average harvested age over time — Kalum TSA base case, 1999

4.3 Age class composition over time

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

Currently, about half of the timber harvesting land base (46%) consists of stands at or above minimum harvestable age. The productive land base also contains areas which are forested but have been excluded from the timber harvesting land base ("inoperable" or non-contributing stands). While these inoperable stands range significantly in age, enough of them have older forest characteristics or can meet wildlife habitat criteria so that initially, very little of the timber harvesting land base must be retained for these values. As time progresses, less of the timber harvesting land base is covered by older forests; however, inoperable stands, which are ineligible for harvest, have continued to age, and after the first four decades of the analysis horizon, meet most wildlife habitat requirements and most

landscape-level biodiversity requirements for the TSA. After 100 years very little older forest remains in the timber harvesting land base; the forested area is almost evenly distributed in 10-year age classes between 10 and 130 years. It should be noted that old-forest will be interspersed with the timber harvesting land base in riparian reserves, wildlife tree patches, environmentally sensitive areas and other excluded forest areas. The trend to even age class distribution within the timber harvesting land base is also evident in the chart showing age class distribution at 150 years. At 200 years into the future, the projected age class distribution is somewhat less even because the relative portion of poor-site productivity stands harvested varies from decade to decade, affecting the amount of area that must be harvested in order to achieve a certain volume. By the end of the 250-year horizon, all of the inoperable areas are older than 250 years, and the timber harvesting land base is characterized by a relatively even-age class distribution.

4 Results

area ('000s hectares)

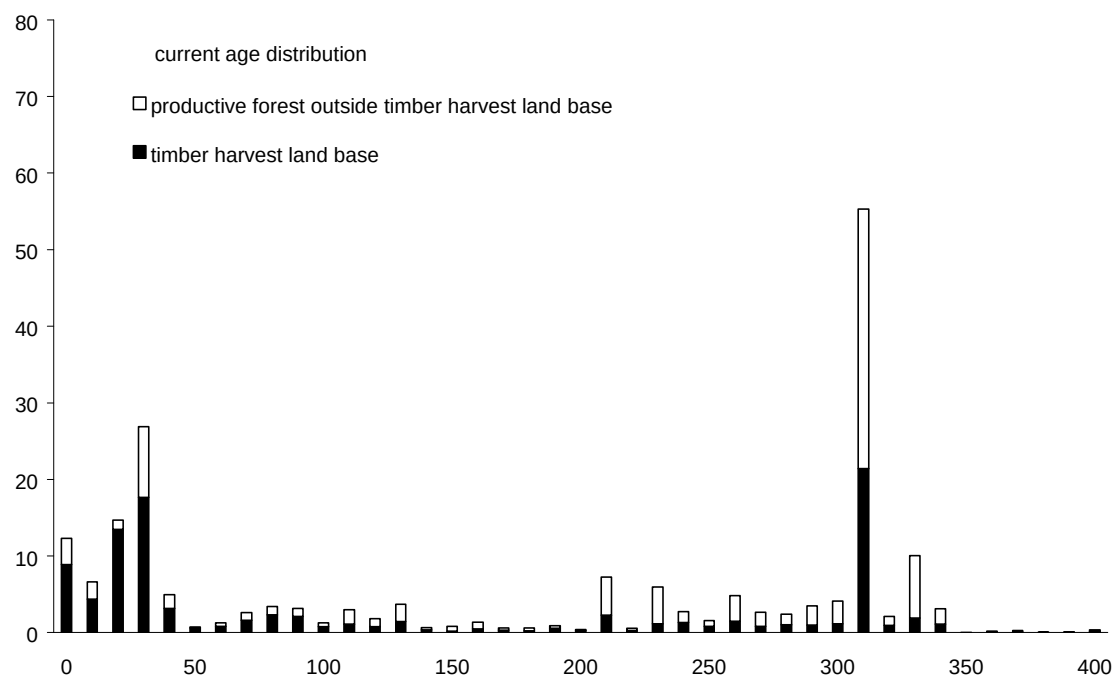
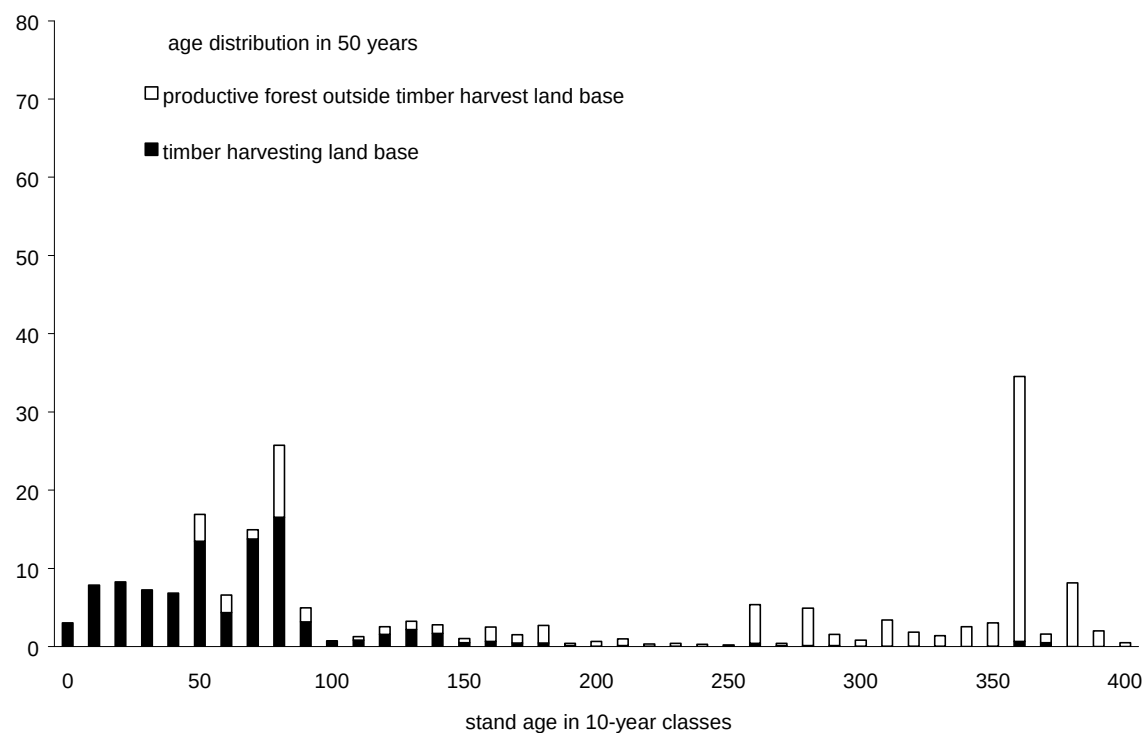


Figure 12. Changes in age composition on the productive forest land base over time —
Kalum TSA base case, 1999

(continued)

4 Results

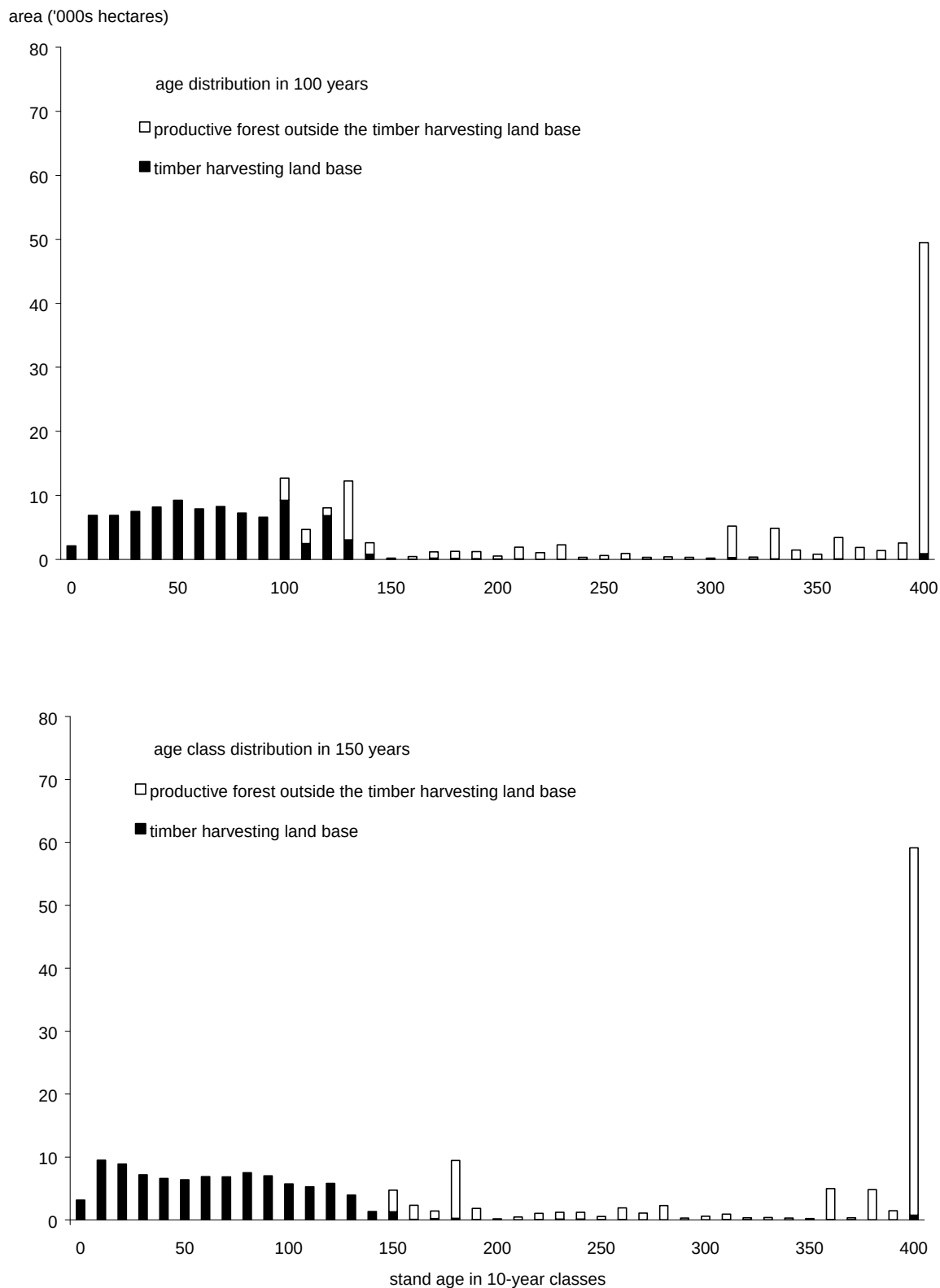


Figure 12. Changes in age composition on the productive forest land base over time —
Kalum TSA base case, 1999

(continued)

4 Results

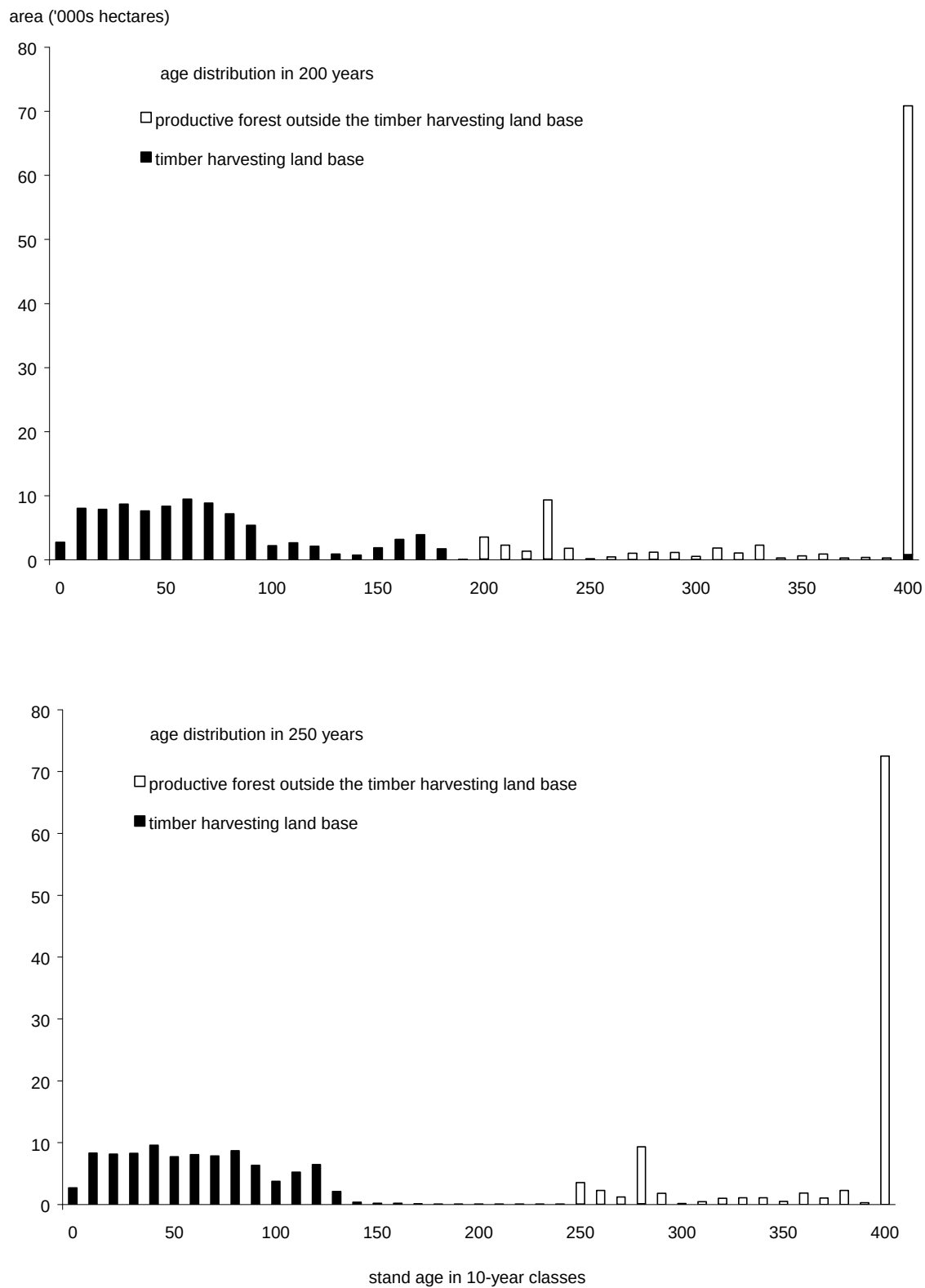


Figure 12. Changes in age composition on the productive forest land base over time —
Kalum TSA base case, 1999

(concluded)

5 Timber Supply Sensitivity Analyses

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

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

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how

uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long-term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

This report does not advocate any particular approach to uncertainty. The goals of the following sections include supplying information to assist people with different attitudes towards forest management and uncertainty to provide input, facilitating assessment of risks associated with uncertainties, and highlighting critical information gaps for future resolution.

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management (shown in Figures 7 to 12) are referred to as the base case.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows over time

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

trade-offs between short- and medium-term rates of harvest.

Figure 13 compares two harvest flow alternatives to the base case. If the initial level is set at the current harvest level of 464 000 cubic metres per year, and maintained for only one decade, the medium term harvest level can be raised to 401 400 cubic metres per year. Over the next 120 years, approximately 0.2% less volume would be harvested under this flow pattern than in the base case. Figure 13 also shows a non-declining harvest forecast, with a harvest level of 408 500 cubic metres per year maintained for 12 decades before rising to the long-term harvest level. Over the next 120 years, approximately 0.2% less volume would be harvested under this flow pattern than in the base case.

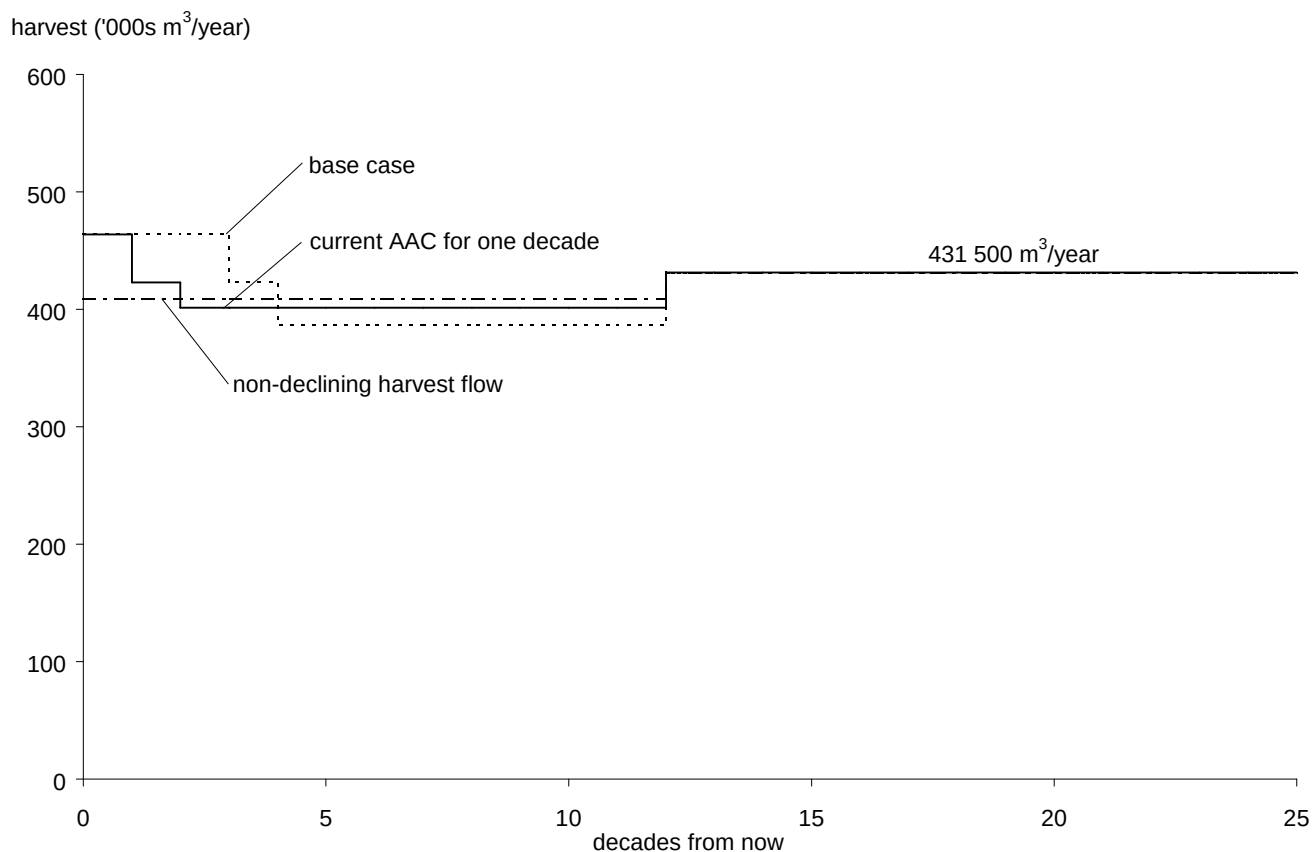


Figure 13. Alternative harvest flow patterns using base case data — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.2 Uncertainty in forest cover approximation for adjacency restrictions

The Forest Practices Code requires that trees in a harvested area must reach a specified height (green-up) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area and to approximate the effects of adjacency restrictions, a maximum limit was set on the overall area that has not reached the green-up condition. In the base case, it was assumed that a maximum of 35% of the timber harvesting land base in the integrated resource management zone could be covered by stands that have not met the green-up condition. These requirements have some uncertainty as it is impossible to define the exact forest structure needed to meet the management objectives, in this case adjacency, for a particular area. Figure 14 examines

how uncertainty about how adjacency is represented in the analysis affects the timber supply.

If adjacency requirements were more accurately approximated by decreasing the maximum amount of allowable disturbance by 10 percentage points from 35% to 25% in the integrated resource management zones, timber supply would not differ significantly from the base case.

In fact, the maximum allowable disturbance would have to be lowered to 18% in both the integrated resource management and modification VQO zones before mid- and long term disruptions relative to the base case harvest forecast would occur. If the forest cover requirement were lowered further, disruptions would begin to occur in the short term as well.

This analysis suggests that uncertainty about the forest cover guidelines used to represent the effect of adjacency requirements for integrated resource management zones do not affect timber supply projections significantly.

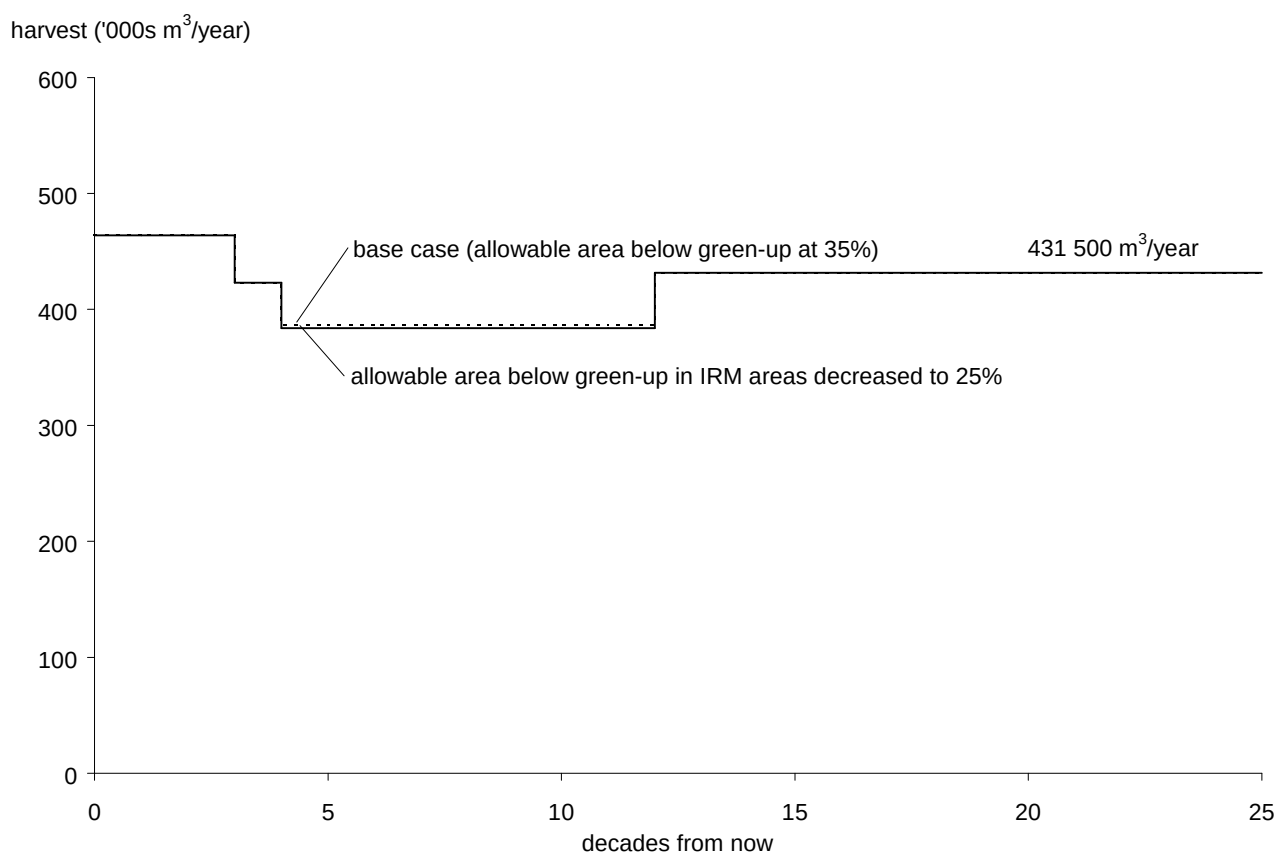


Figure 14. Harvest forecasts if forest cover requirements for limiting area below green-up in the integrated resource management zones are changed — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.3 Uncertainty in green-up ages

Forest cover requirements for visual quality, wildlife habitat, community watersheds, 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 condition (that is tree height) may either exceed or fall short of actual needs, the period of stand establishment may vary, and uncertainties about growth and yield may mean that stands will

reach the desired condition sooner or later than estimated.

Figure 15 shows that potential harvest levels are not very sensitive to uncertainty about green-up ages. If green-up ages were actually five years less than in the base case, both the short term and long-term harvest level would not change. Shorter green-up ages result in a slightly higher medium-term harvest level of 389 000 cubic metres per year, approximately 0.5% higher than in the base case harvest forecast. Overall, cumulative timber supply would be about 0.3% higher over the next 120 years if green-up ages were five years shorter. The slight increase in timber supply is due to the increased availability of timber particularly in the partial retention VQO management zone.

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.

5 Timber Supply Sensitivity Analyses

If green-up ages were five years more than estimated for the base case, the current harvest level could be maintained for only two decades, one decade less than in the base case. The medium-term harvest level would be 385 000 cubic metres per year, about 0.5% lower than that of the base case. The long-term harvest level would also be reduced to

430 500 cubic meters per year, about 0.2% lower than that of the base case.

In summary, an increase in green-up ages slightly affects the amount of time that the current AAC can be maintained and also slightly affects both the medium and long-term timber supply while a decrease in green-up ages only slightly affects the medium-term timber supply.

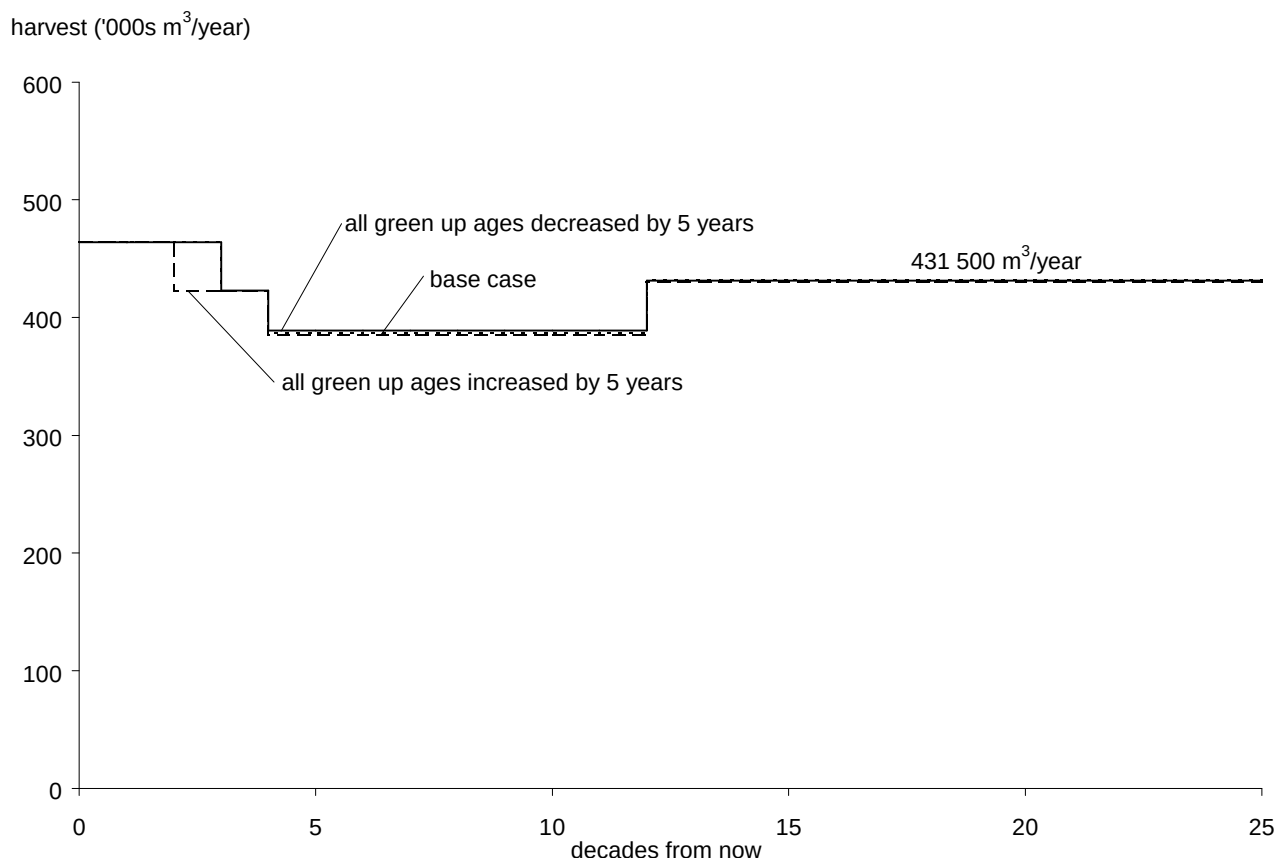


Figure 15. Harvest forecasts if green-up ages were either five years longer or shorter than in the base case — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.4 Uncertainty in the minimum age for old-age forest

Forest cover objectives for old-age forest include an estimate of the age at which stands will develop old-growth attributes. This age was estimated to be 250 years for this analysis. Because of our limited understanding about both biodiversity and old-growth structure and function, there is some uncertainty about the estimate. For example, it may be possible to create old-growth conditions in younger stands through silvicultural treatments such as thinning and pruning. This section examines how timber supply is affected by this uncertainty.

Results shown in Figure 16 demonstrate that large uncertainty in old-growth age can have significant effect on medium term timber supply. If stands actually reach old-growth conditions at 350 years of age rather than 250 years, the current harvest level can be maintained for only one decade before declining to 372 000 cubic meters per year in

decade three. The harvest level rises in decade 12 to the base case long-term level. An old-growth age 100 years less than assumed for the base case does not affect the short- or long-term timber supply and has only a small impact on medium-term timber supply.

Timber supply is sensitive to an increase in old-growth age because the current age distribution (Figure 12) shows that not many stands are classified as older than 300 years currently. Therefore the disturbance in each landscape unit would be limited by the old growth requirement. After another 120 years stands outside of the timber harvesting land base would meet most of the requirement for old growth even at the higher age of 350 years. As a result less old growth area would be needed from the timber harvesting land base than in the short- and mid-terms.

Timber supply is not affected by varying the time to reach old-growth conditions by 20 years.

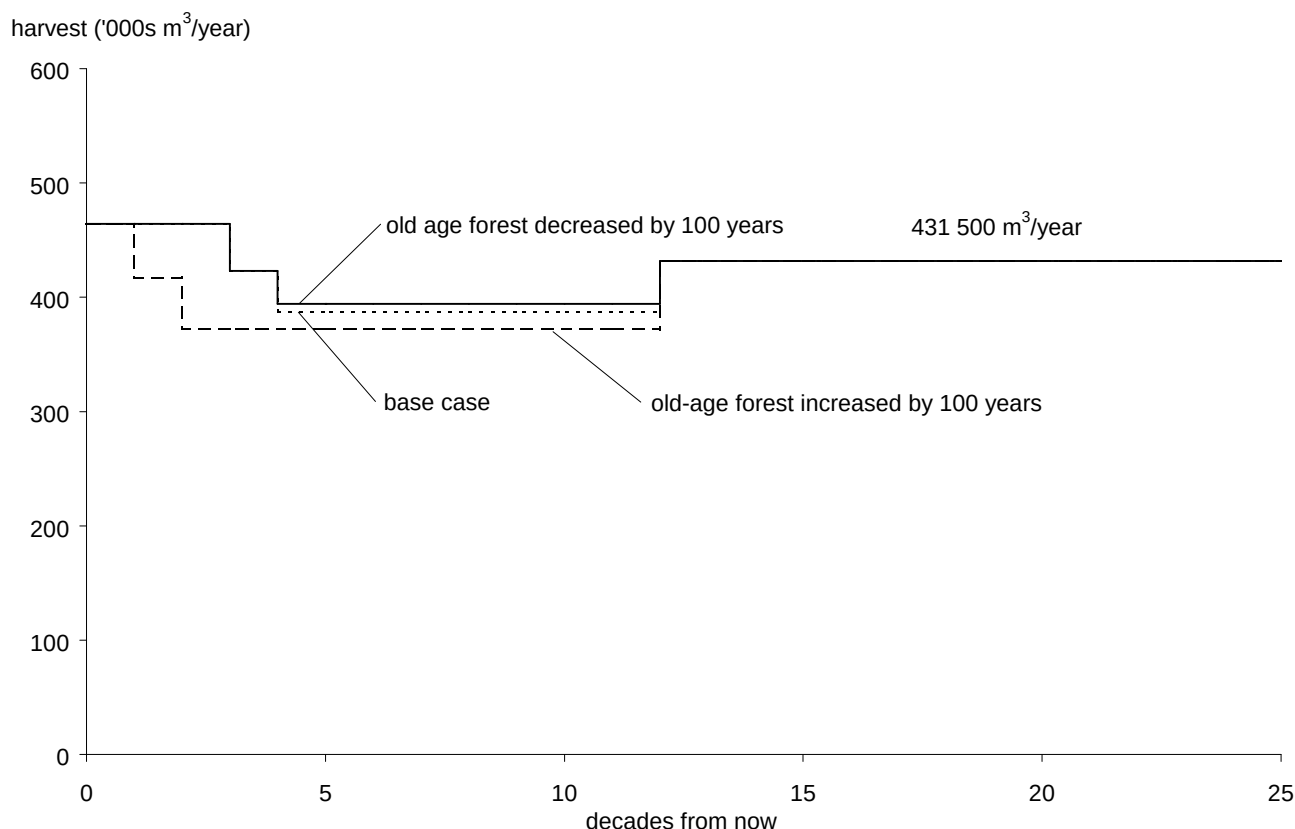


Figure 16. Threshold for old-age forest increased and decreased by 100 years — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.5 Uncertainty in forest cover requirements for visual quality

Visual quality objectives (VQOs) may be stated as the proportion of an area on which forestry activities may be visible. The B.C. Forest Service, Forest Practices Branch, has provided a range of allowable visible disturbance for each VQO (stated as maximum per cent area younger than green-up age). Different disturbance limits will meet objectives for a particular VQO (for instance, partial retention) depending on the specific terrain and forest in the area. In this analysis, areas within a VQO of preservation were combined with retention VQO because only 82 hectares in Kalum TSA have a preservation VQO. The top range of disturbance limits for each VQO are used in the base case. They are: 5% for retention VQO, 15% for partial retention VQO, and 25% for modification VQO.

Figure 17 illustrates that short-term timber supply is insensitive to uncertainty about current forest cover requirements for VQOs in the Kalum TSA. If the forest cover requirements applied in the analysis to model VQOs are changed to the mid-range percentage for each VQO class (3% for retention, 10% for partial retention, and 20% for modification), the current harvest level could be maintained for three decades, as in the base case, without causing future timber supply disruptions. The medium-term harvest level would be 382 000 cubic meters per year, 1.3% below that of the base case. The long-term harvest level would be 423 000 cubic meters, 2% below the base case. The total timber supply over the next 250 years would be decreased by 1.4%.

In summary, these results show that uncertainty about forest cover requirements needed to meet currently defined VQOs only has a small effect on timber supply over the medium-and long-terms. This is primarily because of all the management

zones in the Kalum TSA, the retention VQO zone is the only one in which harvesting is consistently limited in the base case; however, the retention VQO class covers only 2.3% of the timber harvesting land base. Therefore, either relaxing or restricting these requirements does not significantly impact the availability of timber.

5.6 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, therefore affecting the rate at which 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 as the age at which stands are predicted to reach a minimum volume, a minimum height, and a minimum diameter requirement. These minimum stand 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 tree size would be considered available for harvest. The minimum 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 in order to meet management objectives such as forest cover requirements. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

5 Timber Supply Sensitivity Analyses

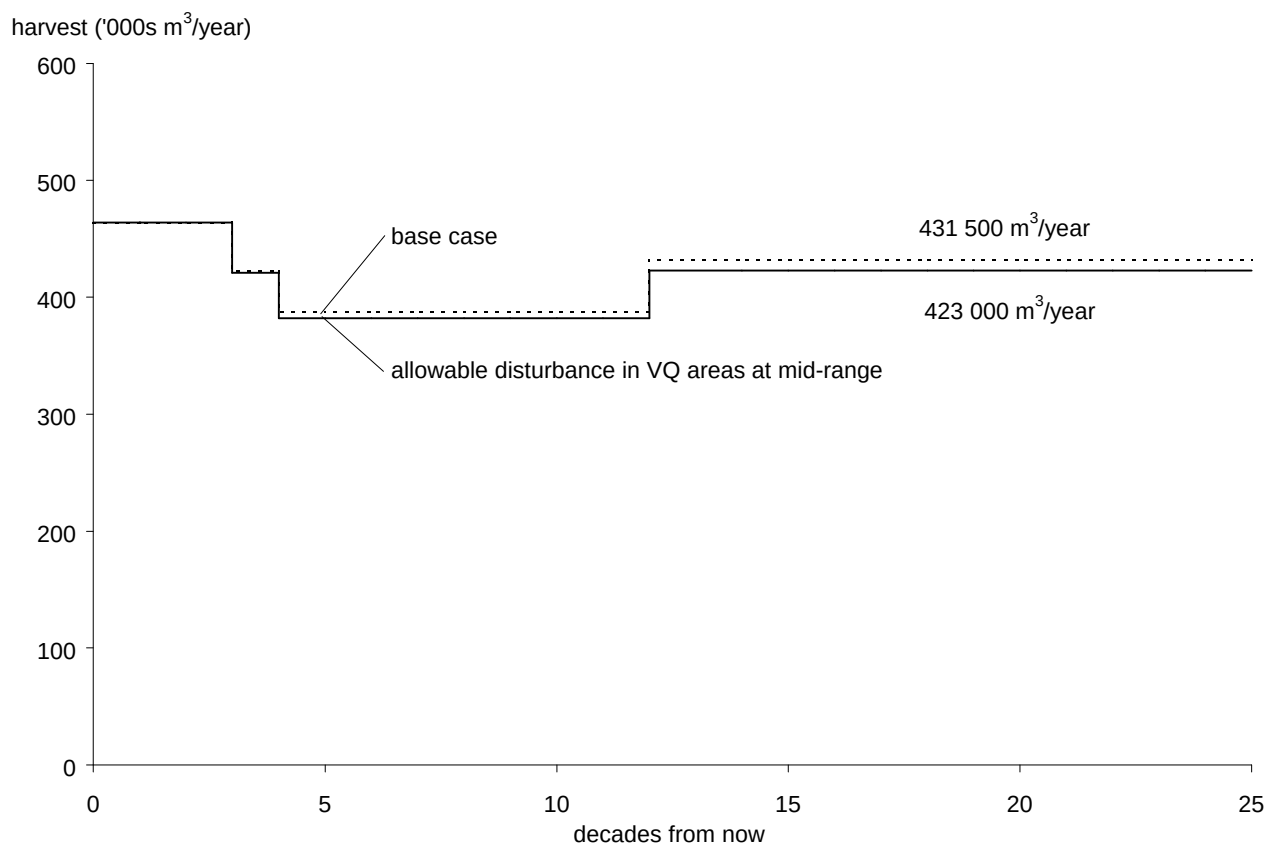


Figure 17. Harvest forecasts if forest cover objectives for visual quality management areas changed to the middle of the ranges — Kalum TSA, 1999

Figure 18 shows how timber supply changes if stands become merchantable either 10 years earlier or later than assumed for the base case, and also if minimum harvestable ages are set at 95% of the age of maximum average growth (culmination age).

If the minimum harvestable ages were decreased by 10 years, the 423 000 cubic meters harvest level in decade four of the base case can be maintained one more decade, to decade five, while the long-term harvest level would be reduced to 428 500 cubic meters per year, about 0.7% lower than in the base case. Over the 250-year period, the total volume harvested would be slightly lower than that of the base case.

If the minimum harvestable ages were increased by 10 years, the medium-term harvest level would be

reduced by 0.8%, but the short- and long-term harvest levels would not be affected relative to the base case.

If minimum harvestable ages were defined as 95% of the age at which stands achieve their maximum average growth, analysis results suggest that timber supply would be substantially reduced in the mid-term. Timber supply could be maintained at the current AAC for one decade only, before declining to a mid-term level slightly below that of the base case. The long-term level would be 2.8% above the base case since, on average, stands would be harvested closer to the time of maximum average productivity. Over the long-term the average harvested age in the base case is 111 years, while in this sensitivity analysis, the average is 127 years.

5 Timber Supply Sensitivity Analyses

In this analysis, minimum harvestable ages are not viewed as decisions made to meet forest management objectives, but rather as approximations of the timing of merchantability.

This analysis shows that timber supply is

significantly sensitive over the mid-term, and moderately sensitive over the long-term to substantial changes in minimum harvestable ages. Conversely, forecasted harvests are not highly sensitive to smaller 10-year changes in the minimum ages.

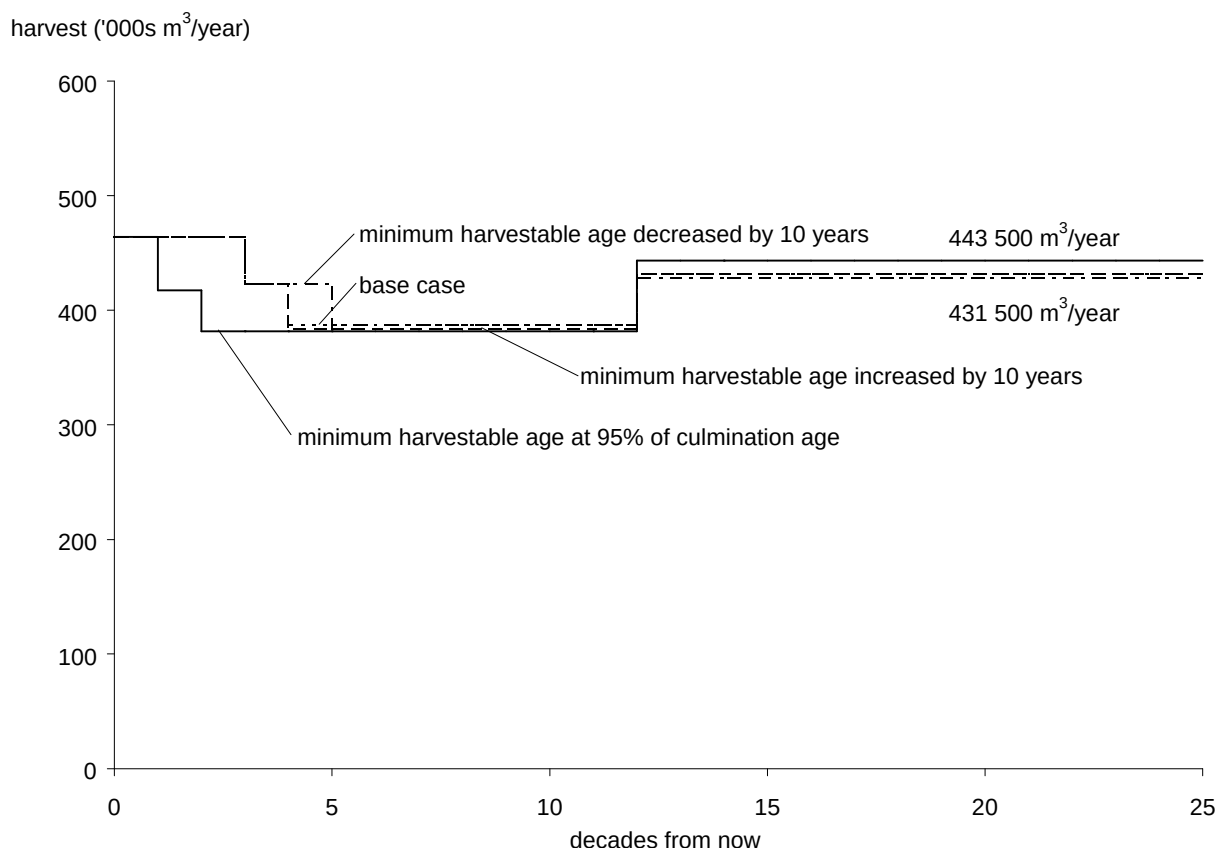


Figure 18. Harvest forecasts if minimum harvestable ages are 10 years younger or older than the base case — Kalum TSA, 1999

5.7 Uncertainty in estimates of timber volumes in existing stands

Estimates of standing timber volumes in existing forest stands 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 standing volumes 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.

5 Timber Supply Sensitivity Analyses

Figure 19 illustrates that timber supply over the next several decades in the Kalum TSA is very sensitive to uncertainty in existing stand volume estimates. If existing volumes are actually 10% greater than those used for the base case, the current AAC could be maintained until decade five - two decades longer than in the base case — with supply then declining to 411 000 cubic meters per year before rising in decade 12 to the same long-term level as in the base case. The cumulative harvest volume over the next 120 years would be approximately 5.8% higher than in the base case if existing volumes were 10% higher.

Conversely, if existing volumes are overestimated by 10% in the base case, the harvest can be maintained at the current AAC for only one decade before declining to 371 000 cubic meters per year by decade three. The medium-term harvest level is about 4.1% lower than that of the base case. If existing volumes are 10% lower than estimated for the base case, the total harvest volume

over the next 120 years would have to be about 6.4% less than that of the base case to avoid creating severe timber supply disruptions further in the future.

The existing stand volume decrease does not affect the long-term harvest level. This is because the existing stands comprise most of the timber harvested from the present time until decade five, after which time the managed stand contribution is higher than that of existing stands.

The mid-term timber supply is highly sensitive to changes in existing stand volumes. For reductions in existing volumes, high sensitivity exists because as the volume of timber that is obtained from each stand harvested decreases, harvesting must occur on more area to obtain the same total harvest volume. Thus, as the area covered by existing natural stands will be harvested at a faster rate than in the base case, the harvest level must be decreased earlier to ensure a gradual transition to harvesting in the second-growth forest. The opposite is the case for increase in estimates of existing stand volumes.

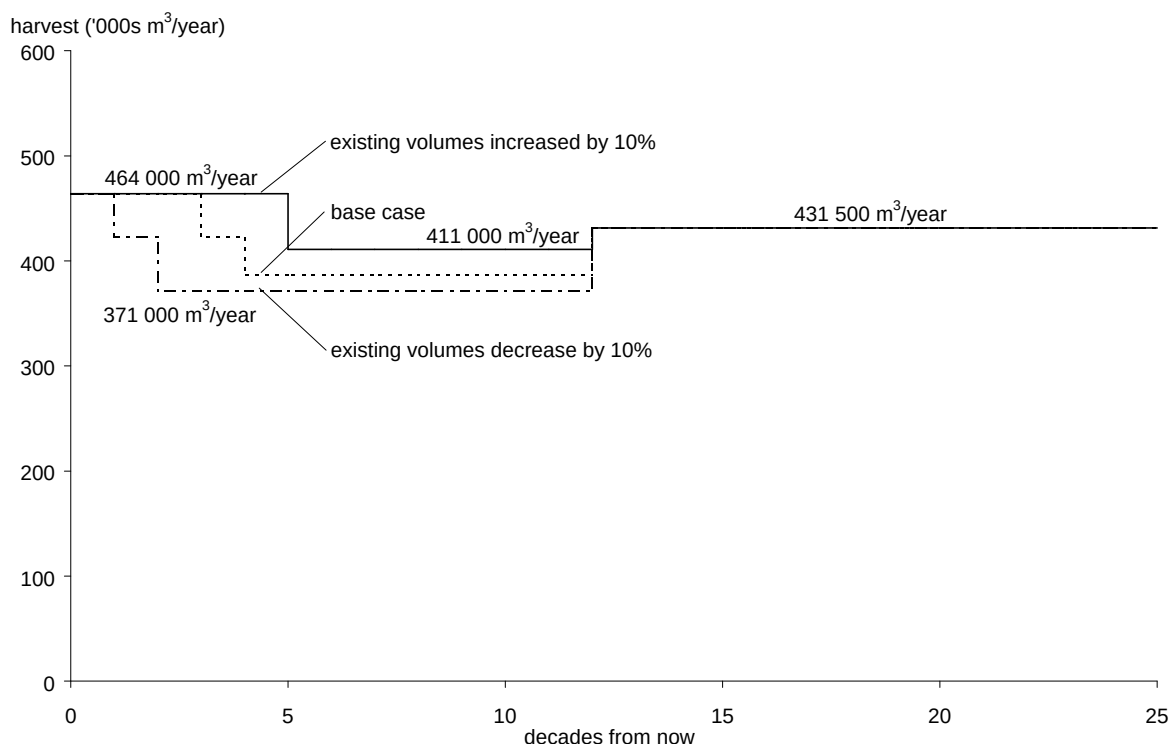


Figure 19. Effect on harvest forecast of 10% uncertainty in existing stand volumes — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.8 Uncertainty in regenerated stand volume estimates

Estimates of timber volumes in regenerated managed stands are uncertain for similar reasons as existing stand volumes; however, there is additional uncertainty around the estimates of site productivity (discussed further in Section 5.9, "Uncertainty in site productivity estimates"). In this section, the effects on timber supply of uncertainty associated with managed stand tables are examined.

Figure 20 shows the results if regenerated volumes are varied by 10% from those assumed in the base case. If managed stand volumes were to

exceed present volume estimates by 10%, medium- and long-term timber supplies would be approximately 9.2% higher than in the base case.

If regenerated stand volume estimates were in fact 10% lower than estimated, the long-term harvest level would be 379 000 cubic metres per year, approximately 12.2% lower than that of the base case, and the medium-term harvest level would be 2.1% lower than in the base case.

In summary, uncertainty about regenerated stand volume estimates has a significant impact on the mid- and long-term timber supply projected in the base case.

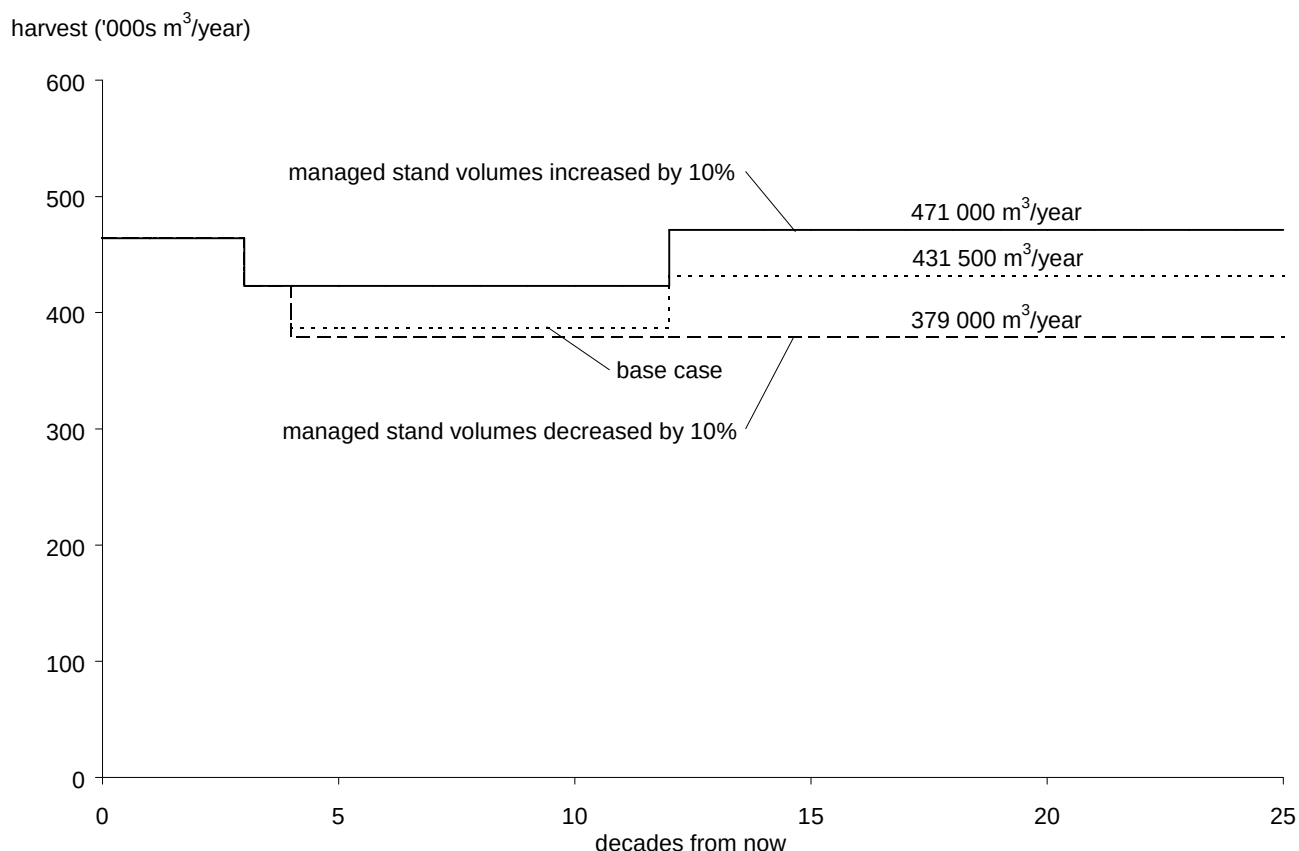


Figure 20. Harvest forecasts with managed stand volume estimates changed by 10% — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

5.9 Uncertainty in site productivity estimates

The productivity of a site largely determines how quickly trees will grow. It therefore affects both expectations of timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate assessments of site productivity come from stands between 30 and 150 years old. Estimating site productivity in both young- and old-stands is difficult. Currently, about 16% of the Kalum TSA timber harvesting land base comprises stands between 30 and 150 years old. Thus, a substantial area lies outside the age range that provides accurate estimates. This section examines how timber supply is affected by uncertainty in site productivity estimates which affect regenerated stand volumes, green-up ages, and minimum harvestable ages. Each of these has been examined individually in previous sections.

Site productivity is often expressed in terms of the site index* at a breast-height age of 50 years. If site indices were underestimated, regenerated stands would grow faster than estimated of the base case. As a result, they would reach the required green-up height sooner, and would achieve minimum merchantable volumes, and thus, minimum harvestable ages, sooner than estimated in the base case.

In 1994, an Old-Growth Site Index (OGSI) adjustment project was initiated to address identified problems with application of traditional site index

curves to old-growth stands (stands over 140 years in age). The project involved a number of studies. One study investigated the reliability of the estimated site indices from old-growth hemlock stands in Kalum TSA (Nigh and Love 1997). The results showed that the site index estimated in older (above 140 years old) western hemlock stands in the coastal western hemlock biogeoclimatic zone was, on average, 10 meters less than the site index measured in adjacent younger stands. This finding was included in the base case to better reflect the productivity of regenerated stands. The site index adjustment was applied to about 11 468 hectares, 11.7% of the timber harvesting land base.

Two other studies of significance for timber supply analysis were a province-wide paired-plot study and a veteran study (Nussbaum 1998, Nigh 1998). Both of these reports provide short-term OGSi adjustments for use in timber supply analysis. Besides those studies, an inventory audit was done in Kalum TSA and found that inventory inaccuracies may lead to underestimation of site index of the stands aged 20 to 60 years by as much as three meters. This section describes results of sensitivity analysis that examined the effects of uncertainties regarding site index adjustments.

Figure 21a displays how timber supply would change if the site index adjustment for coastal western hemlock (a 10-meter increase) was overestimated. If current data overestimate actual site index by only 5 metres, the long-term harvest level would be 396 000 cubic metres per year, 8.2% lower than the base case.

Site index

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

5 Timber Supply Sensitivity Analyses

Figure 21a also shows the effect of not applying the site index adjustment to coastal western hemlock. The short and medium-term supply would be the same as the base case. However, the

long-term harvest level of 363 000 cubic metres per year would be 15.8% lower than projected in the base case.

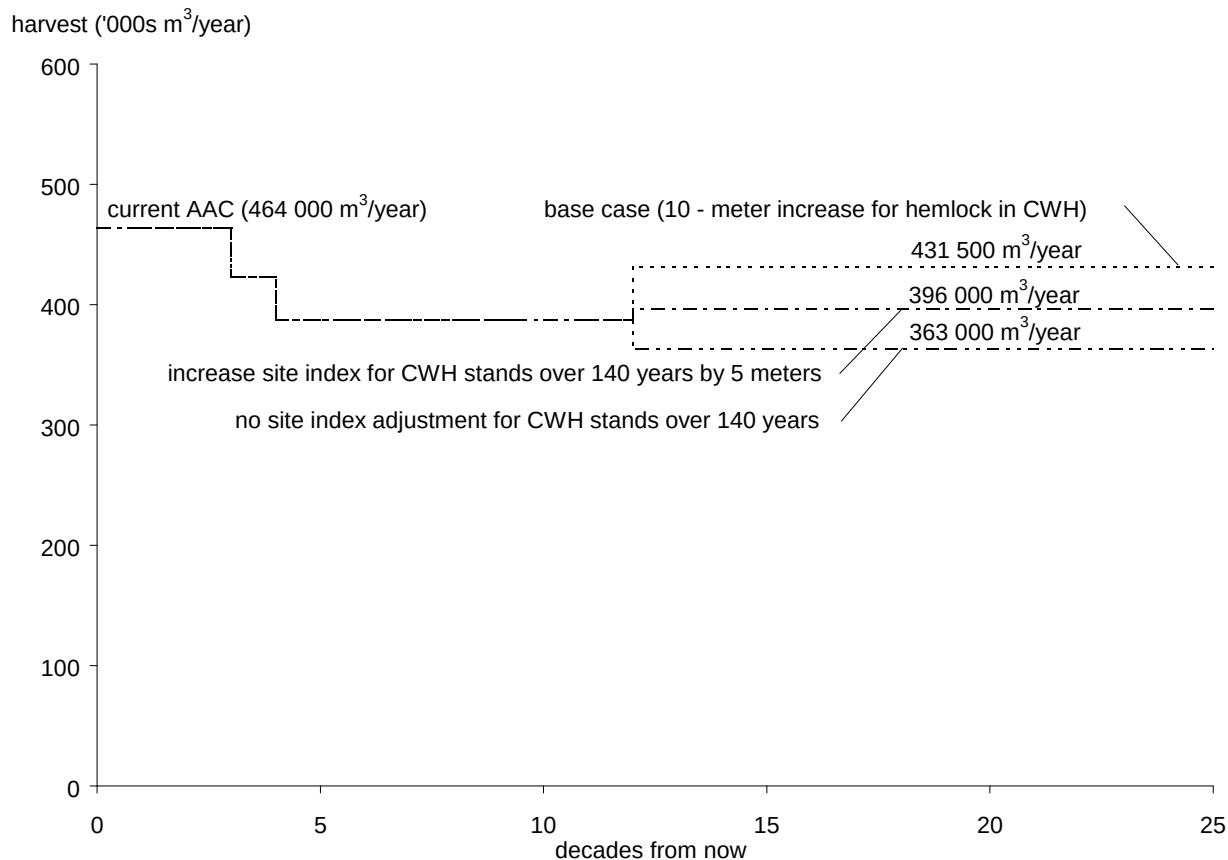


Figure 21a. Harvest forecasts with different levels of site index adjustment for hemlock in the coastal western hemlock zone — Kalum TSA, 1999

5 Timber Supply Sensitivity Analyses

Figure 21b illustrates the results if the site index of all old-growth stands in the current forest inventory except hemlock in the coastal western hemlock zone, were adjusted according to the veteran results (i.e., base case adjustment for hemlock still applied). Timber supply analysis inputs affected by changes in estimated future forest productivity (managed stand volume estimates, green-up ages and minimum harvestable ages) were recalculated based on the increased average site productivity. On

average, adjusted regenerated stand volume estimates were about 14.8% higher, the green-up ages were reduced by one year and the minimum harvestable ages dropped by 0 to 20 years. Results showed the long-term harvest level would be increased by about 13.3% over the base case harvest due to the increased managed stand volumes. The time to achieve the long-term harvest level would also be reduced by three decades.

harvest ('000s m³/year)

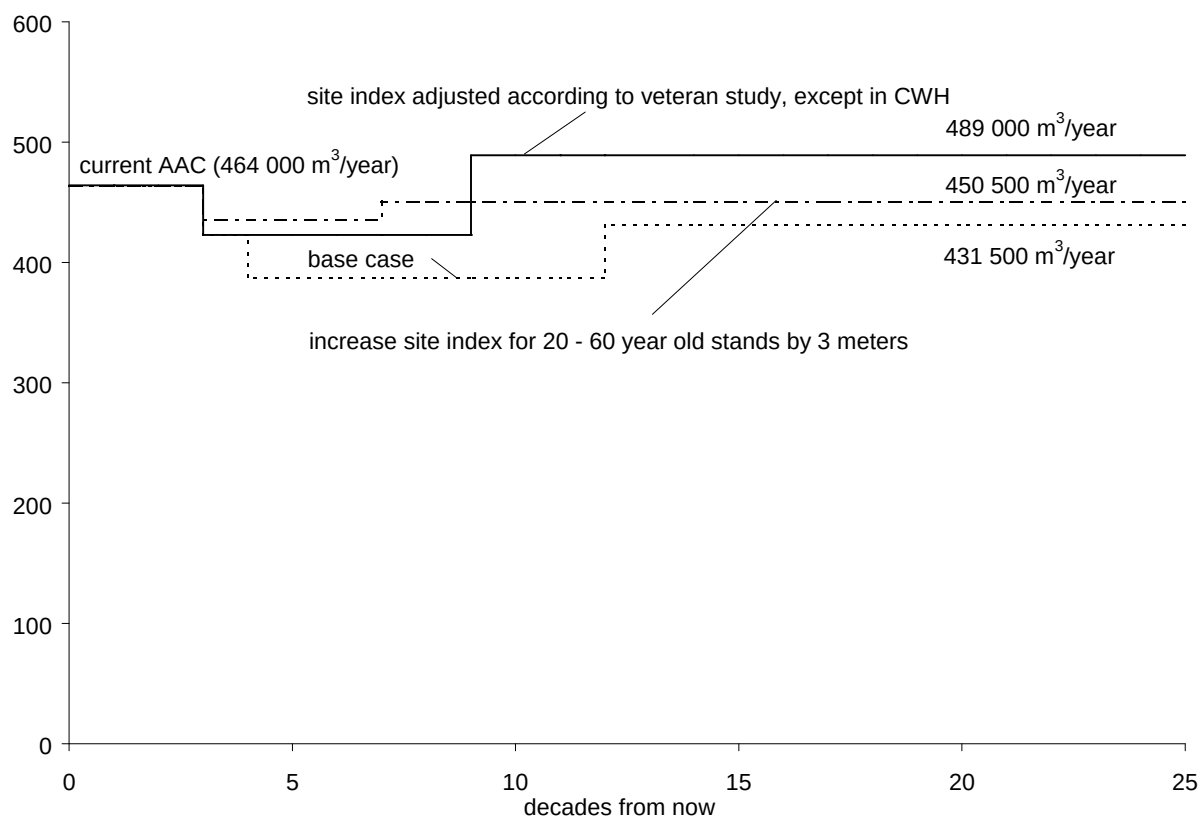


Figure 21b. Harvest forecasts incorporating veteran study and inventory audit-based site index adjustment — Kalum TSA, 1999

Figure 21b also shows the results if the site indexes of stands aged 20 to 60 years were increased by three meters. After 3 decades at the current AAC the timber supply drops to a mid-term level above the

base case and rises to the long term level of 450 500 at decade 8. The long term harvest level is 4.4% higher than that of the base case.

5 Timber Supply Sensitivity Analyses

The effect on the harvest forecast of the above changes in site productivity must be viewed cautiously. Research on the issue of future site productivity of older stands has provided an estimate of the maximum potential productivity that might be achieved in the future forest. How well most regenerated stands are performing relative to this theoretical maximum is still unclear. In addition, cautions have been provided by research and inventory staff that the veteran study and the inventory audit in particular suggest only trends in site productivity. These results should not be viewed as exact representations of actual site index. Hence, the timber supply projections shown in Figure 21b display general trends in timber supply impacts that might occur should improved site index adjustments apply to a larger portion of the land base.

In summary, uncertainty about site productivity dramatically affects long-term, and potentially mid-term timber supply. However, if site productivity has been overestimated in the base case, immediate harvest level reductions would not be required to avoid severe future timber disruptions, while long-term timber supply would be well below that of the base case.

5.10 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 terrain resource inventory mapping (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.

To assess the potential impact of uncertainty in defining the size of the timber harvesting land base, the area in all stand types and ages within the timber harvesting land base in the base case was both increased and decreased by 10%. For increases in the timber harvesting land base, the additional area was assumed to come from inoperable areas. For timber harvesting land base decreases, the area removed from the timber harvesting land base was assumed not to contribute to timber supply, but continued to contribute to forest cover requirements for wildlife and old growth.

5 Timber Supply Sensitivity Analyses

Figure 22 shows how a 10% increase in the land base would affect potential harvests. With the current harvest level being maintained for three decades, the medium-term harvest level could be maintained at 433 000 cubic meters per year, 11.9% higher than the base case, and the long-term harvest level would be 476 000 cubic meters per year, 10.3% higher than in the base case.

Results displayed in Figure 22 indicate that if the land base were 10% smaller than in base case, the current harvest level could be maintained for one decade. Both the medium-term and long-term harvest level would be significantly lower. The medium-term harvest level would be 361 000 cubic

meters per year, 6.7% lower and the long-term harvest level would be 10.8% lower than that of the base case.

In summary, timber supply is sensitive to uncertainty about the size of the timber harvesting land base. Short-term timber supply is not affected in the cases examined here. However, changes in the size of the timber harvesting land base would affect timber supply 10 to 120 years from now, as will as in the long term. An increased land base results in increases in both the medium- and long-term harvest level projected in the base case; a decreased land base would either require earlier harvest level reductions, or large declines further into the future.

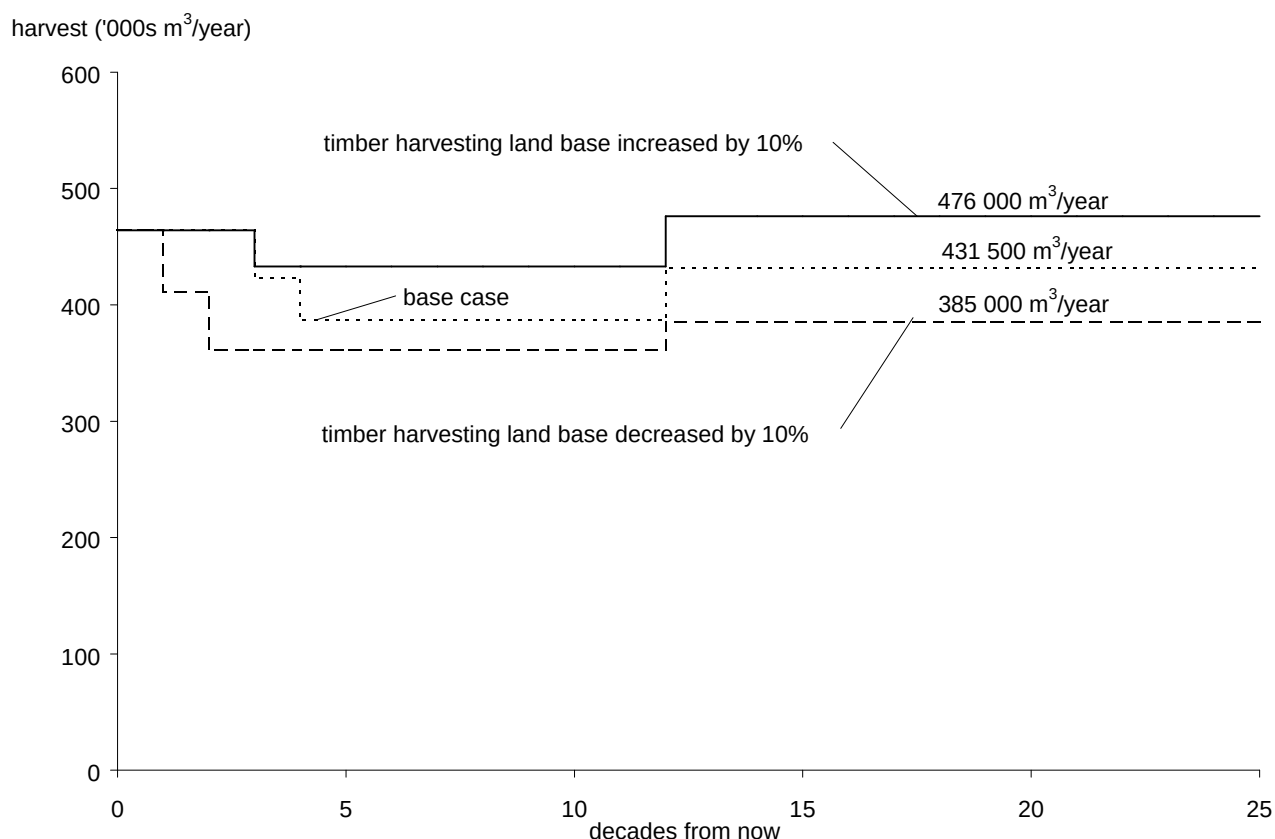


Figure 22. Harvest forecasts reflecting uncertainty in size of the harvesting land base — Kalum TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.11 Effects of land base changes implied by Nisga'a agreement in principle

The Nisga'a Final Agreement identifies a total of 32 286 hectares within the Kalum TSA, of which about 4700 hectares are within the timber harvesting land base.

Figure 23 illustrates two alternative harvest flows if the land outlined in the Nisga'a agreement was taken out of the TSA immediately. Option one maintains the current harvest level for three decades. The medium-term harvest level declines in three steps of approximately 8% each, to 366 000 cubic meters per year, before rising in decade 12 to the

long-term harvest level of 411 000 cubic meters. Option two maintains the current harvest level for one decade. The harvest level then declines in two steps of approximately 8% each to 387 000 cubic meters per year, the same mid-term level as the base case, before rising in decade 12 to the long-term harvest level of 411 000 cubic meters per year. The long-term is 4.8% lower than that of the base case.

Figure 23 also shows one of the many possible harvest forecasts for just the Nisga'a lands within the Kalum TSA. This forecast starts at 29 550 cubic meters per year and declines at approximately 10% per decade to the long-term level of 21 750 cubic meters per year.

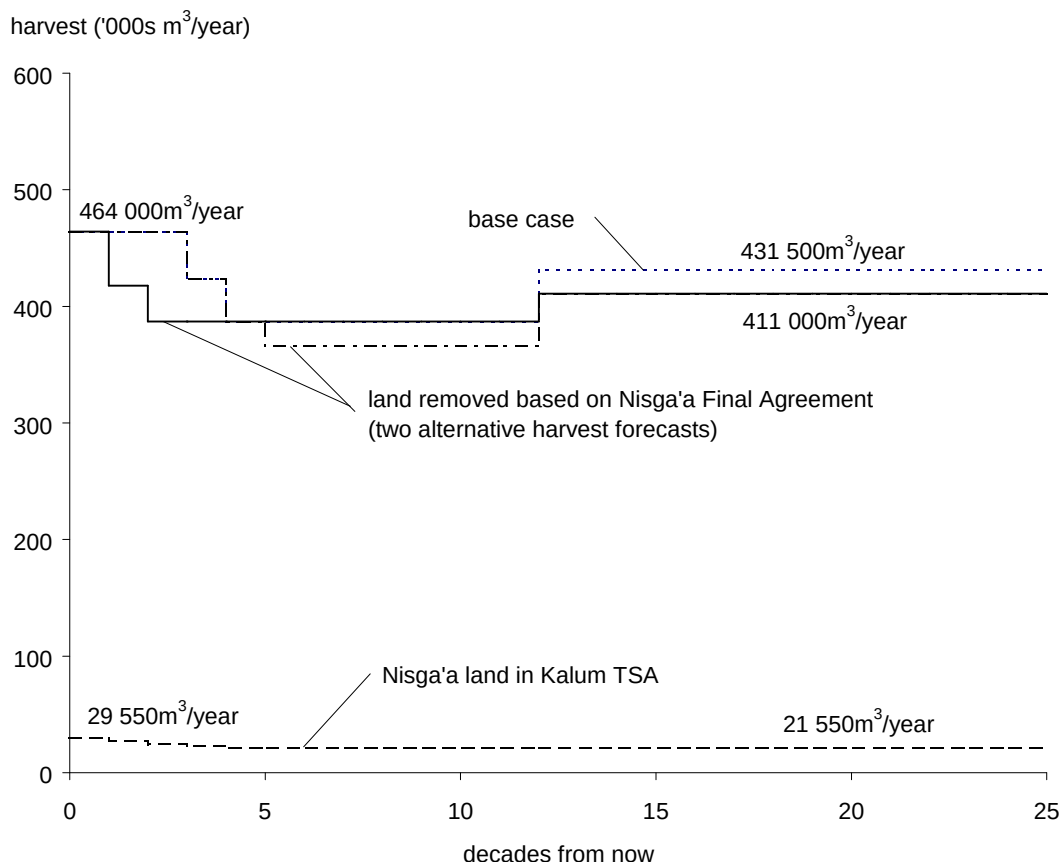


Figure 23. Timber supply impacts of land changes implied in the Nisga'a Final Agreement – Kalum TSA, 1999

In summary, timber supply is impacted substantially by the land changes implied in the Nisga'a agreement. The decreased land base would

require either earlier harvest level reductions, or large declines in the future.

5 Timber Supply Sensitivity Analyses

5.12 Sensitivity to additional helicopter logging areas

Kalum Forest District staff suggested that inoperable stands with volume per hectare 700 cubic meters or greater may be available for helicopter logging. Based on this criterion 4450 hectares or 4.5% would be added to the timber harvesting land base.

Figure 24 illustrates the timber supply impacts of including the additional area in the timber harvesting

land base. Timber supply would follow the base case for 3 decades and then decline slightly to a level that is 15.6% above the base case in the mid-term, and 3.7% higher in the long term. Depending on the economic, physical and environmental feasibility of helicopter logging on different areas, this technology has the potential of substantially increasing timber supply in the Kalum TSA.

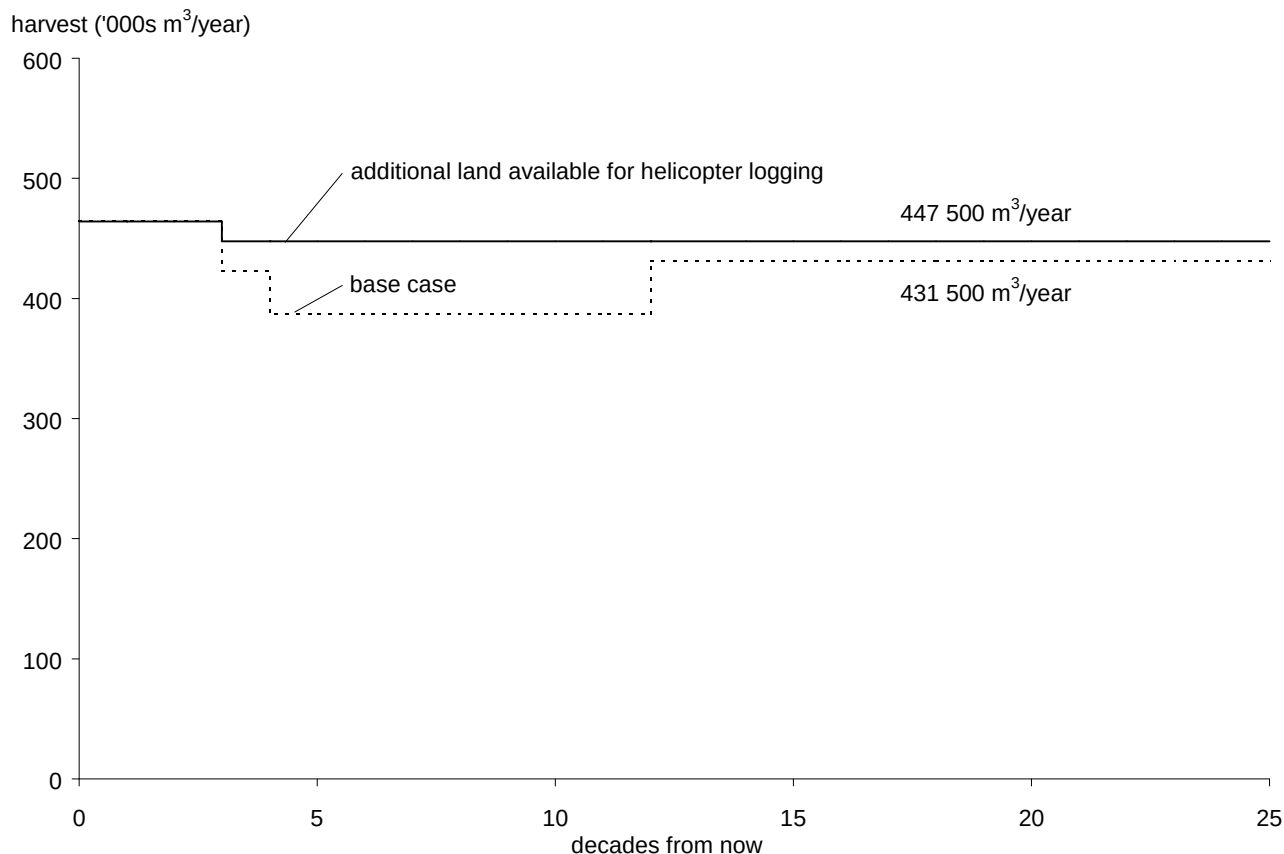


Figure 24. Effects of adding helicopter logging areas to the timber harvesting land base — Kalum TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.13 Uncertainties in application of the seral stage requirements in the Forest Practices Code Biodiversity Guidebook

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biological diversity as an essential component of the sustainable use of forests. The *FPC Biodiversity Guidebook* provides recommendations for maintaining biodiversity at both the stand level and the landscape level. Stand-level biodiversity has been addressed in this analysis by removing portions of each stand from the timber harvesting land base to represent wildlife trees. Uncertainty about stand-level biodiversity can be assessed through sensitivity analysis that examines the timber supply impacts of land base reductions. Landscape-level biodiversity, however, has been modelled in this analysis through the use of forest cover requirements for old-seral forest applied to biogeoclimatic zone/sub-zone/variant types within each landscape unit. There is uncertainty about how the recommendations in the biodiversity guidebook should be interpreted and applied. In the base case, specific biodiversity emphasis options (lower,

intermediate, higher) were applied to each landscape unit. The following sensitivity analyses provide an indication of the risk associated with uncertainty about management for landscape-level biodiversity.

Figure 25 shows the effect on the harvest forecast of applying both the early-seral and mature plus old requirements in addition to the late-seral guidelines which were been included in the base case. Compared to the base case, the short and long-term harvest level would not be affected, while the medium term timber supply would decline by 0.8%.

In areas of the province without declared landscape units and emphasis options, a standard analysis approach has been to model average forest cover requirements, reflecting application of lower emphasis on 45% of the land base, intermediate emphasis on 45%, and higher emphasis on 10%. Analysis showed that application of this 45/45/10 average, rather than the specific emphasis applied in the base case, did not affect timber supply. In conclusion, uncertainty regarding application of biodiversity requirements does not affect timber supply in the Kalum TSA, primarily because of the large amount of forest outside the timber harvesting land base that can meet those objectives.

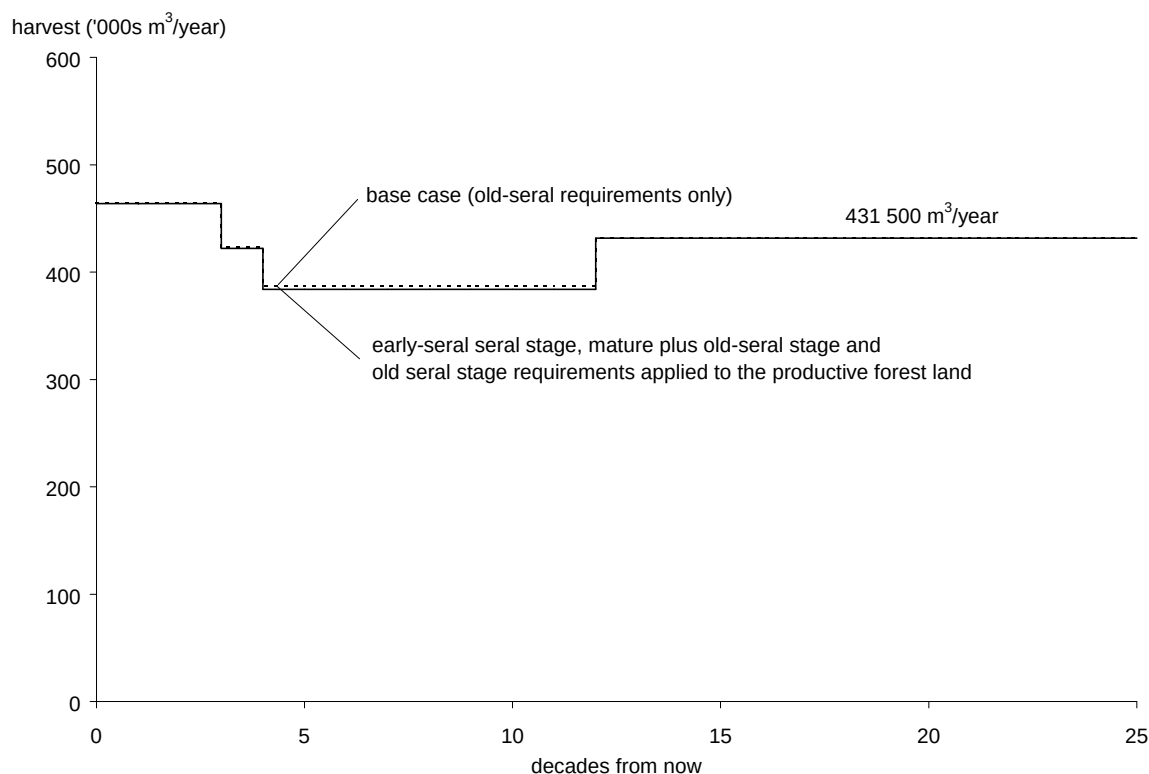


Figure 25. Harvest forecast if both the early-seral stage and mature plus old-seral stage guidelines from the *Forest Practices Code Biodiversity Guidebook* are applied — Kalum TSA, 1999.

5 Timber Supply Sensitivity Analyses

5.14 Uncertainty in the area available for commercial thinning

In the base case, 2157 hectares of forest land with site index over 24 meters at 50 years are scheduled for commercial thinning. Commercial thinning contributes about 1% to timber supply in the short and medium term since the area currently available for thinning is only approximately 2% of the timber harvesting land base. Additional areas amounting to up to 6000 hectares may be suitable for commercial thinning approximately 60 years from now when sites subject to the site productivity adjustments reach suitable age. Due to the uncertainty around the

timing of the availability and whether these sites will actually be suitable, it is difficult to project the effect of commercial thinning on timber supply beyond the contribution of the currently suitable stands. In any case, the effects will be in the mid- and long term. Given the potential for commercial thinning to increase flexibility in harvest scheduling, help achieve integrated resource management objectives, and potentially allow some timber harvesting in areas where non-timber objectives would not permit clearcutting, district staff will continue to evaluate stands for inclusion in the commercial thinning program.

6 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current allowable harvest level in the Kalum TSA of 464 000 cubic metres per year can be maintained for up to 30 years without creating severe future timber supply disruptions. Using current inventory and timber growth information, and assuming continuation of current forest management practices, harvests could be maintained at the current level for 30 years if followed by two declines over the subsequent 2 decades to 387 000 cubic meters per year, and a rise to the long-term harvest level of 431 500 cubic metres per year in decade 12.

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

Several factors were shown to have a significant effect on timber supply either in the medium- or long-term, or both. These include estimates of: site productivity, existing stand volumes, regenerated stand volumes, minimum harvestable ages, additional land available for helicopter logging, the size of the timber harvesting land base, and the Nisga'a land agreement. Uncertainty involving estimates of site productivity had the largest potential effect on projected harvest levels over the next 250 years.

Uncertainty about the age at which stands reach green-up conditions, about forest cover requirements to maintain visual quality, and about the older-forest cover requirements for biodiversity, have a small to moderate impact on timber supply during the transition to harvesting mainly second-growth stands. Areas of uncertainty which have almost no effect on short-term supply and only a small impact on medium-term timber supply include: application of young and mature seral requirements for landscape biodiversity and the age at which old-forest characteristics are achieved.

Over the long-term, (the period from 120 to 250 years from now), site productivity, regenerated stand volume estimates, additional land base available for helicopter logging, and the size of the timber harvesting land base have large effects on timber supply. Forest cover requirements for visual quality have moderate effects on long-term harvest levels. Minimum harvestable ages, green-up ages, maximum disturbance objectives for the integrated resource management zone, and estimates of timber volumes in existing stands have low 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 Kalum TSA can be maintained at the current allowable level for the next 30 years. Several factors related to the current forest inventory and management regime could affect timber supply over the next 10-50 years.

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. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Kalum TSA to the level of activity that could be supported as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines the harvest levels as projected in the base case harvest forecast and does not evaluate alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Kalum 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 Overview

The socio-economic analysis focuses on the timber supply from the Kalum TSA; however, the TSA is part of the larger Kalum Forest District (see map, page 5). The forest district is comprised of two

timber supply areas (Kalum and Nass) and includes portions of Tree Farm Licences (TFLs) 1 and 41. Since there are communities located throughout the forest district and employment is not easily separated between the TSA and TFLs, this section profiles the forest district, instead of the TSA; Section 7.3 describes the socio-economic impacts that result from changes to the Kalum TSA timber supply, and how those changes could affect communities within the larger forest district and province.

7.1.2 Population and demographic trends

According to the 1996 Census, the population of the Kalum Forest District increased 4.6 per cent since 1991 to 34,900 (see Table 3). In comparison, the population of the province increased approximately 14.1% over the same period. The population of the Kalum TSA is concentrated in the two largest centres: Terrace (13,372) and Kitimat (12,077). Other smaller communities include Thornhill, a residential suburb of Terrace, and the First Nations settlements of Gitlakdami, Gitwinksihlkw, Kitselas, Kitamaat Village and Kitsumkalum. By 2001, the population of the district is expected to grow by another six or seven percent to approximately 37,250.¹

Table 3. Population trends — Kalum Forest District (1986-1996).

COMMUNITY	1986	1991	1996	% Chg/yr 1991-96
Terrace	10,753	11,765	13,231	12.5
Kitimat	11,518	11,634	11,490	-1.2
Others	8,999	9,977	10,179	2.0
Kalum Forest District	31,270	33,376	34,900	4.6

Source: Census of Canada 1986, 1991, 1996

¹ Estimate from Population Section B.C. STATS.

7 Socio-Economic Analysis

7.1.3 Economic profile

The average unemployment rate in the Terrace-Kitimat region, during 1996, was about 9.6 percent, down about three percentage points from 1991, and about at par with the British Columbia provincial average. The annual value of residential, commercial, and industrial building permits, has remained relatively constant, at about \$30 million annually, attesting to the build-up of infrastructure and associated construction activities.

Terrace and Kitimat dominate the economy of the Kalum TSA, and although the two communities are closely linked on the basis of trade and services, they exhibit very different economic profiles.

Kitimat's economy relies primarily on the Alcan complex, with the Eurocan pulp and paper facility and the Methanex Corporation methanol-ammonia plant also playing important roles. Alcan Ltd. operates a 272 000 tonne-per-year aluminum smelter at Kitimat and a hydro-electric generating plant at

nearby Kemano, employing approximately 1,800 people in these operations. Eurocan's Kitimat mill employs over 650 people and produces unbleached kraft paper and linerboard. The Methanex plant employs 130 people in Kitimat and produces approximately 500 000 tonnes of methanol and 270 000 tonnes of ammonia per year. In 1997, Methanex supplied approximately 27 percent of the total world demand for methanol.

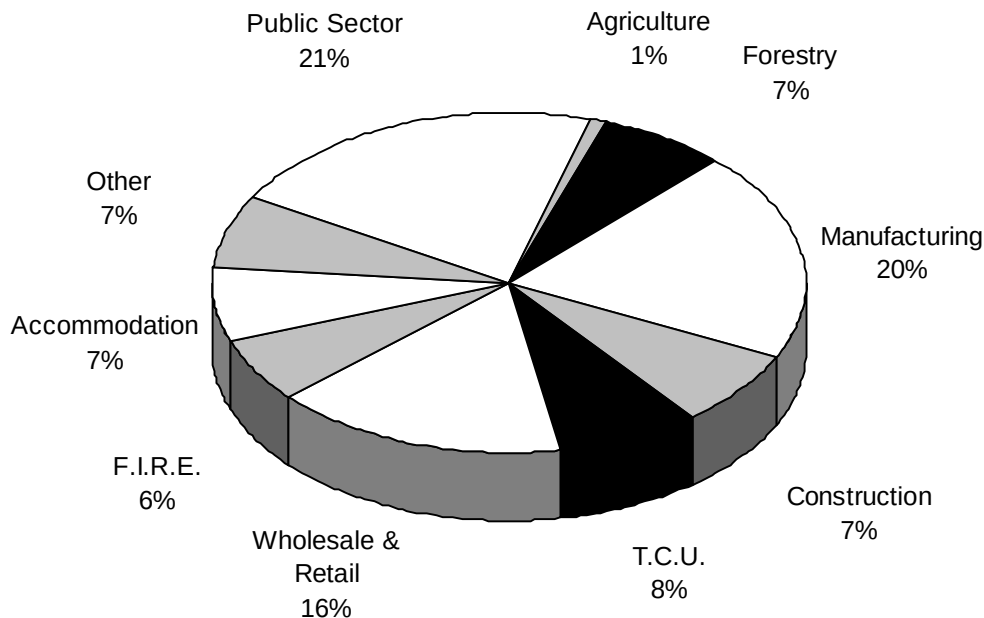
The economy of Terrace is primarily based on the forest industry, although Terrace is also the service and trade centre for the northwest. The area is known for exceptional sport fishing and outdoor recreational activities. Terrace is the headquarters for Skeena Cellulose Inc.'s woods operation which supplies logs to its sawmill in Terrace as well as to the company's kraft pulp mill in Prince Rupert. West Fraser Mills Ltd. also has a large processing plant in Terrace. Together, these two facilities employ close to 500 people.

7 Socio-Economic Analysis

During 1996, direct forestry-related employment at all TSA mills amounted to almost 1200 positions. Figure 26 illustrates the shares of total employment by industry sector for the Kalum Forest District.

Although it suggests only a minor dependence on forestry, the transportation, F.I.R.E. and manufacturing sectors all include significant amounts of direct and indirect forestry related activity.

Figure 26. Employment by industry sector, Kalum Forest District 1996



Notes: The figures are for the Kalum Forest District and include employment that relies on both the Kalum and Nass TSAs as well as TFL timber supply. Forestry consists of harvesting related activity, but does not include processing. Processing is included in the manufacturing sector. Forestry headquarters employment is captured in business services of the FIRE category. FIRE consists of finance, insurance, real estate and other business services; TCU consists of transportation, communications and utilities; and Public Sector consists of local and provincial government services, health and education.

Source: Statistics Canada / Census of Canada

An analysis of employment multiplier impacts confirms forestry's relative importance in the Kalum TSA. For every 100 direct forestry jobs in the TSA another 30 to 59 indirect and induced jobs² are supported, depending on the type of forestry activity (logging, pulp & paper or wood manufacturing) and the associated level of wages and salaries. In contrast, for every 100 public sector jobs, another 11 positions are supported, while every 100 tourism jobs support a further six positions. Only the mining and

mineral processing industry (associated with the Alcan and Methanex plants) falls into a similar range as forestry, at 29 associated positions per 100 direct jobs.

A breakdown of income dependencies (including direct, indirect and induced impacts) further confirms forestry's importance to the economy of the Kalum Forest District. Twenty percent of all basic, after tax income is forestry dependent³ accounting for approximately 25 percent of all local employment⁴.

² British Columbia Local Area Economic Dependencies and Impact Ratios, February 1995, Ministry of Finance and Corporate Relations

³ Ibid

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

7 Socio-Economic Analysis

7.2 Kalum TSA forest industry

7.2.1 First nations and treaty negotiations

Two recent and pertinent court rulings (June 1998) temporarily shut down logging about 30 kilometers south of Prince Rupert, in the adjoining North Coast TSA. In these decisions, British Columbia Supreme Court judges issued injunctions ordering International Forest Products Ltd. to halt logging on parcels of land claimed by members of the Kitkatla Indian Band. The decisions were based on the Supreme Court of Canada's Delgamuukw ruling in December of 1997, which found that aboriginal bands that have not signed treaties have a constitutional right to their ancestral lands, and that governments must consult with them when making decisions about the use of their traditional lands.

Once the Nisga'a treaty is ratified, it may result in the gradual transfer of jobs associated with the transfer of cutting rights to the Nisga'a. In addition, the province will no longer collect stumpage and rents for forest activities on these lands; the Nisga'a will retain this revenue which will help reduce transfer payments from provincial and federal governments to the Nisga'a

government. The magnitude of transfers and/or reductions to forestry activity should be relatively minor compared to the size of the regional industry. A transition period, to be included in the treaty, will also help to minimize the effects. Job loss experienced by non-Nisga'a may be offset by naturally occurring vacancies within the industry.

After 10 years, new economic activity could result if the Nisga'a establish a new primary processing facility, and if existing plants are able to maintain a sufficient supply of wood. Any Nisga'a venture into value-added timber processing would also increase economic activity.

7.2.2 Current allowable annual cut

The current allowable annual cut (AAC) for the Kalum TSA is 464 000 cubic metres; reduced from 480 000 cubic metres in 1995. The AAC is apportioned into a number of licence types as outlined in Table 4. Three companies have replaceable forest licences in the TSA accounting for 81% of the total AAC (375 476 cubic metres). The remainder is apportioned among several other forms of tenure including timber sale licences and the Small Business Forest Enterprise Program (SBFEP).

Table 4. Allowable annual cut apportionment, by licence type — Kalum TSA 1997.

Type of licence	Volume (m ³)	Percent
Forest Licences - replaceable	375 476	80.9%
SBFEP*	75 120	16.2%
Timber Sale Licences	2 404	0.5%
Forest Service Reserve	4 500	1.0%
Woodlot Licences	6 500	1.4%
Total	464 000	100.0%

*Small Business Forest Enterprise Program.

Source: Ministry of Forests, Resource Tenures and Engineering Branch

7 Socio-Economic Analysis

7.2.3 Kalum TSA harvest history

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

From 1994 to 1997 approximately 415 000 cubic metres of timber were harvested annually from the Kalum TSA; accounting for 25% of the total Kalum Forest District harvest. Additional sources of timber include private lands and Indian reserves, which amounted to approximately 6000 cubic metres per year over the last two years. Another source of timber and employment in the region are Skeena

Cellulose's TFL 1, and West Fraser Mills' TFL 41 with AACs of 690 050 cubic metres and 378 500 cubic metres per year, respectively.

The Kalum Forest District makes up about five percent of the total harvest in the Prince Rupert Forest Region (8.2 million cubic metres) while the region, in turn, accounts for about 11 percent of the total provincial harvest (73 million cubic metres).

Table 5 summarizes the volume of timber harvested in the Kalum TSA from 1994 to 1997. It indicates a significant decline in 1997 due to on-going labour difficulties at Skeena Cellulose's Prince Rupert pulp mill during the first half of the year, and poor lumber markets and chip prices later in the year. The decline also reflects the reduction in the Kalum TSA's AAC in 1996. Differences in annual harvest levels can also be the result of provisions for cut control⁵ that allow licensees to vary their harvest levels based on operating and market conditions.

Table 5. Volumes billed, by licence type — Kalum TSA 1994-97.

Tenure	1994 (m ³)	1995 (m ³)	1996 (m ³)	1997 (m ³)	average 1995-97 (m ³)
Forest Licences	245 233	383 598	432 653	257 436	357 896
SBFEP*	48 910	63 665	45 151	38 596	49 137
Other**	7 143	7 861	9 102	7 188	8 050
Total	301 286	455 124	486 906	303 220	415 083

Source: Ministry of Forests

* Small Business Forest Enterprise Program.

** Other consists of cutting permits such as rights of way, road permits, and other smaller permits.

⁵ A licensee's harvest may differ from the AAC by up to 50 percent on an annual basis, although the average harvest must be within ten percent of the AAC over each five-year period.

7 Socio-Economic Analysis

7.2.4 Kalum TSA major licensees

Skeena Cellulose Inc. (Skeena) has a replaceable forest licence to harvest 334 254 cubic metres per year in the Kalum TSA. Skeena has numerous other tenures throughout the province and is British Columbia's eighth largest licence holder at 2.3 million cubic metres per year. Table 6 outlines Skeena's recent harvest activity in the Kalum TSA and its 1997 employment levels for Kalum TSA operations.

Skeena operates a large sawmill and chipping plant in Terrace, with an annual capacity of approximately 600 000 cubic metres of timber. The plant employs approximately 225 people. Skeena also operates four other timber processing facilities in the Prince Rupert Forest Region. In 1997, Skeena's facilities in B.C. processed almost two million cubic metres of timber and employed about 1,200 people. The Kalum TSA can provide approximately 15 percent of Skeena's total provincial timber requirement. Skeena obtains another 25 to 30 per cent of its requirement from TFL 1.

Table 6. *Skeena harvest and direct employment statistics.*

AAC	334 254 cubic metres
1997 harvest	170 824 cubic metres
1995 - 1997 average harvest	294 953 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	70
Processing	132

Note: the employment figures relate to the volumes harvested from the Kalum TSA land base only.

West Fraser Mills Ltd. (West Fraser) has a replaceable forest licence to harvest 27 481 cubic metres per year in the Kalum TSA. West Fraser has numerous other tenures throughout the province and is British Columbia's fourth largest licence holder at 4.2 million cubic metres per year. Table 7 summarizes the harvest activity and employment associated with West Fraser's operations in the Kalum TSA.

West Fraser's Terrace mill employs about 250 people. Economic conditions are difficult for the mill due to the predominance of poor quality logs which must be harvested in difficult terrain, together with current low prices for pulp wood. Poor financial

performance resulted in several temporary shutdowns during 1997, although the mill still managed to process 80 percent of its annual capacity of 650 000 cubic metres. The Kalum TSA contributes about five percent of the Terrace facility's annual requirement, with the balance provided by TFL 41 and the adjoining Nass and North Coast timber supply areas. A portion of West Fraser's harvest from the Kalum TSA is processed at Skeena Cellulose's chip and lumber plant in Terrace. Finally, wood chips from West Fraser's Terrace mill are trucked to the Eurocan pulp and paper complex in Kitimat, where they support additional employment.

Table 7. *West Fraser harvest and direct employment statistics.*

AAC	27 481 cubic metres
1997 harvest	66 381 cubic metres
1996-1997 average harvest (see Note 2)	69 123 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	27
Processing	23

Notes

- (1) the employment figures relate to the volumes harvested from the Kalum TSA land base only.
- (2) West Fraser had minimal harvesting activity on FL A16885 in 1994 and 1995.

7 Socio-Economic Analysis

Bell Pole Co. Ltd. (Bell) has a replaceable forest licence to harvest 13 741 cubic metres per year in the Kalum TSA. In addition, Bell holds eight other tenures throughout the province, totalling 178 000 cubic metres per year.

The company operates four post and pole facilities in the province at Terrace, Lumby, Revelstoke and Maple Ridge. The Terrace operation is the smallest of the four, employing between five

and 10 people. Bell exchanges most of its harvest from the Kalum TSA with Skeena's Terrace sawmill, for the specialty timber it requires. Bell obtains between 50 and 75 percent of its requirements from outside the Kalum TSA. Table 8 outlines Bell's recent harvest activity in the Kalum TSA and associated employment levels.

Table 8. Bell harvest and direct employment statistics.

AAC	13 741 cubic metres
1997 harvest	25 076 cubic metres
1995-1997 average harvest	13 653 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	4
Processing	8

Notes: (1) the employment figures relate to the volumes harvested from the Kalum TSA land base only.
(2) Bell had minimal harvesting activity on FL16836 in 1994 and 1996.

Other licensees in the Kalum TSA are mainly comprised of Small Business Forest Enterprise Program participants with an AAC apportionment of 75 120 cubic metres. From 1995 to 1997, SBFEP harvests averaged about 49 000 cubic metres annually, which would normally support between 45 and 60 direct harvesting, silviculture and processing person-years.

Other Processing Facilities

In addition to the mills discussed above, Eurocan Pulp & Paper Co. Ltd. (a subsidiary of West Fraser) operates a large kraft and mechanical pulp plant in Kitimat, employing almost 700 people and producing over 300 000 metric tons of linerboard and more than 100 000 metric tons of kraft paper per year. Over the last 10 years Eurocan's Kitimat facility has seen

significant upgrades with additional expenditures to meet environmental regulations.

7.2.5 Forest sector employment summary

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

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

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.

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Harvesting and Silviculture Employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and in close to the same proportions.

The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities occur at least three to six years after harvesting. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilizing, and pruning. In the Kalum TSA, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown Land, which is normally completed by silvicultural contractors.

Primary timber processing employment

Processing facilities in the TSA rely on the Kalum TSA and other TSAs, TFLs, woodlots, and private lands in the area for their timber supply. Timber from the Kalum TSA also supports processors located throughout the region and province.

Forest Service Employment

The Kalum TSA is administered by the Kalum Forest District office in Terrace. Currently, 65 people work in the forest district office. Since Forest Service activities are related more to the administration and enforcement of government policy than to the timber harvest, these jobs are not included in the analysis of forestry sector impacts.

Kalum TSA Forestry Employment and Employment Coefficient Summary

Table 9 summarizes employment supported by the 1995 to 1997 average harvest in the Kalum TSA, and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

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

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

The average annual harvest from the timber supply area, from 1995 to 1997, was 415 000 cubic

metres, less than the AAC. If the full AAC of 464 000 cubic metres was harvested, it could potentially support a higher level of employment.

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

Table 9. Kalum TSA employment and employment coefficients.

Activity	TSA person-years	TSA coefficients	Provincial person-years	Provincial coefficients
Harvesting	129	0.31	140	0.34
Silviculture	29	0.07	38	0.09
Processing	159	0.38	213	0.51
Total Direct	316	0.76	391	0.94
Indirect + Induced	179	0.43	412	0.99
Total employment	495	1.19	803	1.93

(a) Note: employment estimates are person-years based on average 1995-97 employment levels and the average 1995-1997 harvest of 415 thousand cubic metres. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates. For further discussion please see the economic assessment methodology appendix.

7.2.6 Kalum TSA employment income

From 1995 to 1997 the average annual income for direct forest sector employees was approximately \$49,000; and \$34,000 for indirect and induced employment (in 1997 dollars). Based on these averages, current harvesting, silviculture, and

processing of timber from the Kalum TSA generates an estimated \$19.2 million in direct wages and salaries and \$14.0 million in indirect and induced wages and salaries, annually throughout the province (see Table 10).

Table 10. Average annual direct and indirect/induced incomes and total employment income, 1995 - 1997.

	Average annual income (1997 dollar value)	Total annual income (\$ millions)	Total income (\$ per 000 m3)
Direct	\$49,065	\$19.2	\$46,227
Indirect / Induced	\$34,070	\$14.0	\$33,824
Total income		\$33.2	\$80,051

(a) Statistics Canada, Survey of Employment Payrolls and Hours, 1997.

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7.2.7 Provincial government revenues

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

From 1995 to 1997, average stumpage and rent payments for Crown timber in the Kalum TSA were approximately \$3.1 million per year. Forest and corporate taxes and revenues generated \$3.1 million, while employment supported by the Kalum TSA timber harvest accounted for \$2.8 million in provincial income taxes (see Table 11).

Table 11. Average annual provincial government revenues, 1995 - 1997.

	Average annual revenue 1995 - 1997 (\$1997 millions)	Revenue (\$ per 000 m ³)
Stumpage, rents and royalties	\$3.1	\$7,378
Industry taxes	\$3.1	\$7,429
Provincial income tax	\$2.8	\$7,309
Total government revenues	\$9.0	\$22,116

7.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast suggests that the current AAC could be maintained for the next 30 years before declining by 8.8 percent, and then by a further 8.5 percent in the following decade. The socio-economic analysis focuses on the base case harvest level changes in the short- to mid-term, and considers:

- the short- and long-term implications of alternative harvest levels for both the Kalum TSA and the province;
- possible impacts on the communities within the TSA;

- timber requirements of processing facilities within the Kalum TSA; and
- regional timber supply implications.

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

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

Table 12 estimates the range of impacts the base case harvest forecast may have on employment and income. Ranges are utilized to reflect the availability of employment insurance and social assistance payments, and their mitigating effects in the shorter term. The lower end of the range reflects induced impacts which are diminished in the short term, because employment insurance and social assistance provide income support to displaced workers. The upper end of the range represents long-term impacts when displaced workers leave the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios—some workers accessing social assistance payments, some finding alternate employment and some leaving the area completely—is more likely to occur.

7.3.1 Short and long-term implications of alternative harvest levels

Kalum TSA employment and income impacts

For accounting purposes, TSA employment and income includes only that of workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment

supported by Kalum TSA timber processed at mills outside the TSA. Table 12 indicates the employment and income that could be supported within the Kalum TSA by the base case harvest forecast. If fully harvested and processed, the current AAC of 464 000 cubic metres could support approximately 350 person-years of direct employment and another 200 indirect and induced person-years of employment within the timber supply area. Approximately \$17.8 million (1997 dollar value) total after-tax annual income would be supported by the Kalum timber supply.

In the fifth decade, the reduced timber supply of 387 000 cubic metres per year would support approximately 300 person-years of direct employment and 170 person-years of indirect and induced employment; a reduction of between 15 and 20 percent (approximately 90 person-years). Total after-tax employment income would decline from current levels by approximately \$3.0 million to \$14.9 million per year. Approximately 80 percent of all direct employees reside within the Kalum TSA, with the exception of those employed at Skeena Cellulose's Prince Rupert mill. Changes to the Kalum harvest levels should be expected to have the greatest effect on residents of the Terrace area; the most forestry dependent centre in the TSA. However, since 15 to 20 percent of the Kalum harvest is processed outside of the timber supply area, the location of impacts will depend on how timber flows change and how industry adapts to changes in timber supply. Kalum TSA processing is likewise dependent on the regional timber supply situation.

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Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Kalum TSA. Assuming the current AAC of 464 000 cubic metres is fully harvested and processed, the Kalum TSA can support at least 440 person-years of direct forestry employment and a further 460 person-years of indirect and induced employment across the province. After 40 years, the forecasted timber supply of 387 000 cubic metres per year would lower total employment potential by about 150 person-years; about half of these would be direct forestry jobs.

Provincial government revenue impacts

Based on current tax and stumpage rates, the AAC of 464 000 cubic metres has the potential to provide approximately \$10 million annually to the provincial government (1997 dollar value), \$1.0 million more than the actual harvest level provides. After 40 years, if the timber supply is reduced to 387 000 cubic metres, annual provincial government revenues would be about \$8.4 million; assuming current taxation and stumpage rates do not change.

The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption that all those who are unemployed will leave the TSA. The lower limit is based on the assumption that employment insurance and other social assistance payments will reduce the induced impacts of a lower harvest level.

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Table 12. Socio-economic impacts of the Kalum TSA base case forecast.

	Current ^(a) AAC	Base case harvest forecast	
		Years 30-40	Years 40+
Timber supply (000 m ³)			
Harvest level	464	423	387
Actual harvest Level (average 1995-1997)	415		
Difference from current AAC	-49	-41	-77
Kalum TSA			
Employment (person-years)			
Direct	353	322	295
Indirect/Induced	200	182	167
Total	553	504	462
Cumulative change in total PYs ^(b)		-9 to -89	-55 to -128
Employment Income (\$1997 millions/year)			
Direct	12.5	11.4	10.5
Indirect/Induced	5.3	4.8	4.4
Total	17.8	16.2	14.9
Cumulative change in total income		-0.5 to -2.6	-2.0 to -3.9
Province (includes Kalum TSA)			
Employment (person-years)			
Direct	437	399	365
Indirect/Induced	461	420	384
Total	898	819	749
Cumulative change in total PYs		-9 to -150	-85 to -213
Employment Income (\$1997 million/year)			
Direct	15.5	14.2	13.0
Indirect/Induced	12.1	11.0	10.1
Total	27.6	25.2	23.1
Cumulative change in total income		-0.6 to -4.3	-2.9 to -6.3
Provincial Government Revenues (\$1997 million/year)			
Provincial income tax	3.2	2.9	2.7
Stumpage and rent	3.4	3.1	2.9
Other B.C. revenues	3.4	3.1	2.9
Total B.C. revenues	10.1	9.2	8.4
Cumulative change in total revenue		-0.7 to -1.1	-1.5 to -1.8

(a) Notes: Provincial employment includes both Kalum TSA employment and employment supported outside the TSA by Kalum TSA harvested timber.

(b) Estimates for current employment and income differ from those in Tables 9 and 10. Employment figures in Table 12 are based on the current AAC of 464 000 cubic metres, while the figures in Table 9 are based on the 1995 - 1997 average harvest level of 415 083 cubic metres. Income figures in Table 12 are net of taxes while those of Table 10 are gross income.

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7.3.2 Community level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region the less effect changes in any one sector will have on the regional economy. For less diversified and more remote communities, any reduction to timber supply may lead to population declines and alter the structure of the local economy.

Given that the Kalum TSA timber harvest supports about 25% of basic employment in the forest district, changes to the timber supply might be expected to have some significant impacts on the overall economic trends of the region. However, considering that the 1997 actual harvest levels were 30% below the AAC, and that the average 1995 to 1997 harvest was about 11% below the AAC, the impacts of the first reduction of 9% in decade four could be less significant. It is anticipated, however, that the harvesting and primary processing components of the forestry industry will decline in the TSA over the long term given the base case harvest forecast.

The Terrace region of the Kalum TSA is most dependent on the forest sector. Communities there may be more adversely affected as regional timber supplies decline.

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

Assuming that a reduction in the Kalum TSA timber supply is spread evenly among tenures, the 8.8% reduction in the decade four AAC may have only a

minor effect on local processing activity. The reduction continues to maintain the AAC above the 1995 to 1997 average harvest level. In the long-term, the timber supply will decline further and after decade four will be 16.5% less than its current level, assuming a continuation of current forestry management practices. This translates into a 7% reduction from the 1995 to 1997 average which could be sufficient to lead to shift reductions or other impacts, depending on conditions at individual mills. It is also pertinent that the decade five harvest level will still be roughly 25% higher than the 1997 actual harvest level.

7.3.3 Regional timber supply implications

Only 20% of the total milling requirements—2.5 million cubic metres per year—of the processing facilities in the Kalum TSA is harvested from the timber supply area.

The future of the regional timber supply is also important to primary processing facilities in the Kalum TSA. In the Prince Rupert Forest Region, although the total AAC increased by about 1.4% between 1991 and 1996, the amount attributable to coniferous species decreased by approximately 6%. In two to three decades the annual timber supply from Prince Rupert Region timber supply areas may decline by 5%, or 400 000 cubic metres.

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

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7.4 Summary

The forestry sector is an important source of employment and income for the Kalum TSA. With the exception of Kitimat, the TSA's economy is one of the least diversified in the province.

Approximately 20 percent of the TSA's processing facilities' requirements of 2.5 million cubic metres per year (chips and lumber) comes from the Kalum TSA. The current AAC for the Kalum TSA is 464 000 cubic metres. If the AAC is fully harvested and processed, it can support approximately 440 person-years of direct employment across the province and a further 460 indirect and induced jobs.

The base case harvest forecast for the Kalum TSA indicates that the timber supply could be maintained for the next 30 years. By the fifth decade the harvest level is projected to decline to an average of 387 000 cubic metres, which could reduce direct

employment by over 70 person-years, and indirect and induced employment by a further 70 to 100 person-years. At that time, the Kalum TSA would support approximately 365 person-years of direct employment and 384 person-years of indirect and induced employment. Regional effects could be in sharp contrast to individual community impacts. The Kitimat economy is not as dependent on forestry as some of the other less diversified communities are, and projected changes to the forestry sector could be diminished by economic growth in other basic sectors. Smaller communities, especially in the Terrace area, are the most vulnerable to forest sector changes. Individuals who lose their jobs in any sector often have difficulty financially and emotionally, and the specialized skills acquired in forestry jobs are often not easily transferable to other types of employment.

8 References

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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.
Analysis unit	A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.
Available volumes	The portion of total inventory volumes that is available for harvesting after all management constraints on timber harvesting have been considered, including definition of the timber harvesting land base, age of tree merchantability, deferrals, and any other priorities or constraints on timber harvesting.
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.
Basic income and employment	Indicators used to describe the size of a basic sector.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.
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.
Buffer strip	A strip of land where disturbance is not allowed or is closely monitored to preserve or enhance non-timber values along or adjacent to trails, water bodies and recreation sites.
Clearcut harvesting	A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.
Coarse woody debris	Logs and stumps that provide habitat for plants, animals and insects, and a source of nutrients for soil development.

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Commercial thinning	A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts (see also, Juvenile spacing). It is carried out to improve the health and growth rate of the remaining crop trees.
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.
Diameter limit harvesting	A silvicultural system used to maintain established understory trees. All trees larger than a specified diameter are removed, with care being taken to not damage the residual stand. Horse skidding is often used to harvest trees under this system.
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 cover requirements	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green-up).
Forest inventory	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 planning model	An analytical (usually computer-based) model that successively harvests and grows collections of forest stands over a period of several decades according to specific data and management assumptions. Forest planning models are of two basic forms: forest estate simulation models, which address "what-if" questions by determining the effects a specified policy or management alternative; and optimization harvest scheduling models, which seek out the policy or management alternative that best attains a specified management objective (e.g., maximum volume harvested over time) subject to specified management constraints. This analysis employs a computer simulation model developed by the B.C. Forest Service.
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 representation	Retaining a representative sample of all naturally occurring forest types.
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.

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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.
Hydrologic green-up (height)	The height a stand must reach for it to provide the same timing and quantity of water yields as old-growth.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource guidelines	Guidelines requiring that forest management activities (such as harvesting, road building and silviculture treatments) be conducted in a special way to protect or enhance timber and non-timber forest resource values.
Integrated resource management	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Juvenile spacing	A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased (see Commercial thinning).
Karst features	Karst features include fluted rock surfaces, vertical shafts, sinkholes, sinking streams, springs, complex sub-surface drainage systems and caves. Karst is a distinctive topography that develops as a result of the dissolving action of water on carbonate bedrock (usually limestone, dolomite or marble).

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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.
Long-line skylines	A system that allows harvesting over long distances, as well as suspension of logs above the ground. Such systems decrease the amount of road needed to access an area, and minimize soil disturbance. The operability classification distinguishes between areas operable by conventional skyline (yarding distance up to 750 metres) and non-conventional skyline (longer than 750 metres).
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.

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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.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (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).
Protected Area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Pulpwood agreements	An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.

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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.
Rehabilitation	Removing all non-commercial cover, preparing the site and stocking it with acceptable commercially valuable species.
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.
Riparian habitat	The stream bank and flood plain area adjacent to streams or water bodies.
Seed-tree system	Removal of most of the mature, merchantable trees in one harvest, except for a small number of trees to provide seed to facilitate establishment of a new stand.
Selection management	A silvicultural system used to maintain or create areas containing a wide range of tree ages or sizes. The time interval between harvests in such areas is fairly short (usually less than 30 years), and during these harvests either single scattered trees or small groups of trees are removed from across the entire area.
Sensitive terrain areas	Areas with moderate to high potential for landslide initiation. If timber harvesting or road construction occurs and where specific combinations of forest practices are required to ensure adequate site.
Sensitivity analysis	Examines how uncertainty in data and management assumptions affect timber supply.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Shelterwood system	Involves leaving a significant proportion of the mature, merchantable trees standing after an initial harvest to provide seed and shelter to assist in establishing a new stand. Usually the shelter trees are harvested after the new stand is well established.

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Silvicultural treatments	Activities that ensure the regeneration of young forests on harvested areas, enhance tree growth or improve wood quality in selected stands. Activities include: site rehabilitation and preparation, planting, spacing, fertilization and pruning.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
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 Section 7 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.

9 Glossary

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.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimate (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
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 Kalum 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 1995 Ministry of Forests forest cover inventory for the Kalum TSA was used to determine the timber harvesting land base and to develop a model of the forest management objectives and practices in the area. The Kalum Timber Supply Area Timber Supply Review Data Package, January 1998, includes more discussion of the inventory information used.

A.2 Zone and Analysis Unit Definition

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

Six resource emphasis groupings, or zones, were defined for this analysis. Zone delineation was based on common forest management objectives such as forest cover requirements or geographic location. The following zones were identified for the purpose of modelling current forest management:

1. Thunderbird Integrated Resource Management Plan — At least 12% of the productive forest land in the Thunderbird Integrated Resource Management Plan zone must be maintained in stands that are older than 140 years.
2. Community watershed zone — an overall forest cover requirement was derived allowing a maximum of 30% of the productive forest land to be below five metres in height (23 years old).
3. Retention VQO zone — for areas with an approved recreation management code of retention or preservation on the inventory file (less than 90 hectares of Kalum TSA are described as preservation VQO areas so they were treated as part of the retention VQO zone), an overall forest cover requirement was derived allowing a maximum of 5% of the productive forest land to be below five metres in height (21 years old).
4. Partial retention VQO zone — for areas with an approved recreation management code of partial retention on the inventory file, an overall forest cover requirement was derived allowing a maximum of 15% of the productive forest land to be below five metres in height (20 years old).
5. Modification VQO zone — for areas with an approved recreation management code of modification on the inventory file, an overall forest cover requirement was derived allowing a maximum of 25% of the productive forest land to be below five metres in height (23 years old).
6. Integrated resource management (IRM) zone — all areas not assigned to one of the other management zones. In the IRM zone, a maximum of 35% of the timber harvesting land base can be covered by stands less than three metres in height (20 years old).
7. Landscape-level biodiversity — a portion of the productive forest in each of the 43 landscape units in the Kalum TSA is to be retained in old forest to help achieve biodiversity management objectives. Section A.4.3 "Forest cover requirements" contains details on the old-forest area required.

All lands considered unavailable for timber harvesting contributed to the attainment of old forest cover objectives.

A.2 Zone and Analysis Unit Definition

Table A-1. Timber harvesting land base by management zone.

Zone	Timber harvesting land base (hectares)	Per cent of timber harvesting land base
(1) Thunderbird special management zone	11 179	11.4
(2) Community watershed	1 815	1.8
(3) Retention ^a VQO	1 854	1.9
(4) Partial VQO	5 803	5.9
(5) Modification VQO	12 913	13.1
(6) Integrated resource management	64 692	65.9
Total	98 256	100

Note (a) a small area with preservation VQO (<90 ha) was included with the retention VQO area

Grouping enables the analyst to apply constraints to different parts of the land base. Groups may be thought of as layers of different objectives which must be tracked over time. Groups were identified on the basis of biogeoclimatic zone, subzone, and variant in order to model landscape level biodiversity.

A.2.2 Analysis unit characteristics

To simplify the analysis, individual forest stands were grouped according to dominant tree species (inventory type group) and timber growing capability (site index). An analysis unit represents a combination of stands dominated by specific tree species or silvicultural regime within a set range of timber growing capability — as indicated by the inventory type group and site index in the forest inventory file.

Table A-2. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-18. for existing natural stands and Table A-19. 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 of multiple objectives."

A.2 Zone and Analysis Unit Definition

Table A-2. Definition of analysis units.

Analysis unit number	Leading species	Inventory type groups	Site index range (m@50 yrs)	Average site index (m@50 yrs)	Timber harvesting land base (includes NSR) (hectares)	Per cent of total timber harvesting land base (%)
1	Western Hemlock – Coast	12 - 17	8 - 18	13.5	11 468	11.7
2	Hemlock/Balsam/Cedar/Spruce – Coast (good/medium)	9 - 27	> 18	22.1	23 557	24.0
3	Hemlock/Balsam/Cedar/Spruce – Coast (poor)	9 - 27	<= 18	13.3	10 132	10.3
4	Lodgepole pine – Coast	28 - 31	>= 8.5	17.9	1 568	1.6
5	Cottonwood – Coast	35 - 36	>= 8	25.3	2 387	2.4
6	Hemlock/Balsam/Cedar/Spruce – Interior (good)	9 - 27	> 18	18.6	12 639	12.9
7	Hemlock/Balsam/Cedar/Spruce – Interior (medium)	9 - 27	13 - 18	15.4	13 427	13.7
8	Hemlock/Balsam/Cedar/Spruce – Interior (poor)	9 - 27	< 13	11.5	14 747	15.0
9	Lodgepole pine – Interior	28 - 31	>= 9.5	16.8	4 660	4.7
10	Cottonwood – Interior	35 - 36	> 7	26.0	690	0.7
12	Hemlock/Balsam	12 - 20	> 24	27.6	2 157	2.2
111	Spruce	21 - 26	> 18	23.7	824	0.8
Total					98 256	100.0

The area noted for analysis unit 12 – hemlock/balsam with site index greater than 24 metres – is the total area eligible for commercial thinning in the analysis.

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Kalum TSA area. One of the first steps in this timber supply analysis was to define the timber harvesting land base. This land base was derived by identifying certain types of land and forest where timber harvesting is not likely to occur under current management. The characteristics of each of these types are discussed below, but *not* in the order in which the classifications were evaluated for inclusion or exclusion from the timber harvesting land base. The order of application is as listed in Table 2 of the main report.

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

The ownership (OWN) codes on the inventory file were used to determine which areas are not managed by the B.C. Forest Service. This category may include areas such as parks, ecological reserves, private land and various special use permit areas. Forest in ownership 62-C (forest management unit) and 69 - C (forest reserves) contributes to timber harvesting.

A.3.2 Non-forest land

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

A.3.3 Non-commercial (brush) cover

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

A.3.4 Estimated area in riparian reserves and riparian management zones

To account for protection of riparian and stream values within the Kalum TSA, 4625 hectares were excluded from the timber harvesting land base. The riparian management area reductions were established by Ministry of Forests (MoF) staff in collaboration with specialists, and applied to each biogeoclimatic zone. Table A-3. describes the information used to derive this reduction.

Table A-3a. Riparian management areas.

Riparian class	Reserve width (metres)	Management zone width (metres)
S1 (20m < width < 100m)	50	20
S1(width > 100m)	0	100
S2	30	20
S3	20	20

In order to determine appropriate riparian considerations in the Kalum TSA, a fishery biologist was tasked with classifying streams S1-S3 for the entire TSA. Forest district staff reviewed this information, and six representative mapsheets were chosen to be digitized. The streams were then buffered for riparian reserve zones and riparian management zones. These buffers have been merged with the forest cover information. An examination of the buffer areas was performed to determine an appropriate reduction to be applied to the area outside the sample area. Current practice in the Kalum TSA is 100% retention of the riparian reserve zones and about 10% retention of the riparian management zones. To reflect this, the management zone width was effectively reduced by 10% to reflect that 90% of the management zone is available for harvest. A percentage of the productive forest, based on the information from six mapsheets already surveyed, was excluded from the timber harvesting land base to reflect both riparian reserve and management zones (see Table A-3b).

A.3 Definition of the Timber Harvesting Land Base

Table A-3b. Percentage exclusions for riparian reserves and management zones.

Biogeoclimatic variant	Percentage excluded to account for riparian reserves and management zones (%)
CWH vm	10.2
CWH ws1	4.6
CWH ws2	1.6
ICH mc2	7.0
MH mm2	0.9

A.3.5 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as wildlife habitat, sensitive soils and regeneration. A portion of areas classified as environmentally sensitive were excluded from the timber harvesting land base according to Table A-4. The total reduction is 3017 hectares for ESA1 and 1819 hectares for ESA2.

Table A-4. Per cent of area considered unavailable for timber harvesting due to environmental sensitivity.

ESA code (1- high sensitivity) (2- moderate sensitivity)	Per cent of area unavailable for timber harvesting
Es1 (soils)	50
Es2 (soil)	30
Er1 (recreation)	100
Ep1 (regeneration difficulty)	100
Ep2 (regeneration difficulty)	50
Ea1 (avalanche)	100

Environmentally sensitive area reductions were established by the Ministry of Forests (MoF) staff in collaboration with specialists from the Ministry of Environment, Lands and Parks (MELP). The percentage unavailable reflects site sensitivity to forest management, value for other resources, and current management practices. The ESA exclusion factors shown in Table A-4. were applied in all management zones.

The ESA definitions are:

- Es — areas with unstable soils that may deteriorate unacceptably after forest harvesting.
- Er — areas with high recreation features.
- Ep — areas where regeneration will likely be difficult.
- Ea — avalanche area.

A.3 Definition of the Timber Harvesting Land Base

A.3.6 Inoperable areas

The inventory file contains an operability classification for Kalum TSA. All areas that were inoperable (OPERABLE = I or N) were excluded from the timber harvesting land base. Characteristics used in defining operability include slope, topography (for example, the presence of gullies, exposed rock), difficulty of road access, soil instability, elevation and timber characteristics. Operability maps for Kalum TSA were drafted in late 1991. Methods used in determining operability lines are documented in *A Report on Mapping of Operability Lines within the South Kalum* (November 25, 1991).

A.3.7 Sites with low timber growing potential

Sites may have low timber growing potential either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. Typically, these stands are intermixed with other stands within the forested land base. Stands not considered to be harvestable were identified through an examination of the distribution of sites in the forested land base and removed from consideration for the timber harvesting land base. The stands excluded from the timber harvesting land base due to low timber growing potential are described in Table A-5.

Table A-5. Description of sites with low timber growing potential.

Species	Forest inventory zone	Site index (meters in height at age 50)	Reduction per cent (%)
Balsam	A	< 6.5	100
Balsam	J	< 6.5	100
Cedar	A	< 8.5	100
Cedar	J	< 9.0	100
Hemlock	A	< 7.0	100
Hemlock	J	< 7.5	100
Spruce	A	< 3.0	100
Spruce	J	< 5.0	100
Pine	A	< 8.5	100
Pine	J	< 9.5	100
Cottonwood	A	< 8.0	100
Cottonwood	J	< 7.0	100

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Problem forest types

Problem forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. These types were identified based on current forest management practices and recent harvesting performance, and were excluded from the timber harvesting land base. Table A-6. shows the criteria used for excluding problem forest types from the timber harvesting land base.

Table A-6. Problem forest types criteria

Species	Inventory type groups	Age (yrs)	Height (meters)	Crown closure (%)	Volume (m3/hectare)	Reduction per cent (%)
All deciduous except cottonwood	37 - 42					100
All species		> 100	< 22			100
All species		> 60		0 - 25		100
All species		> 100			< 250	100

A.3.9 Roads, trails, and landings

Separate estimates were made to reflect the loss in productive forest land due to existing and future roads, trails and landings (RTL). Existing RTL estimates were applied as reductions to the current productive forest considered available for harvesting, and future RTL were applied after stands are harvested for the first time in the simulation model. Estimates were applied as the percentages of area to be excluded from specified age classes, and account for areas that are permanently removed from the timber harvesting land base.

Table A-7. Estimates for existing and future roads, trails and landings

Roads, trails and landings	Age (years)	History reference	Total reduction per cent (%)
Existing	≤ 35	1	7.5
Future	> 35	—	6.5

A.3.10 Cultural heritage resource reductions

Archaeological overview and cultural heritage inventories for the entire Kalum TSA have been completed. Within the Kalum TSA, 2512 hectares are identified as having high archaeological potential. The management measures that will be taken on these sites are not known and thus cannot be addressed at this time. When management practices have been defined for these areas, they will be accounted for in future timber supply analyses and AAC determinations.

A.3 Definition of the Timber Harvesting Land Base

A.3.11 Timber licence reversions

Timber licences (TLs) are a form of timber tenure that gives the holder exclusive right to harvest merchantable timber from defined areas of Crown land. After the area is harvested and reaches a free-growing condition the land reverts to Forest Service jurisdiction. The timber cut from TLs is not part of the allowable annual cut of a TSA. There are 3310 hectares of TLs in Kalum TSA. Of this, 2406 hectares have characteristics that indicate the area will contribute to the timber harvesting land base as defined for this analysis. These areas are anticipated to be harvested within the next 5 years, and therefore will revert to the Forest Service in a stocked and free-growing condition, during the first decade of the analysis horizon.

A.3.12 TFL reversion

A portion of the Humphrys landscape unit, totalling 906 hectares, is being transferred to Tree Farm Licence 41. This area was excluded from the Kalum TSA timber harvesting land base for the analysis.

A.3.13 Stand-level biodiversity reductions

Wildlife tree patches (WTP) are retained within cutblocks in the Kalum TSA to maintain stand structures valuable for the conservation and enhancement of wildlife. Forest District staff indicated that in all management zones within the TSA, wildlife tree patches larger than 2 hectares in size will be retained in perpetuity within a cutblock boundary. Thus, these patches are expected to contribute to old-forest retention requirements at the landscape level. Forest district staff estimate that about 75% of WTPs will be accounted for from non-contributing land base areas (e.g., riparian management zone, inoperable forest, etc.). The remaining 25% of the area required for WTPs was removed from the timber harvesting land base. This additional reduction was assumed to be located in the integrated resource management (IRM), and modification visual quality objective (VQO), (i.e., not in the partial retention, retention or community watershed zones) as forest district staff feel that only these areas require some management activity to retain stand structure. It is assumed that these wildlife tree patches will not be economical to harvest at a later date, nor will they be available to harvest in subsequent harvesting of the stand.

A percentage of the productive forest area in the following three biogeoclimatic variants was excluded from the timber harvesting land base to account for WTPs: 1.7% of the CWHvm variant; 3.1% of the CWHws variant; and 2.9% of the ICHmc. The total reduction for wildlife tree patches, following other land base exclusions, was 1359 hectares.

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 Kalum TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-8.

Table A-8. Utilization levels.

Analysis unit	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Cottonwood	22.5	30	10
All other conifer	17.5	30	10

A.4.2 Minimum harvestable ages

Minimum harvestable ages are the lowest age at which a stand type is estimated to be available for harvest. While harvesting may occur in stands at the minimum age to meet forest-level objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large declines in harvest levels), most stands will not be harvested until well past the minimum timber production ages because other resource values take precedence (e.g., requirements for the retention of older forest).

Table A-9. Minimum harvestable age criteria for coniferous.

Analysis unit	Minimum criteria		
	Height (metres)	Volume (m ³ /hectare)	Average dbh (cm)
All	22	250	25

A.4 Forest Management Assumptions

Stands must meet all three criteria before being eligible for harvest, except for cottonwood. The age was determined by examining the volume tables for each analysis units, and using linear interpolation to determine the age at which the minimum volume was attained. A minimum harvestable age for cottonwood of 60 years was decided by district staff.

Table A-10a. lists the minimum harvestable ages for each of the analysis units.

Table A-10a. Minimum harvestable age — existing stands.

	Analysis unit		Minimum harvestable age (yrs)	Age at maximum MAI ^a
1	H/B/C/S	Coast-for site index adjustment	110	100
2	H/B/C/S	Coast G/M	60	80
3	H/B/C/S	Coast P	120	130
4	Pine	Coast	100	120
5	Cottonwood	Coast	60	70
6	H/B/C/S	Interior G	70	90
7	H/B/C/S	Interior M	90	110
8	H/B/C/S	Interior P	140	150
9	Pine	Interior	110	130
10	Cottonwood	Interior	60	70
12	H/B	commercial thinning	50	90
22	H/B	commercial thinning	40	40

Note: (a) MAI — mean annual increment, or the average annual growth, calculated as volume divided by age

Table A-10b. Minimum harvestable age — managed stands.

	Analysis unit		Minimum harvestable age (yrs)	Age at maximum MAI ^a
101	H/B/C/S	Coast-for site index adjustment	50	100
102	H/B/C/S	Coast G/M	55	110
103	H/B/C/S	Coast P	110	150
104	Pine	Coast	100	120
105	Cottonwood	Coast	60	70
106	H/B/C/S	Interior G	70	90
107	H/B/C/S	Interior M	90	130
108	H/B/C/S	Interior P	130	160
109	Pine	Interior	110	130
110	Cottonwood	Interior	60	70
207	H/B/C/S	Interior M	90	130
212	H/B	commercial thinning	40	40

Analysis units (AUs) 12, 22 and 212 represent those areas eligible for commercial thinning. AU 12 includes stands 50 years old or more that have passed the commercial thinning age. These stands are projected for clearcut harvest, and will be eligible for commercial thinning after regenerated. AUs 22 and 212 consist of stands that are younger than 40 years, and hence currently eligible for thinning (whether a stand falls within AU 22 or 212 depends on whether it is defined as managed. See section A.4.5.4 “Immature plantation history”).

A.4 Forest Management Assumptions

A.4.3 Forest cover requirements

Forest cover requirements were applied to each distinct management emphasis within each landscape unit.

Landscape-level biodiversity guidelines - only the old-seral guidelines were modelled, consistent with the assumptions used in the *Forest Practices Code Timber Supply Analysis*. The percentages listed in Table A-11. were applied to each biogeoclimatic variant in each landscape unit, and reflect the requirements from the *Forest Practices Code Biodiversity Guidebook* for the draft biodiversity emphasis option (BEO) assigned to each landscape unit. When the analysis was initiated, it was anticipated that the BEOs would be officially established by the time the analysis was completed; however, the BEOs remain draft at the time of publication. Sensitivity analysis included in the main report examines the effect of applying weighted average requirements based on an assumption that lower, intermediate, and higher emphases will eventually be applied to 45%, 45%, and 10% of the forest area of the TSA, respectively. While standard analytical practice is to phase in the old-seral requirement in areas subject to the lower emphasis option, analysis showed that immediate application of the full requirement would not reduce timber supply.

It should be noted that the Fiddler Creek landscape unit includes much of the area covered under the Fiddler Creek Total Resource Plan. In addition the forest cover requirements that apply under the plan are very similar to those contemplated under the *Biodiversity Guidebook*. Therefore, the forest cover requirements for landscape-level biodiversity were applied to the landscape unit, and assumed to represent implementation of the Fiddler Creek Total Resource Plan.

Table A-11. Seral-stage requirements (per cent old seral) by natural disturbance type (NDT).

Biogeoclimatic unit	NDT	Old-seral stage			Minimum age (years)	Application
		Minimum retention area (%)				
		L	I	H		
CWH	1	13	13	19	250	Productive forest
MH	1	19	19	28	250	Productive forest
CWH	2	9	9	13	250	Productive forest
ICH	2	9	9	13	250	Productive forest

VQO prescriptions were adjusted to account for the non-contributing forest.

Table A-12. Cover requirement for VQO and integrated resource management zones.

Zone	Green-up height (metres)	Green-up maximum allowable disturbance (% area)	Application
IRM areas	3	35	Timber harvesting land base
VQO = R	5	5	Productive forest
VQO = PR	5	15	Productive forest
VQO = M	5	25	Productive forest

The maximum allowable disturbance constraint for the integrated resource management (IRM) areas is applied to the timber harvesting land base. Kalum Forest District staff indicated that the IRM areas are generally large contiguous patches of harvestable forest and the maximum disturbance of 35% adequately describes the cutting pattern used at this time.

A.4 Forest Management Assumptions

Kalum Forest District and the Prince Rupert Forest Region recreation staff have assigned visual quality objectives to visually sensitive areas in the TSA. Kalum Forest District staff indicated that the large amount of non-contributing forest assists greatly in achieving forest cover requirements. The maximum allowable disturbance limits were applied to the total productive forest area in each VQO class in each landscape unit.

Table A-13. Forest cover requirements for the Deep Creek community watershed.

	Green-up height (metres)	Green-up maximum allowable disturbance (% area)	Application
Deep Creek community watershed	5	30	Productive forest

The regional research hydrologist indicated that the above guideline is appropriate for the Deep Creek community watershed due to its relatively gentle topography.

The following forest cover requirements were applied to the area under the *Thunderbird Integrated Resource Management Plan* (IRMP).

Table A-14. Forest cover requirements for the Thunderbird integrated resource management area.

	Minimum age (years)	Minimum retention (% area)	Application
Thunderbird IRMP	140	12	Productive forest

A.4.4 Unsalvaged losses

Table A-15. shows the estimated average annual unsalvaged volume loss to catastrophic events such as insect epidemics, fires, wind or other agents over the long-term on the timber harvesting land base. The unsalvaged loss column reflects only those areas in which the volume will not be recovered or salvaged. The windthrow and fire estimates are based upon district records, district experience with salvage and district fire occurrence records. These figures constitute the best information available.

Table A-15. Unsalvaged losses.

Cause of loss	Total loss (m ³ /year)	Annual unsalvaged loss (m ³ /year)
Fire	2 500	2 500
Wind	14 000	7 000
Total		9 500

A.4 Forest Management Assumptions

A.4.5 Silviculture

A.4.5.1 Site productivity estimates for managed stands

A "paired plot" study completed in 1996 showed that the site index in old-hemlock stands is currently underestimated by about 10 metres when compared to adjacent managed hemlock stands (Nigh, G.D and R.A. Love. 1997. Site index adjustment for old-growth coastal western hemlock stands in the Kalum Forest District. Res.Br., B.C. Min. For., Victoria, B.C. Work. Pap27/1997). The results of this study show that some adjustment to site productivity estimates should be made when hemlock-leading stands currently greater than 140 years of age, are harvested and replaced with managed hemlock stands. The actual practices and the inventory file were reviewed, and a site index adjustment of 10 meters was applied on coastal western hemlock stands with age older than 140 years and previous site index from 8 to 18 meters.

A.4.5.2 Silviculture and regeneration activities in managed stands

The silviculture program reflects the mix of treatments expected to be carried out. This level of activity assumes basic silviculture on all sites plus innovative silviculture on some sites. Table A-16. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay.

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

Table A-16. Regeneration assumptions by analysis unit.

Analysis unit		Regen delay ^a	OAFs ^b		Method		Density	
			1 %	2 %	Type	%	Initial	Space
H/B/C/S	Coast — SI adjustment	3	15	5	Natural	100	1400	1000
H/B/C/S	G / M — Coast	3	15	5	Planted	100	1400	1000
H/B/C/S	P — Coast	6	15	5	Natural	50	4000	1000
PI	G/M/P — Coast	3	15	5	Planted	100	1400	
Ac	Coast	3	15	5	Planted	100	1400	700
H/B/C/S	G — Interior	3	15	5	Planted	100	1400	1000
H/B/C/S	M — Interior	3	15	5	Planted	50	1400	1000
		6	15	5	Natural	50	4000	1000
H/B/C/S	P — Interior	6	15	5	Natural	100	4000	
PI	Interior	3	15	5	Planted	100	1400	700
Ac	Interior	3	15	5	Natural	100	4000	800
Ss (early rotation)	G — Kitimat Valley	3	15	5	Planted	100	1400	1200

(a) Regeneration delay reflects current operational practice and is defined as the time after harvest but before planting or seed germination occurs. Regeneration delays will be applied in the FSSIM forest estate model, not in the TIPSY yield model.

(b) Provincial average operational adjustment factors (OAFs) values are applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch — as no local values are available. OAF 1 reflects small stocking gaps in productive forest land while OAF 2 reflects an estimate for decay, waste and breakage.

A.4 Forest Management Assumptions

All values in the above table are based on current performance as estimated by forest district staff. The average density is 4000 stems per hectare for natural regeneration. The range is from 3000 to 7000 sph. All good sites and relatively good sites are planted. Planting density is on average 1400 stems per hectare for all species and sites. The remainder of the logged areas are managed for natural regeneration and are fill planted at the end of regeneration delay period if density is not 1400 stems per hectare. Analysis units were assumed to regenerate to the leading species of the respective analysis unit with the exception of Sitka spruce which will be regenerated to hemlock.

A.4.5.3. Commercial thinning

In the Kalum TSA, areas within the highly productive hemlock/balsam analysis units (site index over 24 metres at 50 years) are eligible for commercial thinning. The data package outlined the commercial thinning regime employed (juvenile spacing to 800 stems per hectare; 35-40% basal area removal between age 40 and 49 years; final harvest 20 years after commercial thinning). Just over 2150 hectares of the timber harvesting land base were subject to commercial thinning in the base case. Kalum Forest District staff are reviewing the timber supply analysis results, the forest inventory, and silviculture records to determine if there are opportunities for commercial thinning beyond those assumed in the analysis.

A.4.5.4 Immature plantation history

Table A-17. identifies areas of existing immature forest where the density (stems per hectare) was controlled, and which therefore are immediately assigned to a managed stand yield table (MSYT). All NSR and future harvested stands will be managed under MSYTs.

Table A-17. Immature plantation history.

Analysis unit	Area to be assigned to MSYTs (%)			
	Age 1 - 10	Age 11 - 20	Age 21 - 30	Age 31 - 40
All types	100	100	70	30

The proportion of immature stands that are considered "managed" is based on the best professional estimate of forest district silviculture staff. Density levels were reviewed in the inventory file. Any stands with more than 10 000 stems per hectare in stands older than 20 were not assigned to MSYTs.

A.4.5.5. Not satisfactorily restocked (NSR) areas

Land classified in the Kalum TSA FIP file as type identity 4 or 9 is included in the current timber harvesting land base. These type identities indicate not satisfactorily restocked (NSR) land.

Currently about 6493 hectares of NSR are listed in MLSIS/ISIS records. Forest district silvicultural records show 4431 hectares of backlog NSR (i.e., harvested prior to 1987) and 2062 hectares of current NSR. NSR is restocked to tree species in proportion to the current area of each analysis unit in stands less than 20 years old on the assumption that the overall distribution of harvest within analysis units has not changed significantly over this period of time. NSR is assumed to regenerate within the regeneration delays provided in Table A-16.

All NSR within the operable land base was included in the timber harvesting land base. The MOF district staff indicated that any NSR within the inoperable portion of the land base is not included in the timber harvesting land base.

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-18. shows the volume estimates by analysis unit.

Table A-18. Timber volume tables for existing natural stands (cubic metres).

Table no.	1	2	3	4	5	6	7
Age	CWH-A-C	H/B/C/S-G/M-C	H/B/C/S-P-C	Pine-C	Cottonwood-C	H/B/C/S-G-I	H/B/C/S-M-I
10	0	0.1	0	0	0.17	0	0
20	0.09	8.47	0.25	0	5.68	0.41	0.09
30	0.52	47.49	1.53	3.77	27.2	4.4	0.6
40	12.84	145.16	11.39	38.84	56.32	66.08	15.28
50	54.48	234.76	42.42	85.41	84.9	133.72	74.85
60	104.23	312.35	86.95	130.79	113.25	193.34	133.7
70	151.51	379.77	132.38	172.81	135.03	245.22	186.44
80	194.23	438.28	173.48	211.63	152.51	290.83	233.11
90	230.48	487.54	209.36	247.41	166.65	328.99	273.52
100	262	529.96	240.91	280.71	178.28	362.07	309.22
110	289.53	566.67	268.82	311.87	187.94	390.93	340.98
120	312.95	598.06	293.09	341.21	195.98	416.02	369.29
130	337.76	630.63	317.92	369.04	203.18	442.51	398.68
140	360.71	660.29	340.79	387.89	209.4	465.19	424.35
150	381.54	687.03	361.67	402.12	214.74	485.28	447.71
160	400.4	710.98	380.65	411.71	215.98	502.06	468.7
170	417.49	732.63	397.97	417.67	217.08	516.57	487.51
180	433.6	752.65	414.15	420.06	218.1	529.44	504.23
190	448.54	771	429.14	418.95	219.06	540.87	518.95
200	462.46	788.02	443.14	421.74	219.96	551.74	534.04
210	475.38	803.75	456.17	424.74	220.81	561.76	548.34
220	487.4	818.3	468.52	427.78	221.59	571.1	561.63
230	498.59	831.81	480.09	430.7	222.34	579.79	573.87
240	509.01	844.31	490.89	433.42	223.05	587.87	584.86
250	518.72	855.92	501.01	435.94	223.73	595.38	594.82
260	525.63	865.25	509.32	438.23	224.24	600.64	602.82
270	531.96	873.87	517.06	440.28	224.74	605.5	610.26
280	537.79	881.81	524.27	442.05	225.21	609.97	617.18
290	543.11	889.1	531.01	443.57	225.67	614.08	623.61
300	548	895.89	537.25	444.86	226.1	617.87	629.62
310	552.47	902.11	543.09	445.88	226.52	621.36	635.25
320	556.56	907.86	548.53	446.63	226.92	624.57	640.52
330	560.26	913.13	553.61	447.13	227.31	627.54	645.47
340	563.65	918	558.32	447.35	227.7	630.27	650.12
350	566.71	922.46	562.7	446.96	228.07	632.78	654.46

Note: see Tables A-2 and A-10a for descriptions of the analysis units that correspond to the volume tables.

A.5 Volume Estimates for Existing Stands

Table A-18. Timber volume tables for existing natural stands (cubic metres)

(concluded)

Table no.	8	9	10	12	32	42
Age	H/B/C/S-P-I	Pine-I	Cottonwood-I	H/B-thinning	H/B-thinning	H/B-thinning
10	0	0	0.24	0	0	0
20	0.01	0	2.03	0.3	0.3	0.3
30	0.1	1.8	28.85	98.9	98.9	98.9
40	0.73	26.57	61.95	249.4	249.4	249.4
50	11.46	62.14	97.83	399.8	298.9	399.8
60	44.06	98.59	129.84	504.6	432.7	504.6
70	84.12	133.06	154.05	671.5	564.3	671.5
80	123.27	165.23	173.37	798.7	695.8	798.7
90	158.27	195.22	188.91	915.6	823.9	915.6
100	189.75	223.39	201.69	1020.8	944.3	1020.8
110	218.14	249.94	212.29	1114.4	1054.3	1114.4
120	243.8	275.06	221.11	1205.2	1154.8	1205.2
130	269.71	298.59	229.07			
140	292.62	314.22	235.66			
150	313.61	326.29	241.29			
160	332.71	334.65	243.06			
170	349.99	339.82	244.54			
180	365.51	341.95	245.72			
190	379.3	341.08	246.68			
200	393.49	343.64	247.8			
210	407.15	346.46	248.88			
220	420.25	349.31	249.94			
230	432.81	352.11	250.88			
240	444.85	354.76	251.74			
250	456.3	357.25	252.54			
260	466.44	359.43	253.01			
270	475.94	361.4	253.46			
280	484.78	363.14	253.9			
290	493.05	364.64	254.31			
300	500.79	365.88	254.69			
310	508.09	366.92	255.07			
320	514.89	367.7	255.4			
330	521.28	368.23	255.73			
340	527.3	368.42	256.06			
350	533	368.39	256.36			

Note: see Tables A-2 and A-10a for descriptions of the analysis units that correspond to the volume tables.

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 2.0 supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index for each analysis unit was used, along with regeneration assumptions, as input to TIPSY. Section A.4.4 and Table A-17. document which stands are assumed to be managed in the analysis.

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

Table A-19. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age.

A.6 Volume Estimates for Regenerated Stands

Table A-19. Timber volume tables for existing and future managed stands (cubic metres)

Table no.	101	102	103	104	106	107	108
Age	CWH-A-C	H/B/C/S-G/M-C	H/B/C/S-P-C	Pine-C	H/B/C/S-G-I	H/B/C/S-M-I	H/B/C/S-P-I
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	39	17	0	10	1	0	0
40	156	125	0	67	50	1	0
50	271	230	4	125	132	33	0
60	389	333	31	179	209	90	4
70	506	443	69	232	283	151	22
80	612	540	119	269	349	208	57
90	718	635	168	301	411	263	101
100	813	725	216	328	464	309	150
110	892	807	259	348	510	356	194
120	959	876	298	366	554	398	235
130	1025	934	334	380	592	434	273
140	1088	989	370	392	628	465	303
150	1146	1043	404	403	658	493	330
160	1200	1092	436	412	688	520	358
170	1246	1139	462	419	714	546	382
180	1279	1182	485	423	738	569	404
190	1310	1223	507	427	761	588	423
200	1338	1249	527	430	781	605	441
210	1370	1273	546	434	799	621	456
220	1499	1295	565	436	816	635	469
230	1426	1217	582	439	831	649	481
240	1452	1339	598		844	661	492
250	1469	1361	614		857	673	502
260	1483	1381	628		868	683	512
270	1497	1400	642		878	693	521
280	1510	1418	654		888	702	529
290	1523	1428	666		897	708	537

Note: see Tables A-2 and A-10a for descriptions of the analysis units that correspond to the volume tables.

A.6 Volume Estimates for Regenerated Stands

Table A-19. Timber volume tables for existing and future managed stands (cubic metres) (Concluded)

Table no.	109	111	207	212	312	412
Age	Pine-I	Spruce/SR	H/B/C/S-M-I	H/B-thinning	H/B-thinning	H/B-thinning
10	0	0	0	0	0	0
20	0	0	0	7	7	7
30	7	49	0	147	147	147
40	47	195	3	299	299	299
50	93	345	46	448	327	448
60	129	486	108	586	461	586
70	170	627	169	715	594	715
80	205	749	224	835	723	835
90	232	860	277	948	850	948
100	255	963	322	1045	970	1045
110	276	1056	368	1138	1081	1138
120	293	1135	407	1224	1182	1224
130	308		442			
140	321		472			
150	332		499			
160	343		525			
170	352		549			
180	360		570			
190	368		589			
200	374		605			
210	379		620			
220	383		634			
230	387		646			
240	391		658			
250	394		669			
260	397		678			
270	400		688			
280	402		696			
290	405		702			

Note: see Tables A-2 and A-10a for descriptions of the analysis units that correspond to the volume tables.

Appendix B

Socio-Economic Analysis Background Information

B.1 SOCIO-ECONOMIC ANALYSIS ASSUMPTIONS

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

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

B.2 ECONOMIC IMPACT 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.

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

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

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

The procedure for estimating employment and income impacts involves 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 and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — Harvesting. Direct employment in harvesting consists of all woodlands related jobs including harvesting, log salvage, planning and administration functions. While log transport and hauling, road building and maintenance work are important activities in the forest industry, the employment multipliers used in this analysis define these activities as indirect rather than direct. As a result log transport and hauling, road building and maintenance employment are not included in the direct impact estimates; including these as direct would result in double-counting and an overestimation of employment impacts.

Data on employment, place of residence and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents vs. 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 on a per 1000 cubic metres basis. 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 METHODOLOGY

Employment — Silviculture. Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilizing, 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, silviculture jobs were 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 about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from 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 which is supported by chip by-products from milling operations was also estimated in a similar fashion.

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 employees in the forestry sector are those who work to provide goods and services to firms directly engaged in the basic forestry sector; for example, those who provide log transport services. Induced employees 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 used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that a displaced worker will leave the region, reducing total income in the region by his/her full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 ECONOMIC IMPACT METHODOLOGY

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

Table B-1. Total employment multipliers.

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial interior migration multiplier	Provincial interior no-migration multiplier
Harvesting	1.69	1.44	2.14	1.80
Solid wood processing	1.52	1.30	2.29	1.93
Pulp	1.86	1.59	3.02	2.48

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

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

Employment Estimates of Alternative Timber Supply Levels. To estimate employment generated by alternative timber supplies, the forecasted harvest level is multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions far into the future. 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.

Employment Income Estimates. Employment income was calculated using average income estimates for workers in the forest industry. Income data is from Statistics Canada Survey of Employment Payrolls and Hours. In 1997, the average pre-tax annual income (less benefits) for sub-sectors of the forestry sector were approximately: \$47,850 for logging and forestry services; \$46,250 for solid wood manufacturing; and \$54,990 for the pulp and paper sector. The weighted average annual income for direct forestry workers was \$49,065. Indirect and induced employees averaged an annual income of \$34,070 in 1997. This figure is based on a selection of business and personal service sectors, accommodation, food and beverage sector, and the construction sector average annual wages. Income taxes were calculated based on marginal tax rates of 23 to 28% with one third of the total income tax accruing to the province.

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. See Table B-2.

Table B-2. Kalum TSA provincial government revenue estimates

	Average revenue 1995-97 (\$1997 millions)	Revenue (\$ per 000m ³)
Stumpage, rents and royalties	3.1	7,378
Industry taxes	3.1	7,429
Provincial income tax	2.8	7,309
Total government revenues	9.1	22,116

Source: Ministry of Forests. Price Waterhouse.