Kispiox TSA
Timber Supply Analysis

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Preface

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

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

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

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province to be completed by mid-1996. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

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

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Kispiox Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the 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 area of the Kispiox TSA available for timber harvesting under current management practices is about 318 000 hectares out of a total land base of approximately 1 223 000 hectares. The total volume of standing timber on the timber harvesting land base is about 85 million cubic metres, of which 81 million cubic metres (approximately 95%) is currently above minimum harvestable age. The forest on the timber harvesting land base is composed of stands of hemlock (47%), balsam (31%), spruce (12%) and lodgepole pine (8%).

The current AAC for the Kispiox TSA is 1 100 000 cubic metres per year. Under current forest management assumptions, the analysis results indicate that the current harvest level can be maintained for 4 decades without causing a drop in future harvest levels below the long-term harvest level. Beginning in the fifth decade, the harvest level would have to decline by 10% per decade until the long-term level of 630 000 cubic metres per year is reached in decade 10. This harvest projection is referred to as the base case throughout this report.

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

The largest impact on the base case harvest forecast observed in the analysis is due to uncertainty in the volume estimates for existing stands. If existing stand volumes are overestimated by as much as 20%, the initial harvest level must decrease immediately by 10% and continue decreasing by 10% per decade to avoid serious shortfalls in the future. Conversely, if existing stand volumes are underestimated by as much as 20%, then the current harvest level can be maintained for 8 decades before beginning the transition to the long-term harvest level.

While there is no evidence to suggest that existing stand volumes are different from those used in the analysis, there is considerable difficulty accessing the northern portion of the Kispiox TSA. The analysis indicates that if this area, comprising 24% of the Kispiox TSA, is excluded from the timber harvesting land base, harvest levels must decrease immediately to 1 000 000 cubic metres per year and continue decreasing by 10% per decade until a long-term level of 500 000 cubic metres per year is reached.

Site productivity is a key determinant of the expected rate of growth of trees on a site and thus affects green-up ages, minimum harvestable ages and regenerated stand volumes. To approximate the effects of uncertainty in site productivity estimates, sensitivity analysis was conducted in which minimum harvestable ages were changed by 20 years, green-up ages were changed by 5 years, and regenerated stand volumes were changed by 20%. This sensitivity analysis shows that uncertainty in site productivity estimates has significant impacts on medium- and long-term harvest levels. If site productivity is lower than estimated, the initial harvest level can still be maintained for 2 decades due to the large amount of older stands currently available for harvest in the Kispiox TSA. The long-term harvest level, however, will be 21% lower than in the base case. If site productivity is higher than estimated, then the harvest forecast is similar to the base case except that the long-term level is 21% higher and is attained 2 decades earlier.

Uncertainty in the amount of forest cover required to meet visual quality objectives has little medium- and long-term impacts on the base case harvest flow projections. Under more restrictive visual quality requirements, the current harvest level can still be maintained for 30 years before the transition to slightly lower long-term levels. Under less restrictive visual quality requirements, the current harvest level can be maintained one more decade, than in the base case and the long-term harvest level can be increased by 5%.

Further sensitivity analyses examined the timber supply implications of uncertainty in hydrological green-up heights, old-growth forest cover requirements, and adjacency objectives. The green-up height sensitivity analysis shows that timber supply is unaffected if the height requirement for hydrologic green-up is assumed to be 10 metres rather than 6 metres. The old-growth forest cover requirement sensitivity analysis shows that if 6% of the timber harvesting land base is required to be covered by forest greater than 200 years old, the current harvest level must start declining one decade earlier to a level 5% lower than in the base case. The adjacency sensitivity analysis shows that if a 4-pass or a 5-pass harvesting system is required to meet adjacency objectives, the harvest forecast is unaffected. However, if 6 passes are required to meet adjacency objectives, then the initial harvest level must decrease to 1 000 000 cubic metres per year. This level can be maintained for 40 years before declining to a slightly lower long-term level than in the base case.

In conclusion, this analysis indicates that using current forest management, inventory and growth and yield information, the current harvest level can be maintained for the next 40 years. Several uncertainties important to timber supply can affect this projection. The greatest impact on short-term timber supply arises from uncertainty about existing stand volumes and uncertainty about access to the northern portion of the Kispiox TSA.

Table of Contents

Table of Contents

Tables

Table of Contents

Figures

Introduction

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

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

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

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

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

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

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* now 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 6 *of the* Forest Act.

Allowable annual cut (AAC)
The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with Section 7 *of the* Forest Act.

Introduction

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

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

The appendix contains further details about the data and assumptions used in this analysis.

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

1 Description of the Kispiox Timber Supply Area

The Kispiox TSA, in the northern interior of the province, is one of eight TSAs in the Prince Rupert Forest Region (Figure 1). It is bounded to the north approximately by the headwaters of the Sicintine and Kispiox Rivers; to the south by the Nass and Seven Sisters mountain ranges; to the west by the Hazelton Mountains and to the east by the Sicintine mountain range.

Major mountain ranges in the Kispiox TSA are the Atna in the northeast, the Babine in the east, the Nass and Seven Sisters in the south-west, the Kispiox and Rocher Deboule in the south-central, and the Kuldo in the north-west. Mountains generally follow a north-west to south-east orientation with broad valleys between the ranges. Highways 16, 37, and 62 are major paved roads in the Kispiox TSA. Highway 16 (the Yellowhead Highway) is the major travel route between Smithers, Vanderhoof and Prince George in the east and Terrace, Kitimat and Prince Rupert to the west. Highway 37 connects with Highway 16 at Kitwanga and provides a northern route to Dease Lake, Yukon and Alaska.

In 1995, Horne and Powell classified employment in the Kispiox Forest District into the following categories: forestry providing 42% of all employment in the area, public sector (25%), tourism (8%), agriculture (4%), and other (21%). Horne and Powell (1995) estimated total employment in the Kispiox Forest District to be 1,685 jobs, and annual after-tax income was estimated to be $39.7 million.

Most of the timber in the Kispiox TSA is processed by five sawmills — Repap British Columbia Inc. at Carnaby; Bell Pole Inc. at Terrace; Kitwanga Lumber and C GED Forest Products at Kitwanga; and Kispiox Forest Products at New Hazelton — and a Repap British Columbia whole log chipping plant at New Hazelton. All of the chipping plant output is sold to the Repap British Columbia pulpmill in Prince Rupert. The Kispiox TSA provides up to 72% of the fibre requirements of local facilities.

A Land and Resource Management Plan (LRMP) was recently completed for the Kispiox TSA. This timber supply analysis incorporates the recommendations of that plan wherever possible. This analysis also reflects the objectives of a Local Resource Use Plan (LRUP) for the Babine sub-drainages of the Kispiox TSA.

1 Description of the Kispiox Timber Supply Area

Figure 1. Map showing the location of the Kispiox TSA within the Prince Rupert Forest Region.

2 Information Preparation

Many pieces of information are required to conduct a timber supply analysis. Each piece falls into one of three categories: land base inventory, timber growth and yield, and management practices.

2.1 Land base inventory

Land base inventory information used in this analysis comes in the form of a computer file prepared by the B.C. Forest Service, Resources Inventory Branch in 1995. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

Initially, this file is a representation of the land base for the entire TSA. It includes data for areas on which timber harvesting operations are not expected to take place, and therefore do not contribute to the timber supply of the area. Examples include land that has been set aside for a park, or areas occupied by power lines, highways or town sites. Before this land base file is used to make timber supply projections, data for these non-contributing areas must be removed to ensure that the file represents the timber harvesting land base*.

The reduced data file is derived through a computer process that identifies information for non-contributing areas and removes it from the file. When these reductions are made, care is taken to ensure that only a single reduction is made where categories overlap (for example, where a park area also has unstable soils).

It is important to remember that removal of data for areas not contributing to the timber supply does not imply withdrawal of these areas from the TSA. The B.C. Forest Service still manages the entire area of the TSA (except for certain designated lands) as a forest unit that contributes a mix of timber and non-timber values. Within that integrated resource context, the timber supply is managed. The timber supply analysis discussed in this report is consistent with this philosophy.

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

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

2 Information Preparation

Under current management within the Kispiox TSA, certain areas are not expected to contribute to the active timber harvesting land base. These are:

- areas not managed directly by the B.C. Forest Service — these include non-Crown land, areas managed by other agencies (for example, parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licences).
- non-forest areas — areas not capable of growing productive forest (e.g. rock, swamp and alpine areas).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- environmentally sensitive areas (ESA)* — portions of the areas classified as sensitive are considered unavailable for timber harvesting.
- Babine riparian and forest ecosystem network (FEN)* areas — portions of the areas within the Babine LRUP classified as riparian areas* or set aside as part of a forest ecosystem network.
- other riparian and wetland reserves — other areas within the Kispiox TSA, excluding the Babine LRUP, classified as riparian areas or wetlands, and including the Telegraph Trail reserve zone.
- inoperable areas* — areas classified as unavailable for harvesting because of terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (for example, presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- visual quality preservation areas — areas of very high visual quality where no harvesting will be allowed.
- low productivity — areas where the site index* is considered too low to support the growth of trees to a commercial size in a reasonable amount of time.

Environmentally sensitive areas
Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest ecosystem network
A Forest Ecosystem Network (FEN) is a planned landscape zone which serves to maintain or restore the natural connectivity within a landscape unit. The goal of a Forest Ecosystem Network is to maintain a network of old growth and special habitats (such as riparian areas, wetlands, calcareous and serpentine bedrock exposures) in their natural state.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Operability
A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Site index
A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species.

- non-merchantable forest types* — areas occupied by timber stands of low volume, non-merchantable species, stands with insufficient height or too dense stocking* (number of trees per unit area).
- existing roads, trails and landings — forest land lost to future timber production due to past access development and harvesting.
- Babine wilderness — an area of forest on both sides of the Babine River recently approved by Cabinet as a protected area.
- future roads, trails and landings — to account for future losses of productive land to development. These areas are initially included in the timber harvesting land base, and are removed after the first harvest.

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

Table 1 summarizes the areas in each category and shows the area of the timber harvesting land base. The reductions to productive Crown forest are made in the order of appearance in Table 1.

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.

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.

2 Information Preparation

Table 1. Timber harvesting land base, Kispiox TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	1 222 624	100.0	
Not managed by B.C. Forest Service	54 511	4.5	
Non-forest/non-productive	418 317	34.2	
Total productive forest managed by Forest Service (Crown forest)	749 796	61.3	100.0
Reductions to productive Crown forest:			
Non-commercial cover (brush)	966	0.1	0.1
Environmentally sensitive areas	157 302	12.9	21.0
Babine riparian and FEN	7 398	0.6	1.0
Other riparian and wetland reserves	7 676	0.6	1.0
Inoperable areas	205 606	16.8	27.4
Visual quality preservation areas	345	0.1	0.1
Low productivity	2 577	0.2	0.3
Non-merchantable forest types	41 954	3.4	5.6
Existing roads, trails and landings	5 330	0.4	0.7
Babine wilderness	2 703	0.2	0.4
Total current reductions	- 431 857	35.3	57.6
Current timber harvesting land base (includes 10 036 hectares of not satisfactorily restocked (NSR)* land[a]	317 939	26.0	42.4
Future roads, trails and landings	-23 826	1.9	3.2
Long-term timber harvesting land base	294 113	24.1	39.2

(a) NSR includes current NSR and backlog NSR.

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

2 Information Preparation

Figure 2 shows the composition of both the total Kispiox TSA area and the productive forest area. Of the total land base, approximately 95% is managed directly by the B.C. Forest Service, and 61% is considered productive Crown forest. Of the productive Crown forest land, approximately 42% is considered to contribute to the timber harvesting land base. The area that is considered unlikely to contribute to harvesting activity under current management is mainly attributable to environmental sensitivity and inoperability.

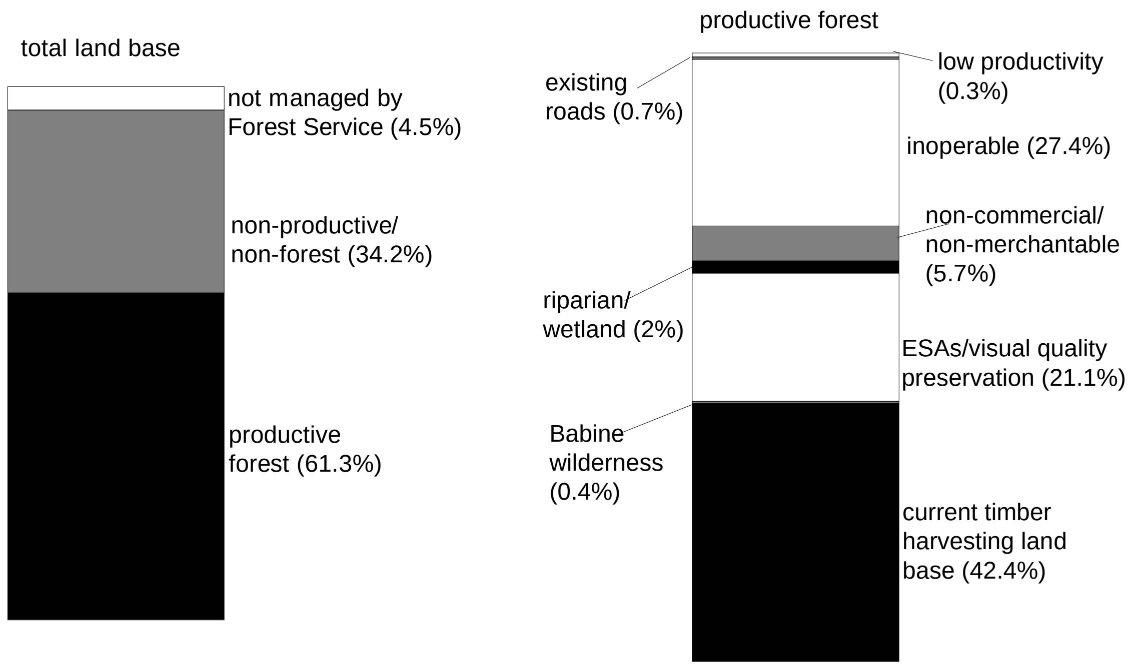

Figure 2. Classification of the total and productive forest land bases — Kispiox TSA, 1996.

The predominant tree species within the timber harvesting land base are western hemlock and balsam. Spruce and lodgepole pine are also present in significant amounts. Cedar and young deciduous (cottonwood and aspen less than 40 years of age) are also included in the timber harvesting land base. Figure 3 provides the breakdown of dominant species by site productivity. The Kispiox TSA is composed predominantly of sites of poor productivity.

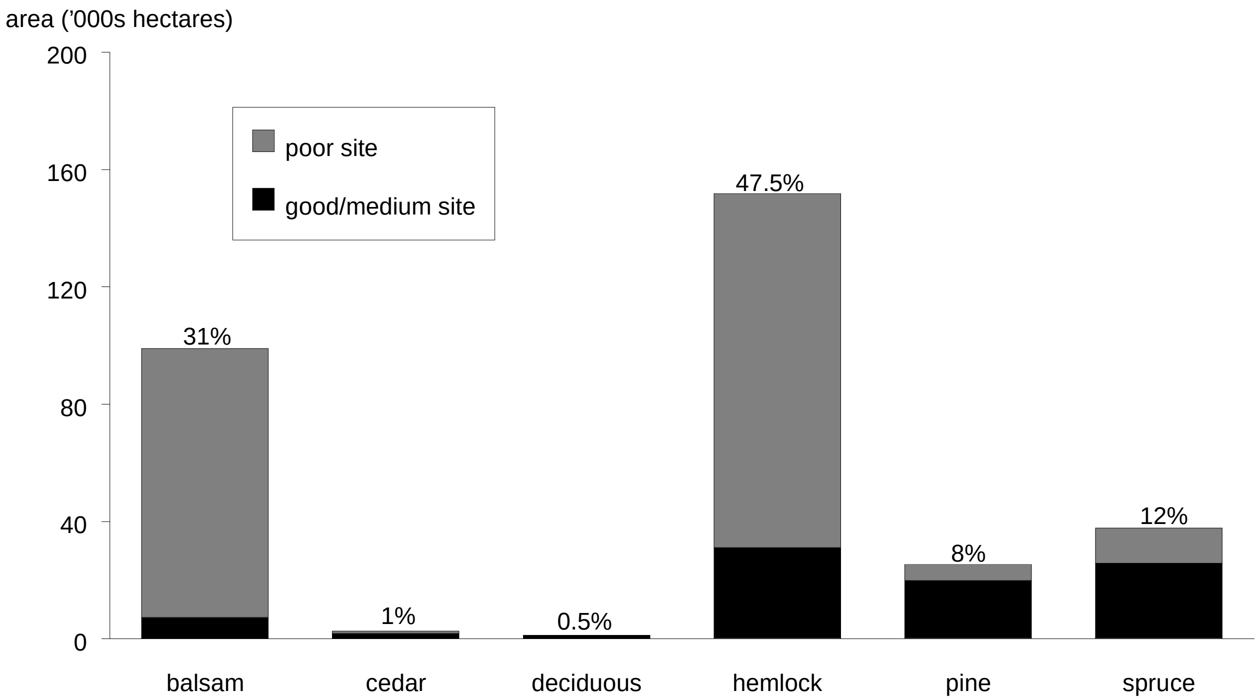

Figure 3. Area by main species and site productivity — Kispiox TSA timber harvesting land base, 1996.

2 Information Preparation

The timber harvesting land base is comprised mainly of mature forest as can be seen in Figure 4. The distribution of the young forest is indicative of the practice of replacing hemlock and balsam forest types* with spruce and pine plantations.

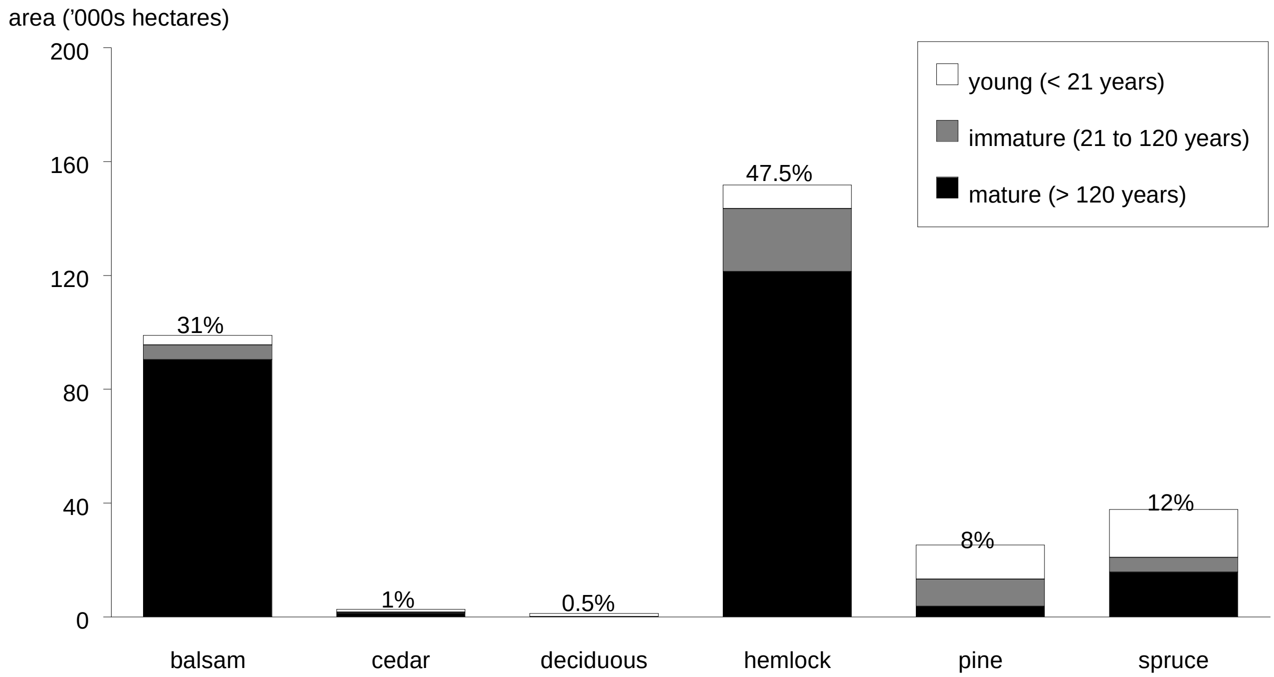

Figure 4. *Area by main species and maturity — Kispiox TSA timber harvesting land base, 1996.*

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.

The current age class distribution (Figure 5) shows that 73% of the timber harvesting land base is covered by stands older than 120 years of age. One noticeable gap in the age classes occurs between the 40-60 year age classes. This gap is a result of few stands being disturbed by insects, wind, fire, or harvesting 40 to 60 years ago. To maintain a steady flow of timber, the existing natural stands must be allocated for harvest over time until currently younger stands become old enough to harvest.

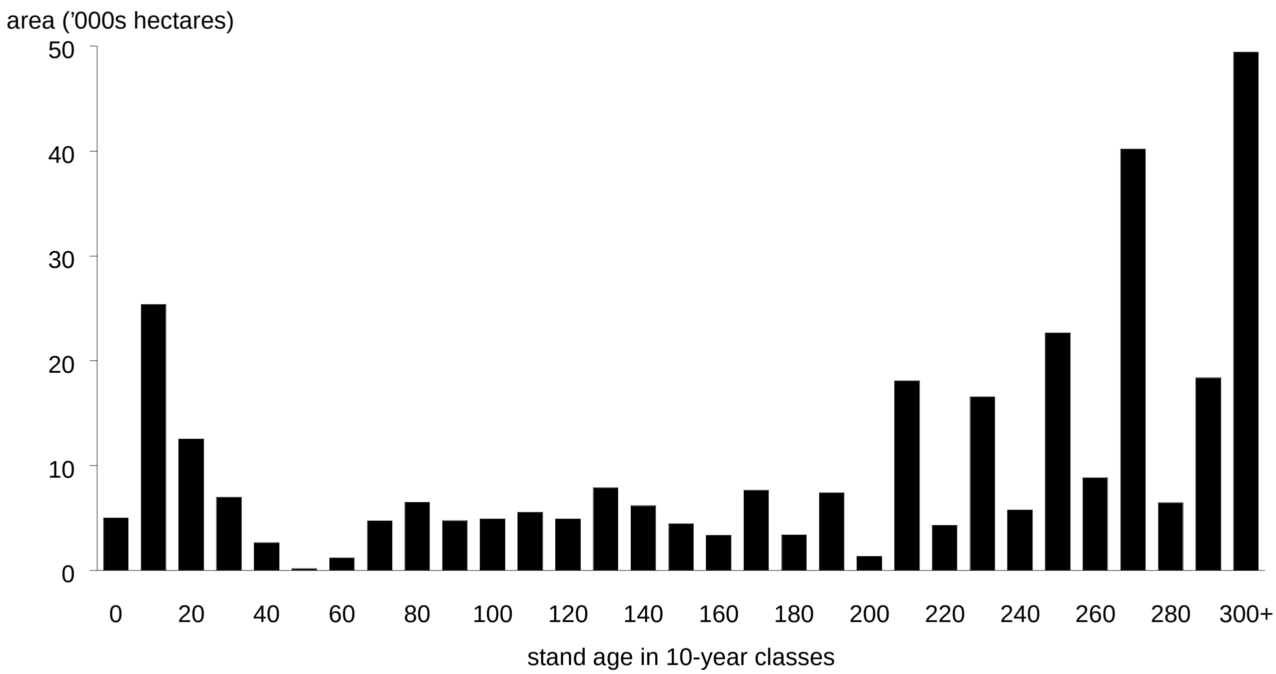

Figure 5. Current age class distribution — Kispiox TSA timber harvesting land base, 1996.

2.2 Timber growth and yield

Timber growth and yield refers to the predictions of the growth and development of individual forest stands over time. The most common measure of the amount of standing timber is volume per unit area (in British Columbia, cubic metres per hectare). This measure assumes a utilization level or set of dimensions that establishes a minimum size limit for trees and logs that may be harvested and removed from a site. See Appendix A, "Description of Data Inputs and Assumptions" for more details on utilization.

In this analysis timber volumes applied to existing stands greater than 20 years old are based on the Variable Density Yield Prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch. This model provides estimates of stand volume according to age. Timber volumes estimated for stands less than 20 years old and for regenerated stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service, Research Branch. Sensitivity analysis addresses the possibility that stand volumes may be different from those predicted.

2.3 Management practices

Timber supply is directly connected to forest management activity. The *Kispiox Land and Resource Management Plan* and the *Forest Practices Code of British Columbia Act (Code)* guide forest management practices in the Kispiox Forest District. The focus of the Timber Supply Review is to describe the timber supply based on current management practices, as implemented in development plans for the area. Staff in the Kispiox Forest District and in the Prince Rupert Forest Region defined these practices as described in the following management assumptions*.

- Basic silviculture levels — reforestation activities required to establish free-growing* stands of acceptable tree species. The primary harvesting system in the Kispiox TSA is clearcut harvesting* with all restocking by planting. In addition, on one-half of all cutblocks, 5% of the timber volume will be retained after harvesting as standing trees.
- Immature plantation history — stands where stocking was controlled will be immediately assigned a volume estimate* based on managed stand yield tables.
- Forest health and unsalvaged losses* — expected losses due to fire are estimated to be 5932 cubic metres per year. This amount has been subtracted from all harvest forecasts* in this report.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. For this analysis the minimum harvestable ages are assumed to be the age at which stands are within 5% of their maximum average annual growth. Actual harvest age may be greater, but not less than the minimum, due to a combination of factors, such as the age of other stands, forest cover objectives* and overall timber harvest targets. It is important to remember that managing for other forest values may necessitate harvesting stands at ages well above the minimum.

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.

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 standard by appropriate means including planting and natural seeding.

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.

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

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

Forest cover objectives
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.

- Cutblock adjacency* and green-up* — the *Code* specifies that previously harvested stands must reach a desired condition, or green-up height, before adjacent stands may be harvested. Green-up heights in the Kispiox TSA are 6 metres in the visual quality zones and 3 metres elsewhere. The Kispiox Forest District requires that at any time a maximum of 33% of an area being developed for harvesting can be covered by stands less than the green-up height. This default requirement is applied whenever less restrictive forest cover requirements are encountered. The purpose of the adjacency and green-up height requirements is to prevent harvesting from becoming overly concentrated in an area at any time.
- Rate of cut by watershed* — the LRMP specifies that on average no more than 22% of the forested land in a watershed may be in a hydrological condition equivalent to that of a clearcut. Kispiox Forest District staff defined hydrologic green-up* height as 6 metres.
- Visual quality — 38 664 hectares (12%) of the timber harvesting land base are being managed for visual quality. Maintaining visual quality requires that visible evidence of harvesting be kept within limits. Guidelines are stated in terms of the maximum proportion of an area that may be less than 6 metres tall (the visual green-up). The proportion depends on the specific visual quality objective (VQO)* and the visual sensitivity*. In this analysis, areas managed for visual quality fall into two categories:
  1) retention*, for which evidence of timber harvesting must be minimal; and
  2) partial retention*, for which harvesting may be noticeable but not dominant on the natural landscape.
- Special management areas — the East Kispiox/Kuldo, Atna/Shelagyote and the Rocher Deboule areas have high scenic, recreation and wildlife values. Harvesting has been deferred in these areas for one decade to allow for collection of data on these values and the preparation of appropriate plans.
- Deer management — an area of prime deer habitat, providing thermal cover, winter forage and security cover, was identified in the Kispiox TSA. At least 6% of this area is required to be covered by forest older than 150 years of age.

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

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

Hydrologic green-up (height)
The height a stand must reach for it to provide the same timing and quantity of water yields as the previous old-growth stand it replaces.

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).

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

- Babine LRUP — a local resource use plan (LRUP) is in effect for the area drained by the Babine River. In addition to the wilderness area excluded from the timber harvesting land base there are:
  - the Babine special management area which buffers the wilderness area. At least 30% of the forested area must be greater than 140 years old at any time;
  - the Sub-boreal spruce (SBS) area. A maximum of 50% of the forest can be less than 20 years old and at least 30% of the forest must be greater than 50 years old;
  - the Englemann Spruce-Subalpine Fir (ESSF) area. A maximum of 30% of the forest can be less than 21 years old and at least 50% of the forest must be greater than 80 years old.
- Deferred areas — in the upper Kispiox area and the Seven Sisters area, harvesting has been deferred until the end of 1996 to allow for the completion of local planning processes currently underway.
- Integrated resource management (IRM) — the largest zone is managed for integrated resources use, and is composed of the areas which have not been allocated to any other specific management objective. The IRM east zone is that portion of the IRM zone north of the Babine River and east of the Skeena River.

A full explanation of the zones and the forest cover requirements* applied to each zone is found in Appendix A, "Description of Data Inputs and Assumptions."

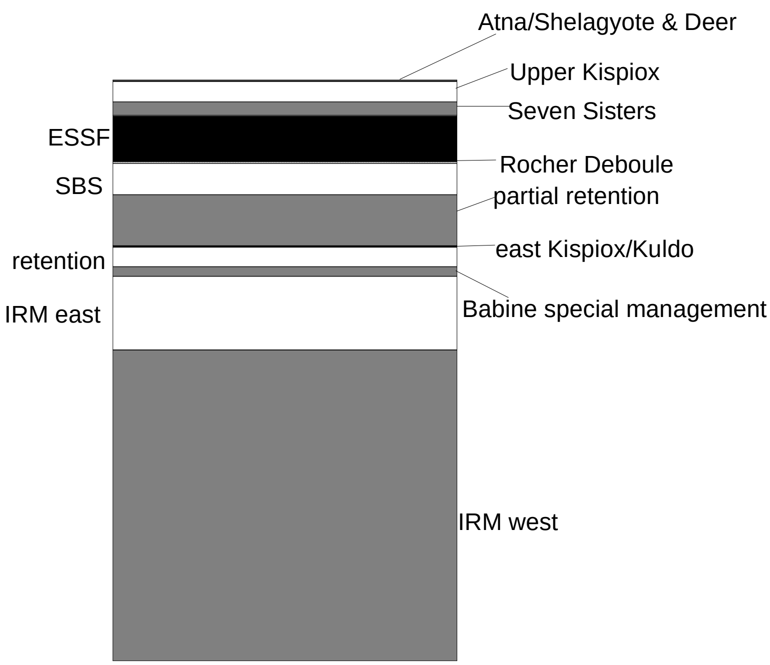

Figure 6. Major resource emphasis zones — Kispiox TSA timber harvesting land base, 1996.

> ***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 adjacency and green-up guidelines are also specified using forest cover objectives (see* ***Cutblock adjacency and Green-up)****.*

3 Analysis Methods

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

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

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

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

4 Results

This section presents results of the timber supply analysis for the Kispiox TSA. The analysis 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." These results will be referred to as the base case because they form the basis for comparison when assessing the effects of uncertainty on timber supply. Because forest management is inherently a very long-term venture, uncertainty surrounds much of the information important in determining timber supply. These factors will be discussed in Section 5, "Timber Supply Sensitivity Analyses."

4.1 Base case harvest forecast

The base case harvest forecast based on current forest management assumptions for the Kispiox TSA is shown in Figure 7. The base case should be viewed in concert with the sensitivity analysis harvest forecasts for a complete understanding of the impacts that various management and data assumptions have on timber supply.

The initial harvest level, set at the current level of 1 100 000 cubic metres per year, can be maintained for 4 decades without causing severe disruptions in timber supply in the future. Beginning in the fifth decade, the harvest level declines by 10% per decade until it reaches the long-term harvest level of 630 000 cubic metres per year in decade 10. This long-term level is maintained for the remainder of the planning period.

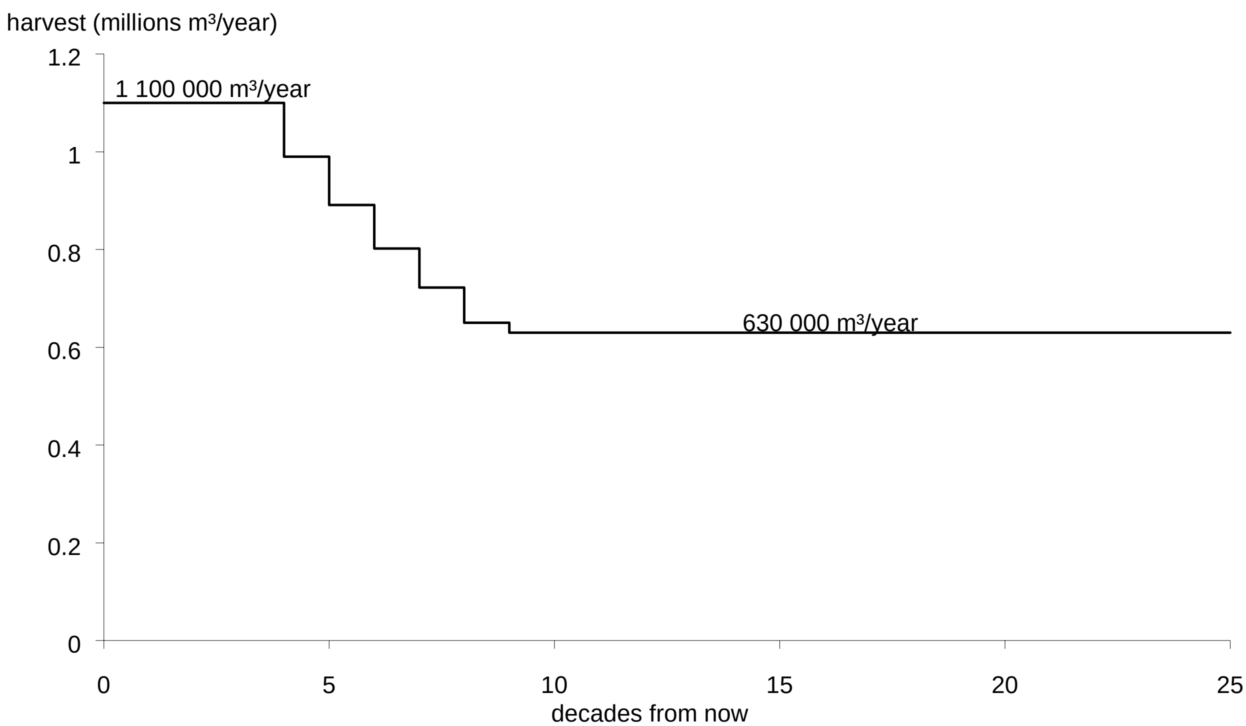

Figure 7. Base case harvest forecast for the Kispiox TSA, 1996.

The estimated unsalvaged losses of 5932 cubic metres per year have been removed from all harvest forecasts shown in this report.

Several criteria have been used in defining the base case harvest forecast for the Kispiox TSA. The initial harvest level is set at the current allowable harvest level. The long-term harvest level* is the level which results in a steady total growing stock* capable of supporting that level of harvesting in perpetuity. A continually declining growing stock would signify that timber is being harvested above the productive capability of the timber harvesting land base. The long-term level in the base case is 13% below the maximum productive capacity of the land due to the impact of forest management objectives such as forest cover guidelines and minimum harvestable ages. The maximum productive capacity of the forest can only be captured if all stands are harvested at the culmination of mean annual increment (MAI)*. For the base case, the minimum harvestable ages were assumed to be the age at which stands are within 5% of culmination MAI; however, the application of forest cover guidelines affect the actual age at which a stand is harvested. For example, in the VQO retention zone, only 2.6% of the area may be covered by stands of less than 6 metres in height. As a result of the application of this forest cover requirement, stands are projected to be harvested well past culmination age* in this zone, which comprises 3% of the timber harvesting land base.

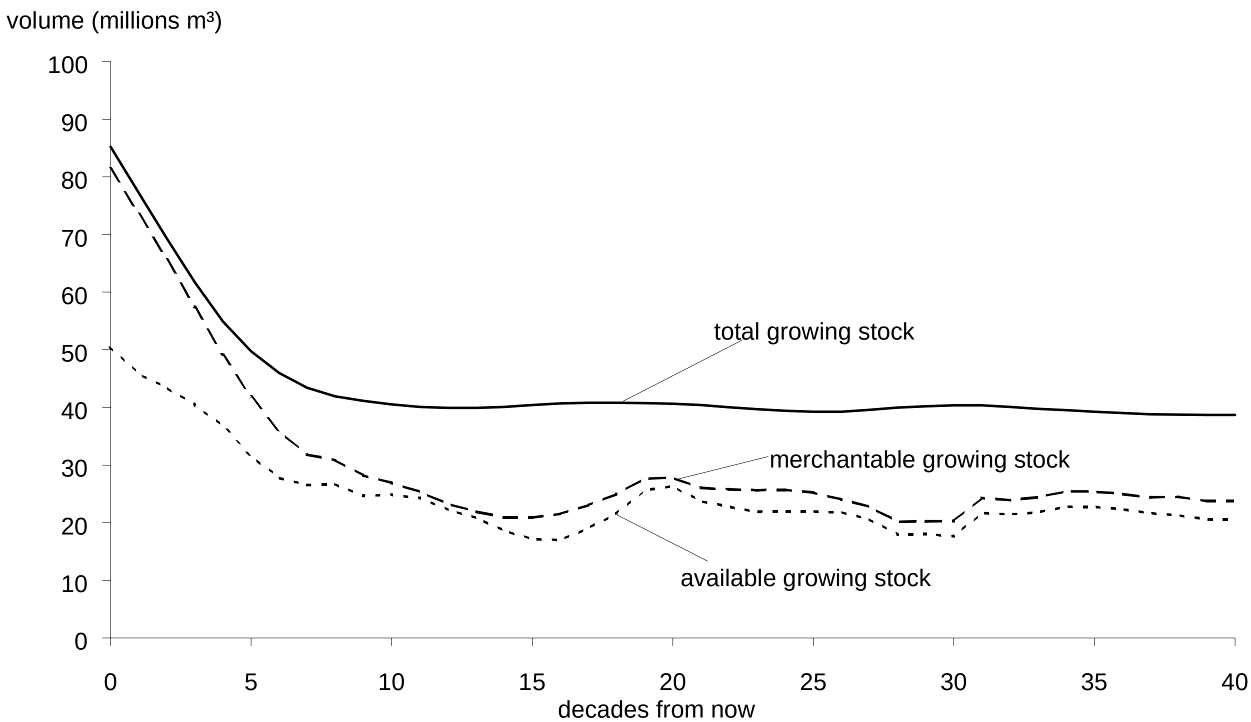

Figure 8. Changes in timber growing stock over time — Kispiox TSA base case, 1996.

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

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

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

Culmination age
The age at which a timber stand reaches its highest 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.

The transition from the initial harvest level to the long-term harvest level is mainly dependent on the transition from harvesting in existing stands to harvesting regenerated managed stands, the rate of acceptable decadal decline, and the depth of that decline. From the infinite number of harvest flows possible, the harvest flow policy chosen for the base case is based on maintaining the current harvest level for as long as possible followed by a gradual transition to the long-term level.

Figure 8 shows the total, merchantable and available growing stock projected over time. There is currently a total of about 85 million cubic metres of timber in the timber harvesting land base, as indicated by the solid line. Of the total, about 81 million cubic metres of timber is currently old enough to be considered merchantable (older than minimum harvestable age). The actual available timber, after forest cover requirements for old growth are met, is 50 million cubic metres and is represented by the dotted line. The growing stock declines rapidly over the next 7 decades as the existing mature stands, which are well past minimum harvestable age, are removed and replaced with a younger forest characterized by a lower average volume per hectare.

The total growing stock is projected to reach a steady volume of about 40 million cubic metres after decade 11. The available timber is projected to steady at about 20 million cubic metres, about one-half the volume of the total growing stock. The planning horizon has been extended to 400 years in this graph to illustrate the steadying of the total growing stock, which indicates that the long-term harvest level can be maintained in perpetuity.

4.2 Area, average volume, and average age harvested

Figure 9 shows the projected variation in area harvested over the next 250 years under the base case harvest forecast assumptions. The amount of area harvested is projected to range from 30 000 to 17 000 hectares per decade, averaging about 21 000 hectares per decade after the seventh decade.

During the first 4 decades of the harvest forecast, the amount of area harvested is projected to increase, even though the harvest level remains the same, because the harvest comes mainly from the poor site, lower-volume balsam and hemlock stands.

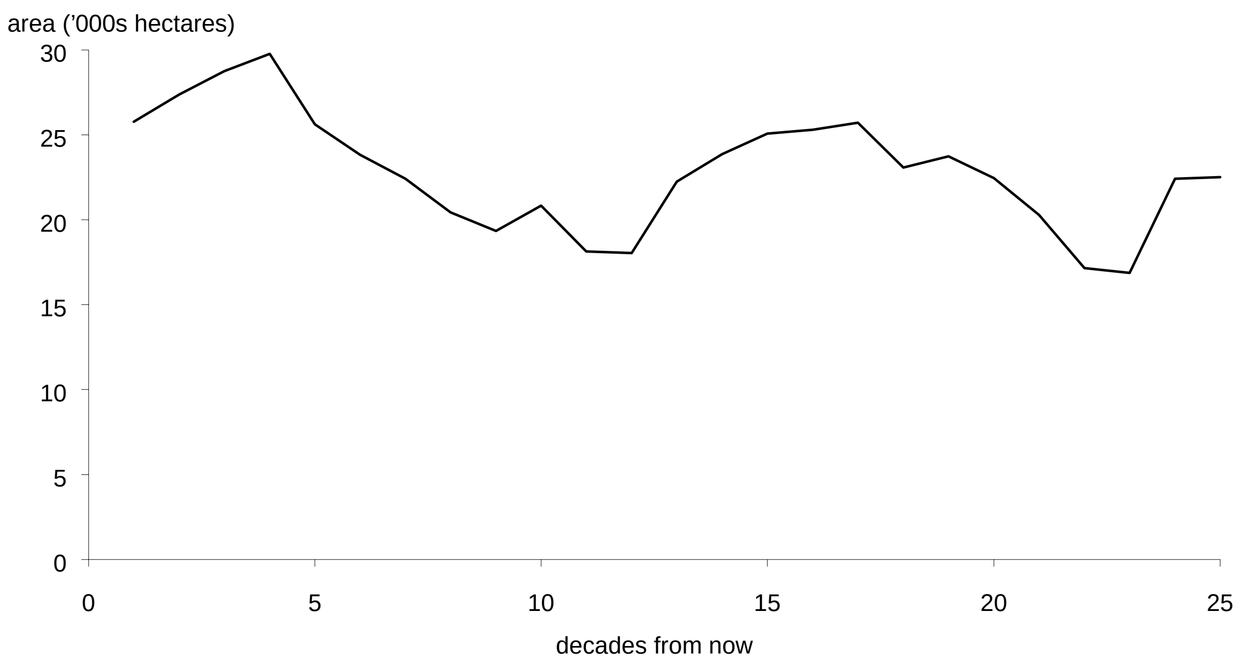

Figure 9. Area harvested over time — Kispiox TSA base case, 1996.

Figure 10 shows changes in the average timber volume per hectare harvested over the same period. When Figure 10 is compared to the area harvested graph in Figure 9, it can be seen that the average volume per hectare harvested is high when the amount of area harvested is low, and low when the amount of area harvested is high. This relationship is expected since the objective is to maintain a steady harvested volume per decade rather than a steady area harvested per decade. After the transition period in decade 10, the first regenerated managed stands that become available for harvesting will be primarily from good and medium quality growing sites. These stands are again available for harvest after decade 21. This explains the higher average volume per hectare harvested in decades 11 and 22.

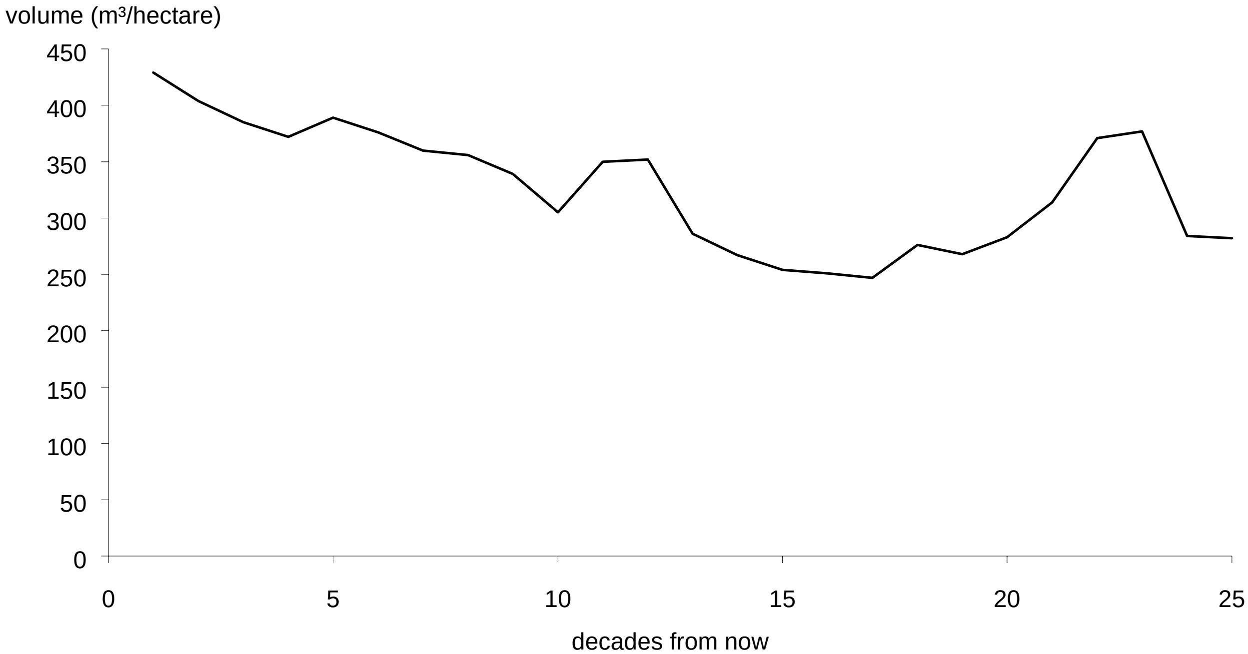

Figure 10. Average volume per hectare harvested over time — Kispiox TSA base case, 1996.

The average harvest ages projected in the analysis are shown in Figure 11. This graph shows the gradual transition from harvesting the existing old-growth forest to harvesting the younger managed forest. The average harvest age remains steady at about 130 years after decade 13; however, most of the volume harvested is from stands of 100-120 years of age. The average harvest age is higher because the harvest ages from younger stands are averaged with the harvest ages of older stands that have been retained to meet forest cover requirements or have high minimum harvestable ages.

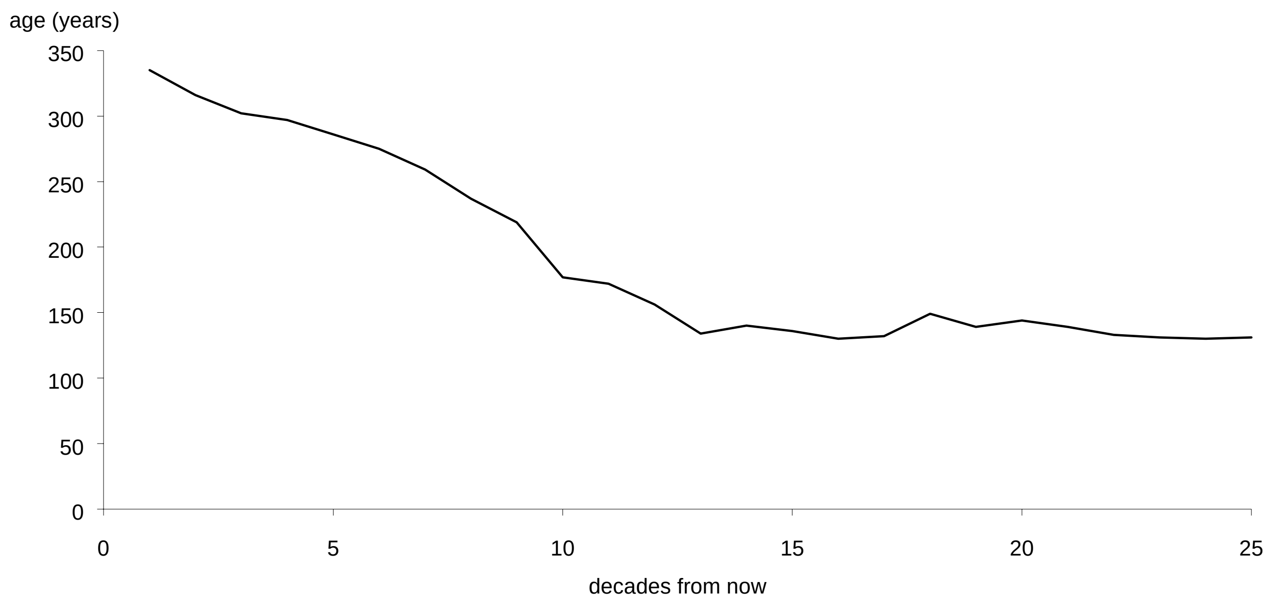

Figure 11. Average harvest age over time — Kispiox TSA base case, 1996.

4.3 Changes in age class distribution

Figure 12 shows the changes projected to occur in the age class distribution of the timber harvesting land base in the Kispiox TSA. Currently, the timber harvesting land base is occupied by stands predominantly older than 120 years. After about 100 years, most of the timber harvesting land base is split into approximately equal areas in each 10-year age class for stands less than 110 years of age. However, approximately 13% of the timber harvesting base is still occupied by stands older than 120 years after 100 years. Many stands in the visual quality zones are not harvested within the 250-year planning period, as indicated by the amount of area accumulating in the older age classes. It is important to note that these graphs do not include the 431 857 hectares of forested land excluded from the timber harvesting land base for reasons such as environmental sensitivity, merchantability or operability.

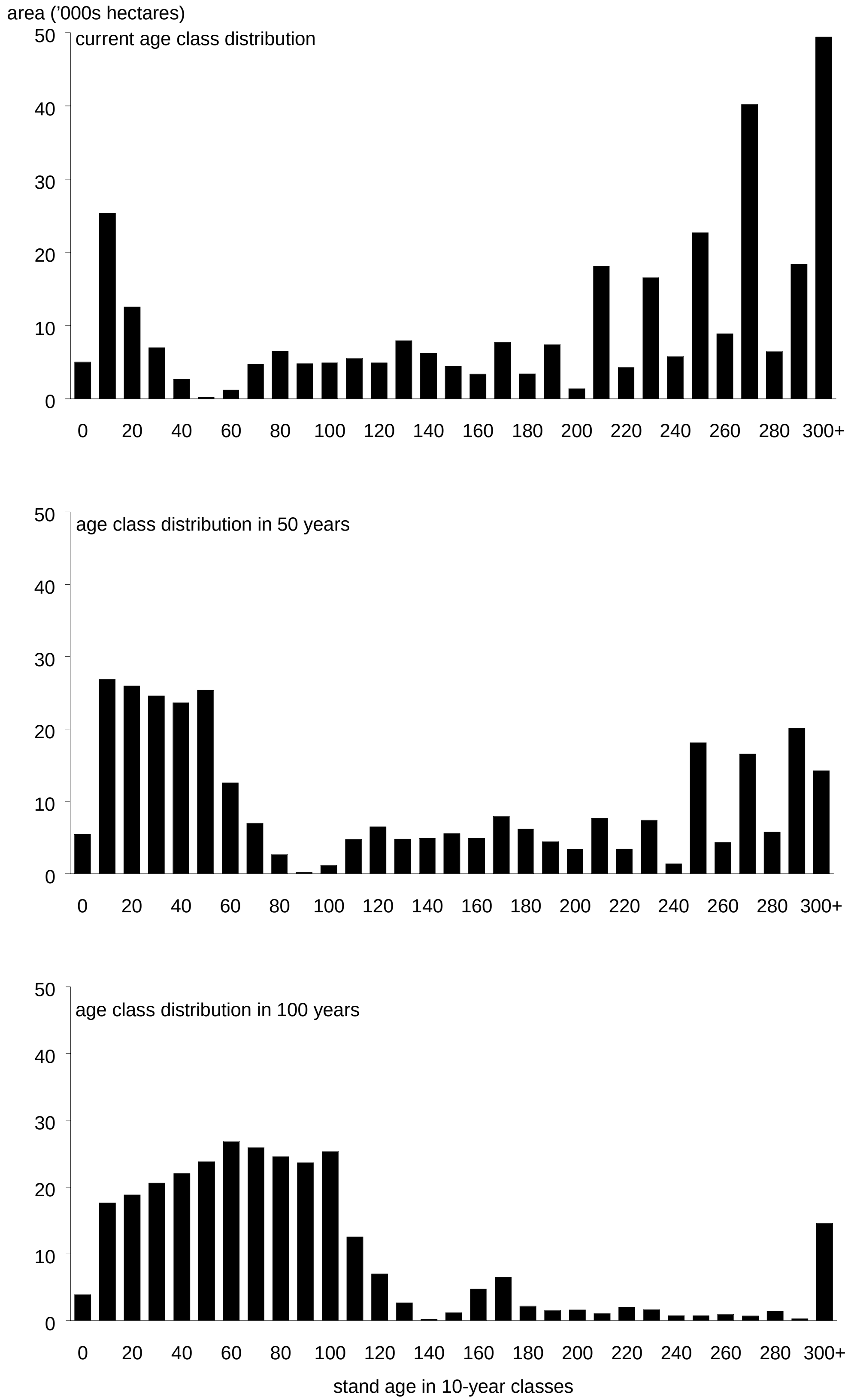

Figure 12. Changes in age composition on the timber harvesting land base over time — Kispiox TSA base case, 1996.

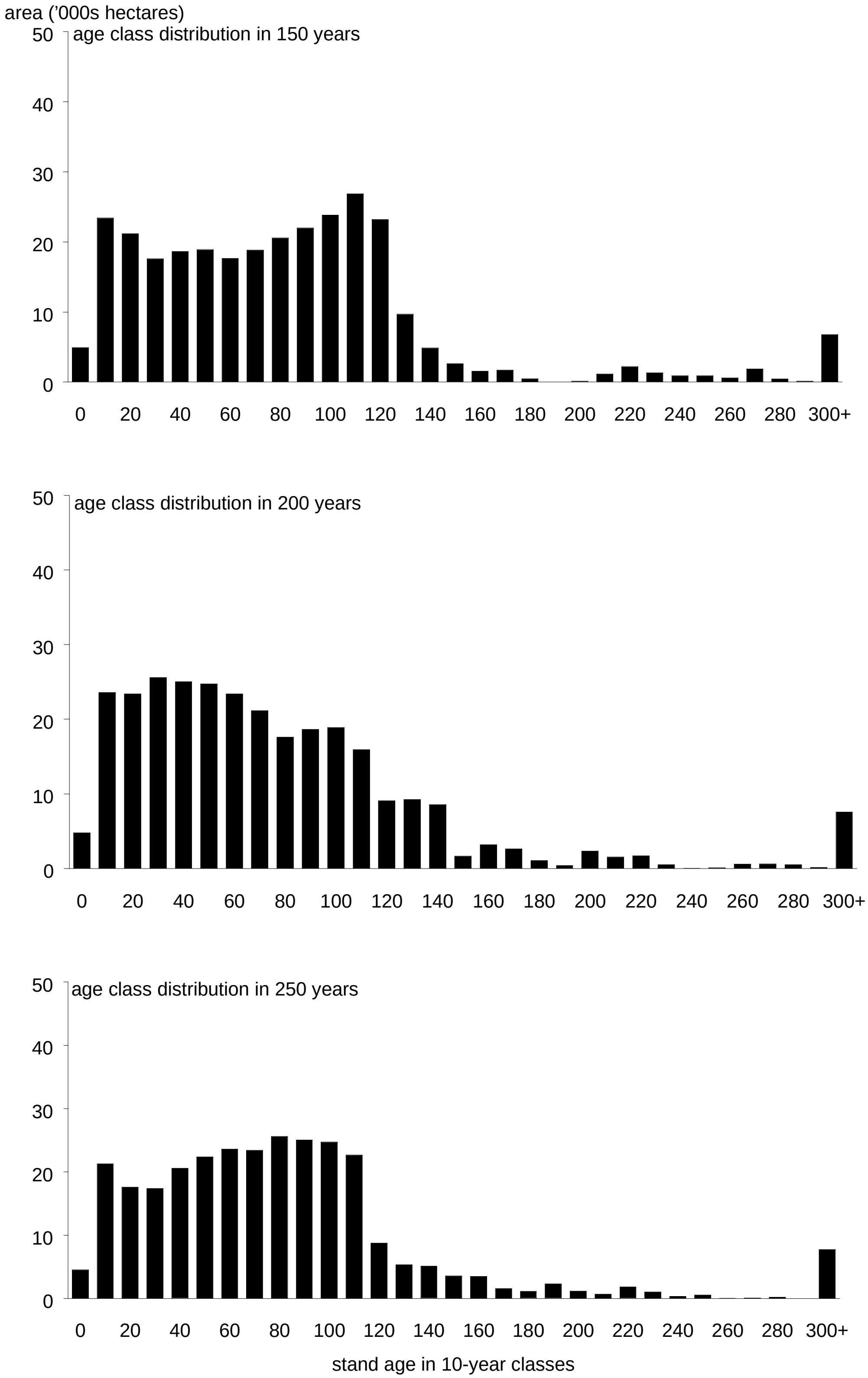

Figure 12. Changes in age composition on the timber harvesting land base over time — Kispiox TSA base case, 1996 (concluded).

5 Timber Supply Sensitivity Analyses

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

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize many 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. One purpose of sensitivity analysis is to highlight which variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

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

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

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

5.1 Alternative initial harvest levels and harvest flows over time

The base case harvest forecast shown in Figure 7 was defined using criteria such as the rate of decline per decade, avoidance of large harvest shortfalls, and maintenance of a fairly constant growing stock level over the long term. While the last of these criteria is linked to maintaining the productivity of forest land, and is therefore a legislated requirement, the other criteria are not requirements, rather they are attempts to avoid both excessive changes from decade-to-decade, and significant timber shortages in the future 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-term and long-term harvests.

Figure 13 compares three harvest flow alternatives to the base case. In alternative one, the objective is to maintain the highest even harvest flow (flat line) throughout the analysis horizon. This can be achieved with a harvest level of 675 000 cubic metres per year which is 39% below the current level. By lowering the harvest level, the transition period from existing stands to regenerated stands is extended and stands are harvested much later than the age at which maximum growth occurs. Thus, this strategy does not completely capture the productive potential of the forest. With this alternative there is a steady decline of the growing stock, which indicates that this harvest level cannot be maintained in perpetuity. The harvest level must be lowered to the long-term level of 630 000 cubic metres some time after decade 40.

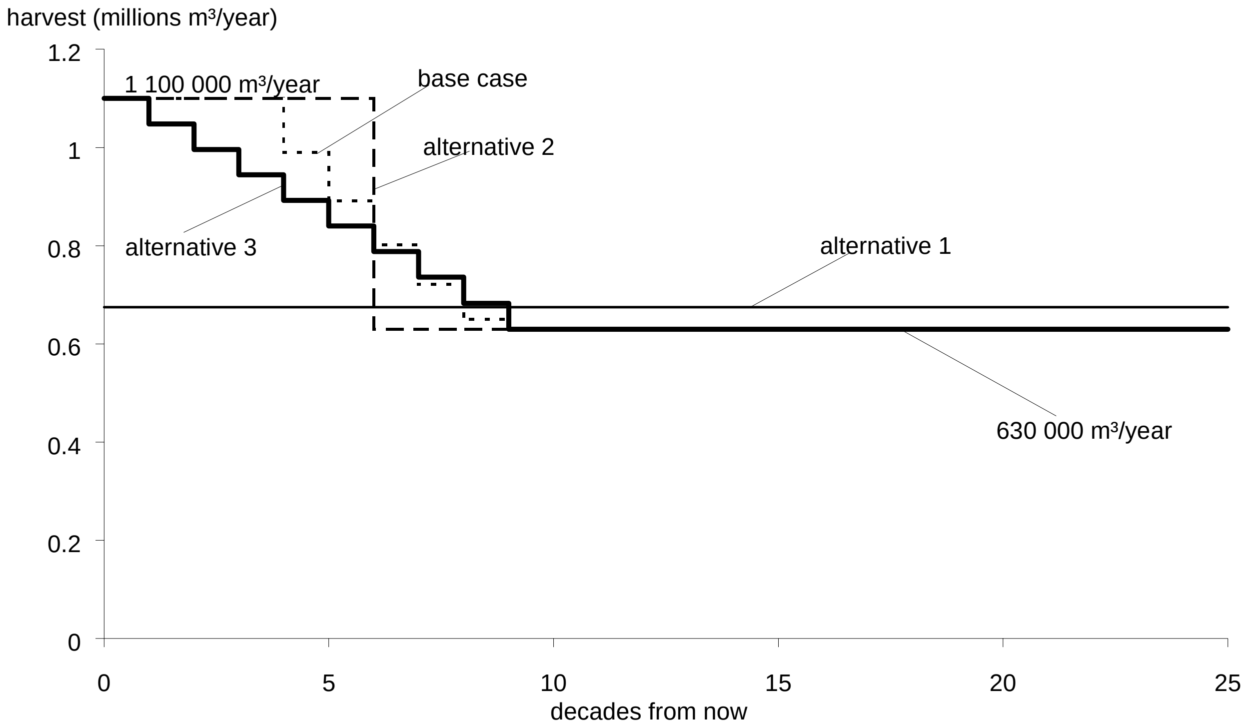

Figure 13. Alternative harvest flow forecasts — Kispiox TSA, 1996.

Alternative two in Figure 13 shows it is possible to maintain the current harvest level for 6 decades followed by a drop of 43% in the seventh decade to the long-term level of 630 000 cubic metres. If the current level is maintained longer than 6 decades, the harvest must drop below the long-term level because most of the existing old-growth forest is harvested before the regenerated stands attain the minimum harvestable age. A third alternative shows a steady decline of 52 000 cubic metres per decade beginning in the second decade and attaining the long-term level in the tenth decade. This more gradual transition results in less total timber harvested over the planning horizon than in the base case because existing old stands are held for as much as 20 years longer before harvesting.

The harvest flow alternatives shown above gives an indication of the range of harvest flows possible, depending on preferences for current benefits versus future benefits.

5.2 Uncertainty in existing stand volume estimates

Estimates of standing timber volumes in existing stands are subject to uncertainty because they are based on extrapolating statistics 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 area. 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 to estimates of utilization levels practiced during harvesting.

Figure 14 demonstrates that timber supply is sensitive to uncertainty in existing stand volume estimates. If existing stand volumes are actually 20% greater than those used for the base case, the current harvest level of 1 100 000 cubic metres per year could be maintained for 80 years before declining to the same long-term level as in the base case.

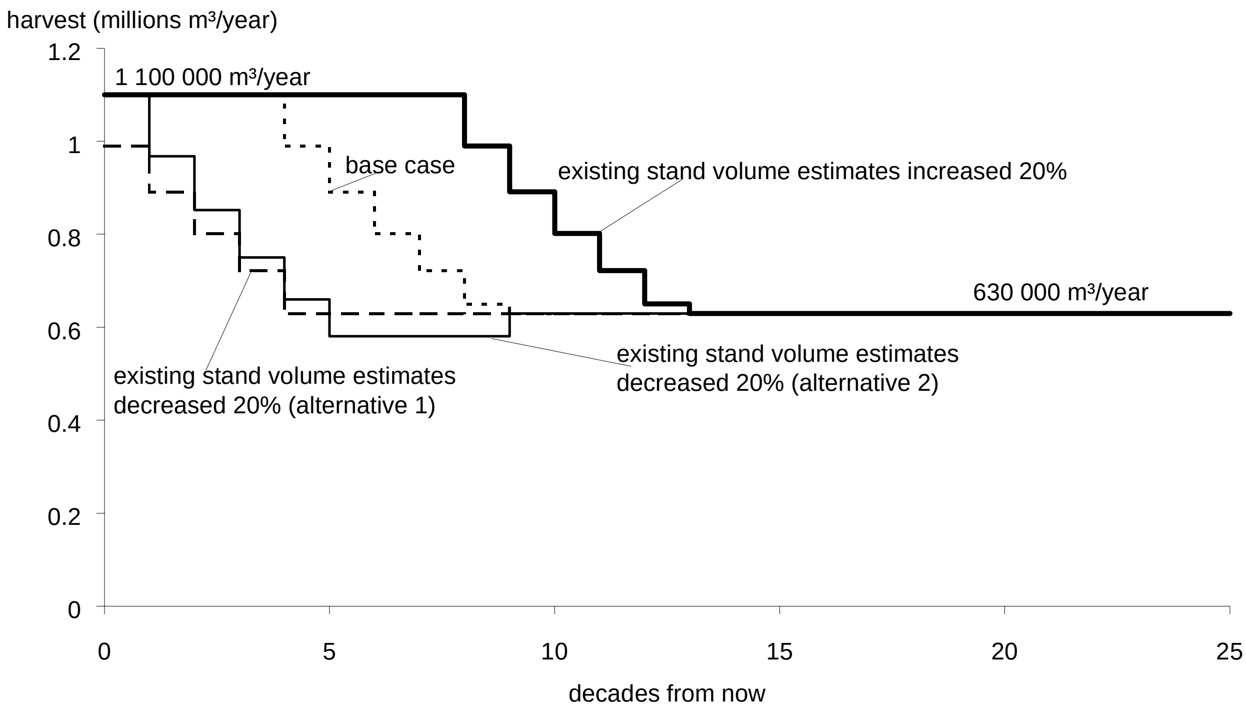

Figure 14. Harvest forecasts with existing stand volume estimates changed by 20% — Kispiox TSA, 1996.

Conversely, if existing stand volumes are in fact 20% lower than those used in the base case, the harvest level would need to decline immediately to avoid falling below the long-term harvest level in the near future. One alternative would be to decline immediately by 10% to 990 000 cubic metres per year for the first decade, and then by 10% per decade until the long-term level is reached in decade 5. A second alternative would be to maintain the current level for one decade then decline by 12% per decade, falling below the long-term level in decade 6 and later rising to the long-term level in decade 10. These two harvest flow alternatives illustrate the trade-off between short- and long-term benefits and costs that exists when harvests must decline in the near future to a level that can be maintained in the long term.

The timber supply is highly sensitive to overestimation of existing stand volumes 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 existing forested area 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.

5 Timber Supply Sensitivity Analyses

This sensitivity analysis shows that timber supply over the next several decades is sensitive to uncertainty about volumes in existing mature stands. However, this uncertainty does not affect the long-term harvest level.

5.3 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 5.10, "Uncertainty in site productivity"). In this section, the effects on timber supply of using managed stand yield tables and their associated uncertainty are shown.

Figure 15 shows the results if regenerated volumes are varied by 20% from those assumed in the base case. If managed stand volumes were to exceed present volume estimates by 20%, the noticeably higher volume contributions of managed stands to timber supply caused the long-term harvest level to be 19% higher than in the base case. The harvest forecast in Figure 15 shows that the current harvest level can be maintained for 3 decades before the transition to the long-term level which is achieved in the seventh decade rather than in the tenth decade. It was possible to maintain the current harvest level for 4 decades, as in the base case, but the harvest level would then have to drop to 722 000 cubic metres per year in decade 8 before rising to the long-term level of 750 000 cubic metres per year in decade 12.

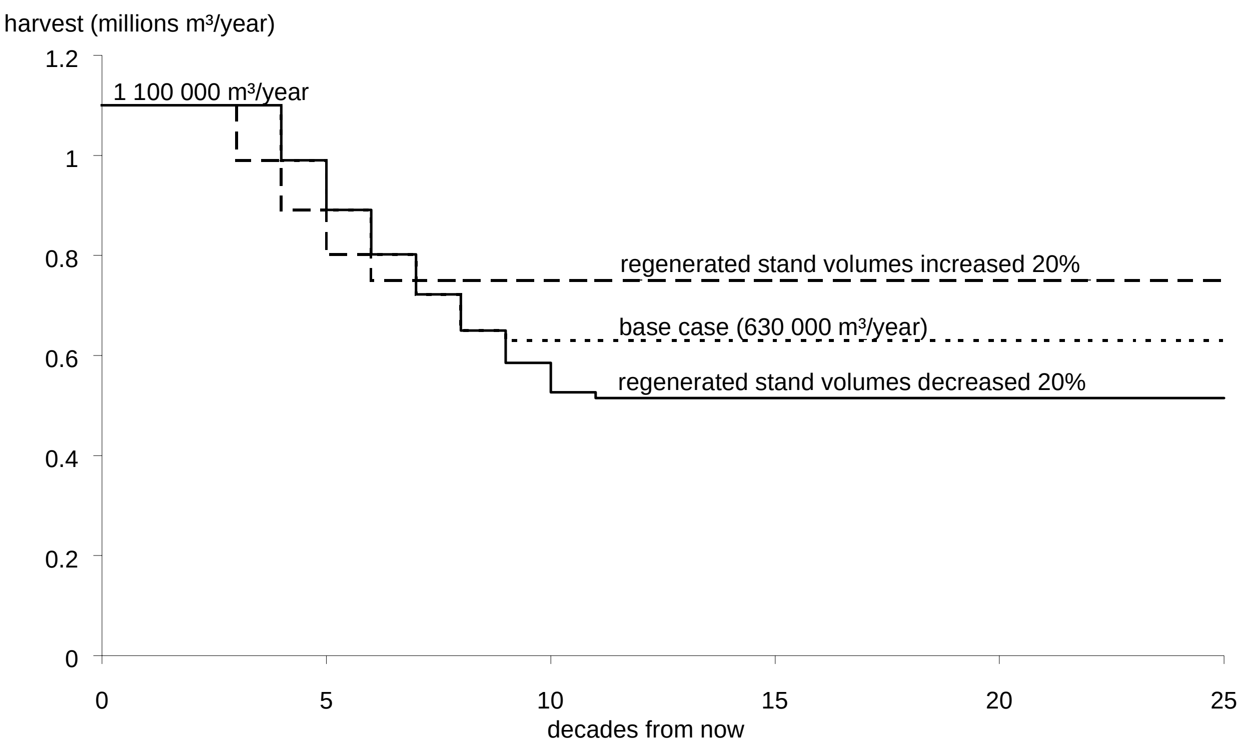

Figure 15. Harvest forecasts with regenerated stand volume estimates changed by 20% — Kispiox TSA, 1996.

If regenerated stand volume estimates are in fact 20% lower than expected, the long-term harvest level is projected to be 515 000 cubic metres per year, which is 18% lower than the base case long-term level. This harvest forecast is similar to the base case, except that harvest levels must decline an additional 2 decades to reach a lower long-term level. A longer period of time is required to reach the lower long-term harvest level and ensure a reasonable transition from harvesting existing stands to harvesting regenerated stands. Some of the existing stands projected to be harvested earlier in the base case must be harvested later to assure a smooth transition to the new long-term harvest level. This harvest forecast is a reasonable approximation of how timber supply would be affected if managed stands showed no improvement in growth over existing stands.

The uncertainty about regenerated stand yields does not impact the projected timber supply projection for the first 3 decades. However, the long-term harvest level could be dramatically affected if the growth of managed stands differs from the estimates used in this analysis.

5.4 Uncertainty in minimum harvestable ages

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

For this analysis, minimum harvestable ages were estimated as the age at which stands reach 95% of the maximum average growth rate (or culmination of mean annual increment (MAI)). This method was chosen to ensure that the long-term timber production of the timber harvesting land base would be close to its maximum. The minimum harvestable ages are minimums; stands may be harvested at older, but not younger, ages. They are meant to approximate the timing of merchantability, and are not legal or policy requirements. If necessary to meet management objectives, forest cover requirements can extend the minimum harvestable ages.

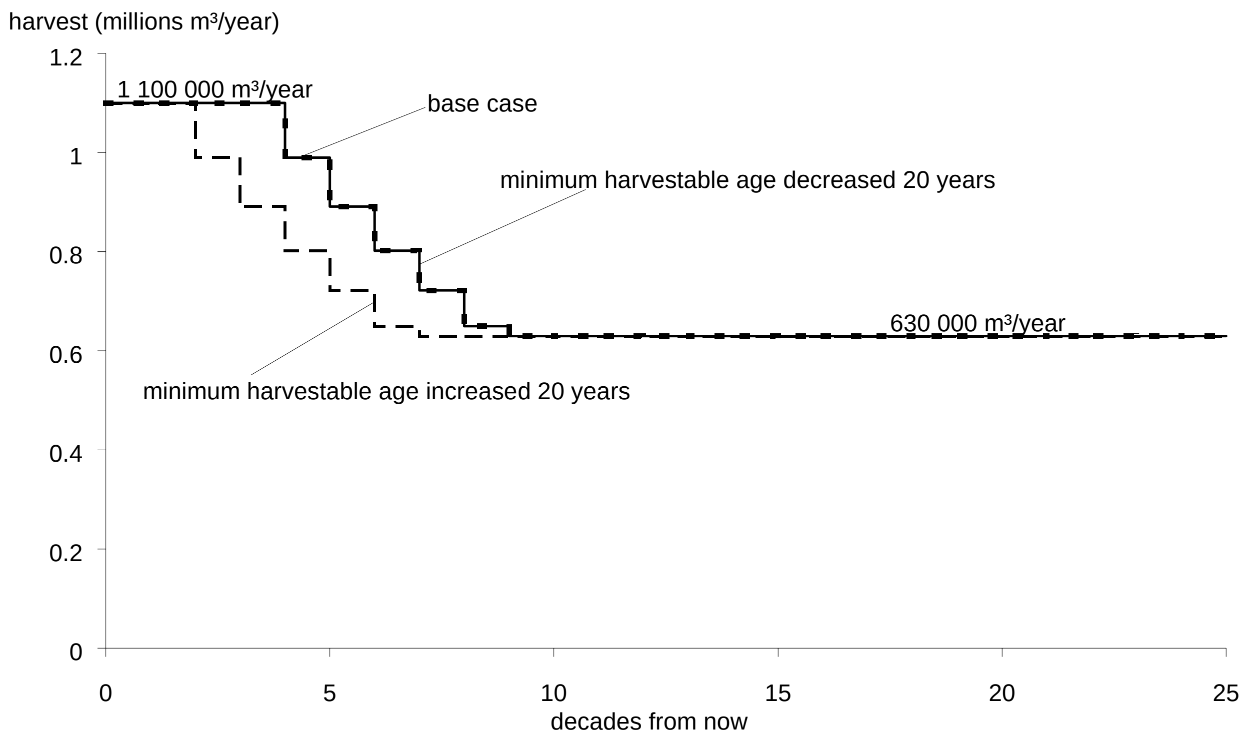

Figure 16. Harvest forecasts with minimum harvestable ages changed by 20 years — Kispiox TSA, 1996.

By lowering the minimum harvestable ages, all stands become eligible for harvest earlier than in the base case. Figure 16 shows that the base case harvest forecast is unaffected when minimum harvestable ages are lowered by 20 years. In the base case, harvest ages were greater than the minimum harvestable ages. Since minimum harvestable ages do not limit timber supply in the base case, lowering them has no affect on timber supply.

Increasing minimum harvestable ages by 10 years has no effect on timber supply; however, increasing minimum harvestable ages by 20 years would cause many stands which were eligible for harvesting in the base case to now become ineligible. This lengthens the transition time between harvesting mainly existing stands to harvesting regenerated stands because the regenerated stands will not be eligible for harvesting as early under this management regime as in the base case. Thus the harvesting of existing timber must occur at a slower rate to avoid serious timber shortfalls in the future. One harvest forecast for accomplishing this slower transition is shown in Figure 16. The current harvest level can be maintained for only 2 decades before declining 10% per decade to the long-term harvest level of 630 000 cubic metres per year in decade 8. Setting the minimum harvestable ages 20 years higher than in the base case does not result in a lower long-term harvest level because the minimum harvestable ages do not a limit timber supply in the long term. Actual harvest ages in this sensitivity analysis are almost identical to those in the base case in the long term.

These results show that the timber supply over the next 40 years is moderately sensitive to a 20-year increase in minimum harvestable ages; however, this increase would not affect timber supply for the next 2 decades.

5.5 Uncertainty in land base available for harvesting

5.5.1 Uncertainty in operability and merchantability

Defining the timber harvesting land base involves several assumptions about the types of forest land that are available for harvesting. The forest cover inventory and the merchantability standards for forest stands currently being harvested were used to identify which stands are merchantable and physically operable for this analysis. Considering that the identification of these stands is an approximate exercise, and that the inventory itself contains uncertainty, there is some uncertainty about how much area is actually available for harvesting under current management. As well, changing markets and technology may further affect merchantability and operability classifications.

To assess the sensitivity of timber supply to uncertainty in defining the timber harvesting land base, sensitivity analysis was performed in which the area in all stand types and ages used for the base case was decreased by 5% and 10%, and increased by 5%, respectively. These land base variations have been chosen to illustrate the stability of the current harvest level; it is not meant to capture specific issues.

Figure 17 displays the timber supply impacts of both a larger and smaller timber harvesting land base. If the land base is 5% larger than in the base case, the current harvest level can be extended for one decade longer than in the base case before decreasing to a long-term harvest level of 660 000 cubic metres. Similarly, if the land base is 5% smaller than in the base case, the current harvest level must begin declining one decade earlier than in the base case to reach a long-term level of 600 000 cubic metres. If the size of the timber harvesting land base is reduced by 10%, the current harvest level can be maintained for 2 decades before declining to a long-term harvest level of 570 000 cubic metres per year.

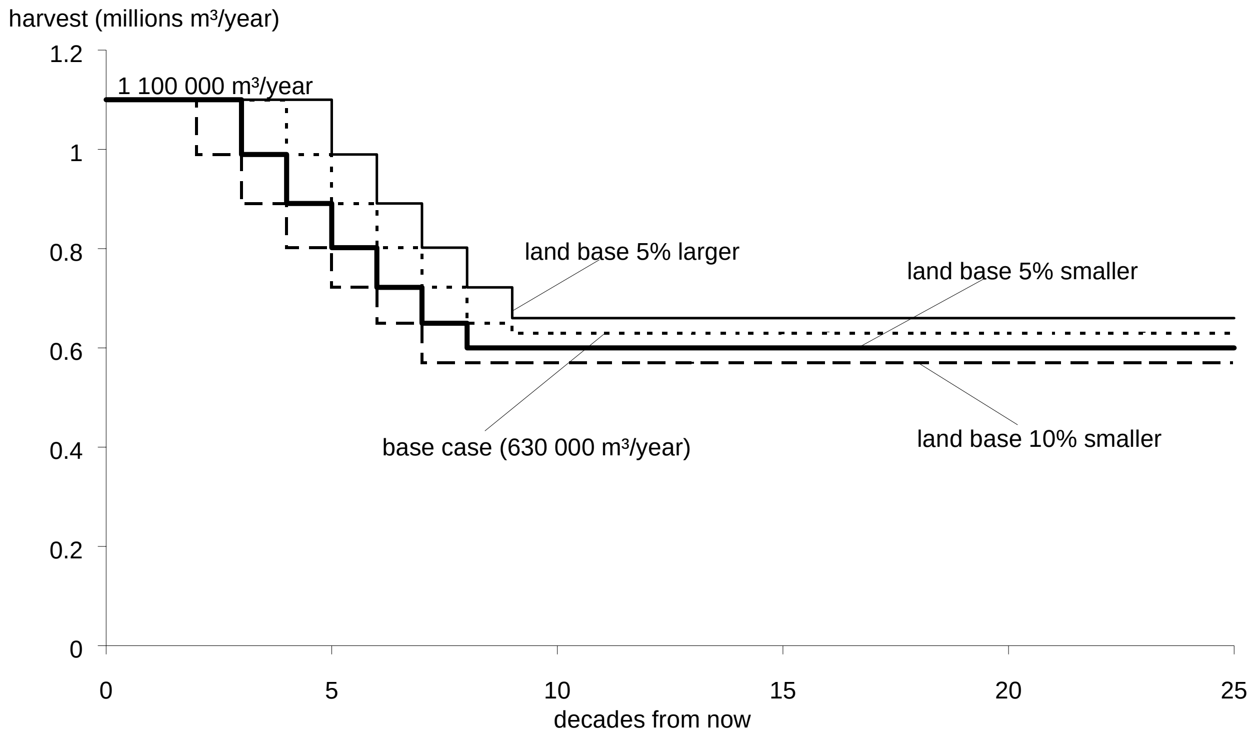

Figure 17. Harvest forecast with a change in size of the timber harvesting land base — Kispiox TSA, 1996.

In summary, even if the timber harvesting land base is 10% smaller than projected in the base case, the current harvest level can be maintained for at least 20 years without causing serious timber supply shortfalls in the future. Impacts from the removal of specific geographic areas may produce different harvest forecasts than this sensitivity analysis, and should be addressed individually for a better understanding of the short- and long-term impacts. See Section 5.5.2, "Uncertainty in access to portions of the Kispiox TSA" for the timber supply implications of the removal of some specific areas.

5.5.2 Uncertainty in access to portions of the Kispiox TSA

There is also some uncertainty about access to portions of the Kispiox TSA, even though the *Kispiox Land and Resource Management Plan* has resolved most of the land use issues in the planning area. To date there has been very little, if any, timber harvesting in the northern portion of the Kispiox TSA. For various reasons, there has been considerable difficulty in bridging the Babine River to access the timber in zones 9 (Atna/Shelagyote) and 14 (IRM east) and parts of zones 5 (Babine Sub-boreal Spruce) and 6 (Babine Englemann Spruce/Sub-alpine Fir), which comprise 20% of the timber harvesting land base. As well, difficult terrain has limited access to 4% of the timber harvesting land base in the Upper Kispiox (zone 8) and the East Kispiox/Kuldo (zone 10).

Delaying harvesting in zones 8 and 10 for up to 20 years has no effect on the base case harvest forecast. Similarly, delaying harvesting in zone 14 for as much as 20 years has no effect on the base case harvest forecast. While these are relatively large areas, the other zones in the timber harvesting land base (except for the VQO zones) have enough available timber in the short term to maintain the base case harvest levels until harvesting can occur in the delayed zones. However, excluding some of the northern zones from harvesting causes dramatic changes to the harvest forecast in both the short- and long-term. Figure 18 shows the timber supply impacts of excluding specific zones from the timber harvesting land base.

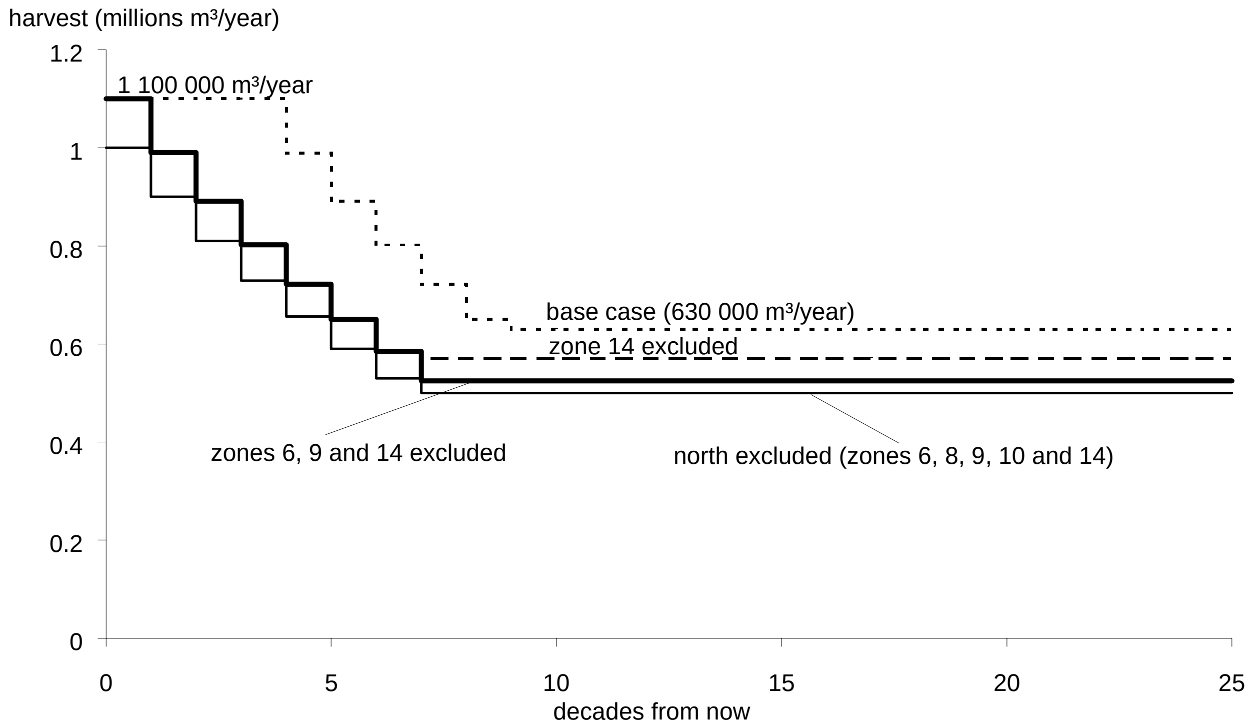

Figure 18. Harvest forecast with specific zones excluded from the timber harvesting land base — Kispiox TSA, 1996.

If zone 14, which accounts for 12.5% of the timber harvesting land base, is excluded from the timber harvesting land base, the initial harvest level declines after the first decade, and the long-term level is about 10% lower than the base case level. The timber supply contribution of zones 9 and 10 is negligible and their exclusion does not affect the harvest levels projected in the base case. Zones 5 and 6 are comprised of areas on both sides of the Babine River. In this sensitivity analysis, it was assumed that the area on the south side of the Babine River in zone 6 is equivalent to the area on the north side of the river in zone 5; thus, the exclusion of zone 6 is a reasonable approximation of excluding the portions of zones 5 and 6 north of the Babine River. Except for zone 14, the exclusion of the other affected zones individually do not have significant impacts on the base case harvest forecast. The access problems, however, lead to several zones being delayed or excluded at the same time. For example, if there is no bridge access the Babine River, zones 6, 9 and 14 are all affected. If zones 6, 9 and 14 (the area north of the Babine River and east of the Skeena River) are excluded from the timber harvesting land base, the current harvest level can be maintained for only one decade before declining at 10% per decade to a long-term level of 525 000 cubic metres per year by decade 8 (17% below the base case level).

Figure 18 also shows the effect on harvest levels of excluding most of the northern portion of the Kispiox TSA (zones 6, 8, 9, 10 and 14), which comprises 24% of the timber harvesting land base. This harvest forecast shows the initial harvest level is reduced immediately to 1 000 000 cubic metres per year for the first decade followed by reductions of 10% per decade until the long-term harvest level of 500 000 cubic metres per year (21% below the base case level) is reached in decade 8. This analysis shows the northern portion of the Kispiox TSA is critical to maintenance of both the short- and long-term timber supply.

5.6 Uncertainty in forest cover objectives for visual quality

Visual quality objectives (VQOs) are stated in terms of the degree to which forestry activities should be visible to the average viewer. The B.C. Forest Service, Range, Recreation and Forest Practices Branch has provided a range of visible disturbance limits for each VQO category (stated as a maximum per cent of forested area allowed to be below the green-up height). Different disturbance limits will meet a particular objective for visual quality (for instance, partial retention), depending on the terrain and forest in the area. For this analysis, determining forest cover objectives for each VQO category involved a series of calculations to incorporate information on visual sensitivity (see Appendix A, "Description of Data Inputs and Assumptions.")

Uncertainty about forest cover objectives may arise from identification and classification of land into VQO and visual sensitivity categories, from estimates of how well different disturbance limits meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality. This section investigates how uncertainty in the VQO classification affects timber supply. To assess the possible effects of uncertainty in VQO classification, the area in each VQO class was shifted to the next more, or less, restrictive VQO class (restrictive refers to the degree to which harvesting should be noticeable). To examine the effects of a more restrictive classification, the area in the partial retention classification was shifted to the retention class, and the area in the retention class was shifted to the preservation class. To examine the effects of less restrictive classification, the area in the retention classification was shifted to the partial retention class, and the area in the partial retention class was shifted to the modification class. (See Appendix A, "Description of Data Inputs and Assumptions," for the actual forest cover guidelines applied to each VQO class). As noted in the Section 2, "Information Preparation" of this report, about 12% of the timber harvesting land base in the base case is subject to some visual quality objective.

Figure 19 shows the impacts of changing the amount of visual disturbance allowed for visual quality objectives. If all VQO areas are shifted to the more restrictive classification (tightened), the current harvest level must start declining one decade earlier than in the base case, and the long-term level is 5% lower as a result of reduced harvesting activity in the VQO zones. Under the assumptions in the base case, no timber is harvested from the VQO zones in the first decade because these zones already exceed their maximum allowed area below green-up height. Therefore, in the short term, further restrictions in these zones have relatively small timber supply impacts.

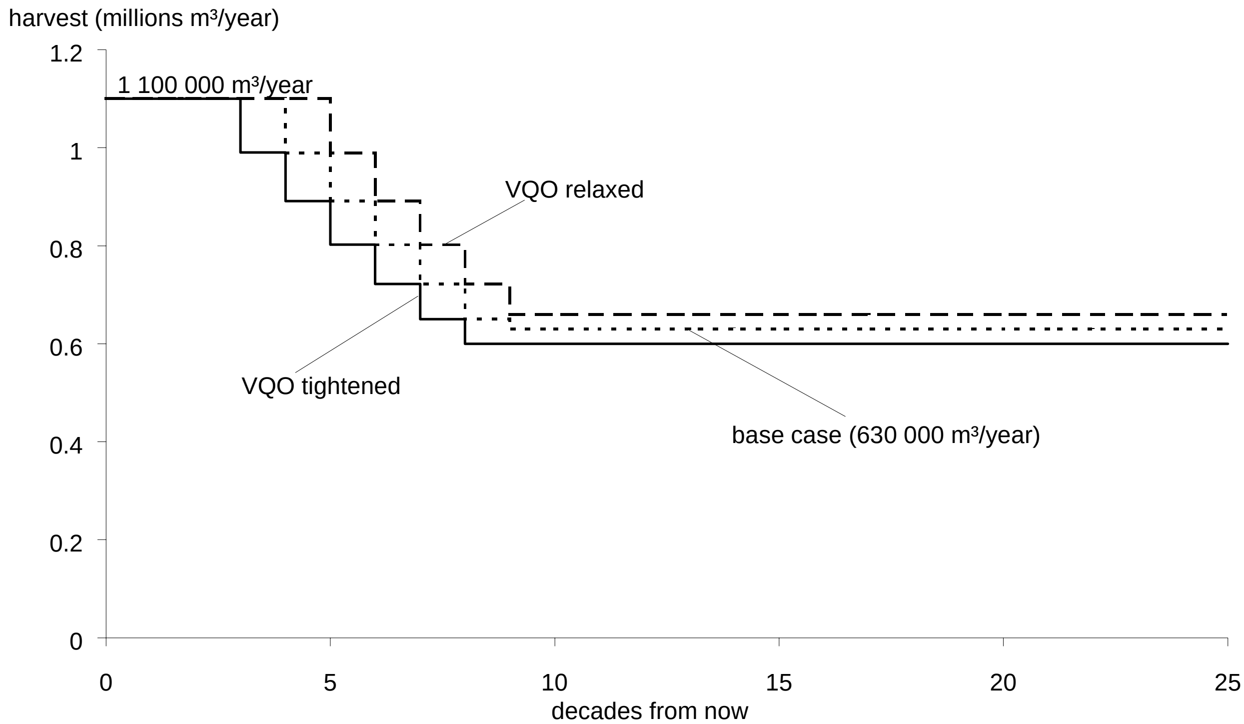

Figure 19. Harvest forecasts if forest cover objectives for visual quality management are changed — Kispiox TSA, 1996.

If all VQO areas are placed in a less restrictive classification (relaxed), the current harvest level can be extended one decade more than in the base case and the long-term level is 5% higher as a result of increased harvesting activity permissible in the VQO zones.

This sensitivity analysis shows that timber supply is moderately sensitive to VQO classification in the medium and long term. This is a direct result of changing the amount of harvesting activity that is permissible in the VQO zones under the different VQO classifications, rather than changing the amount of area in these zones.

5.7 Uncertainty in the forest cover requirements for old growth

The *Kispiox Land and Resource Management Plan* contains several objectives that require the use of forest cover requirements in the modelling process. However, there are limitations on the number of requirements that can be used in the existing B.C. Forest Service timber supply model. In particular, it was not possible to apply a green-up and adjacency forest cover requirement, the hydrological requirement and an old-growth requirement at the same time. Preliminary testing of this issue showed that using one or the other of the hydrological guideline or the old-growth guideline resulted in the same timber supply level over the first 3 decades. B.C. Forest Service staff felt that while the old-growth guideline was important it was more representative to ensure that the base case captured the hydrological requirement in the short term.

It is important to test the medium- and long-term implications of all these objectives. Thus, two sensitivity analysis were completed. The first examines the hydrological green-up height. The base case uses an average hydrological green-up height of 6 metres; however, there is concern that this height may need to be as much as 10 metres in some areas. Figure 20 shows it is possible to maintain base case harvest level, if the hydrological green-up height is changed to 10 metres. Under the guidelines and objectives applied in the base case harvest forecast, such as minimum harvestable ages and forest cover requirements for visual quality, there is already a large amount of forested area greater than 10 metres tall; thus, increasing the hydrological green-up height to 10 metres has no impact.

The second sensitivity analysis looks at the requirement from the *Kispiox Land and Resource Management Plan*, which specifies that 12% of the forested area must be covered by stands older than 200 years of age. For this sensitivity analysis, it was assumed that the forest outside of the timber harvesting land base (approximately 57% of the forested area) contributes one-half of this old-growth requirement and therefore, 6% of the stands on the timber harvesting land base must be greater than 200 years old.

Figure 20 shows that when a minimum of 6% of the timber harvesting land base is required to be covered by stands older than 200 years of age, the current harvest level can be maintained for 3 decades before declining at 10% per decade to a long-term harvest level of 600 000 cubic metres per year (5% below the base case long-term level). This lower harvest level is mainly due to the decreased availability of stands over time, since some stands that were harvested in the base case are required to meet the old-growth requirement in this sensitivity.

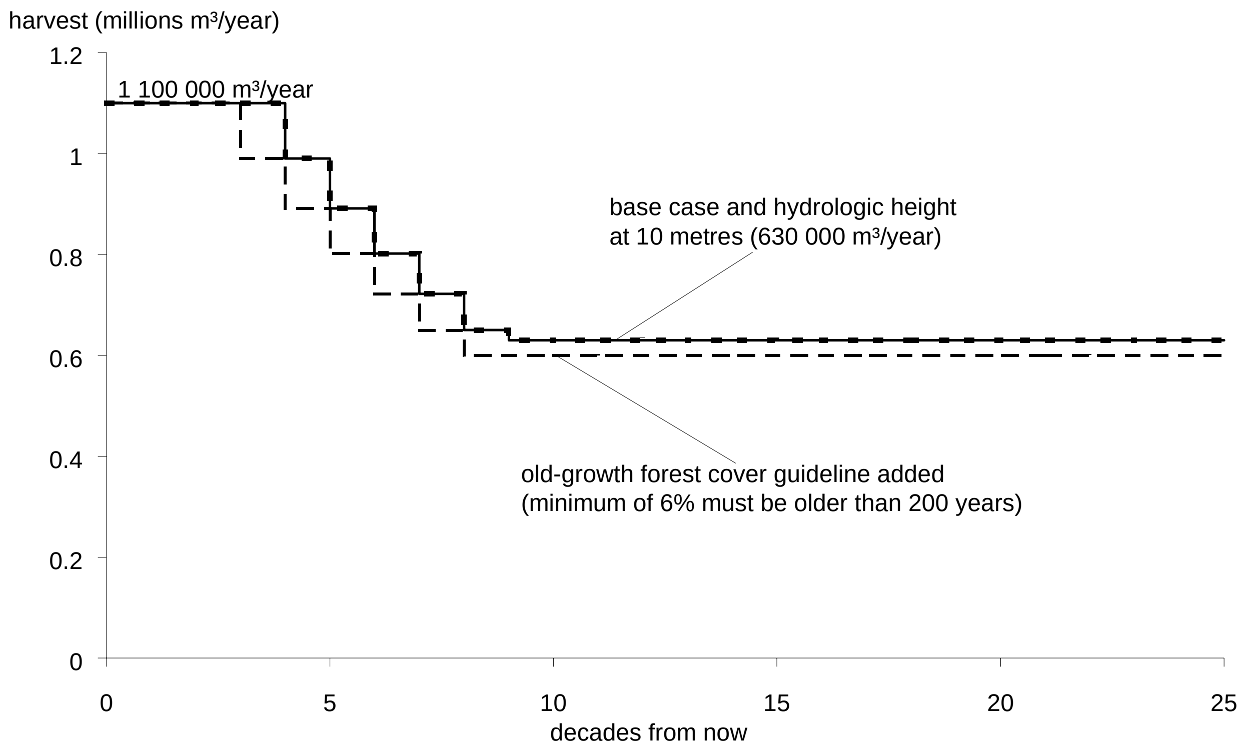

Figure 20. Harvest forecasts if hydrological green-up height and the forest cover objectives for old growth are changed — Kispiox TSA, 1996.

5.8 Uncertainty in green-up ages

Forest cover requirements for visual quality and adjacency applied in this analysis involve estimates of when stands will reach green-up conditions, expressed as the desired height of a stand. In the Kispiox TSA, the green-up height is 6 metres in the VQO zones and 3 metres elsewhere. Green-up age, the age at which a stand exhibits the desired condition, is determined using a growth and yield model. Uncertainty in the required green-up age stems from both the uncertainty in stand height growth rates, as well as the subjectivity of the height requirement before a stand is considered "greened-up." The following sensitivity analysis examines the effect that uncertainty in the required green-up age has on the harvest forecast.

Figure 21 shows the harvest forecast if all green-up ages are changed by 5 years. There is no impact on timber supply if green-up ages are actually 5 years more than the ages used in the base case. Green-up ages do not constrain timber supply in the base case in part due to the short harvesting history (less than 40 years) in the Kispiox TSA. Increasing green-up ages by 5 years is not enough to make this a limiting factor on timber supply.

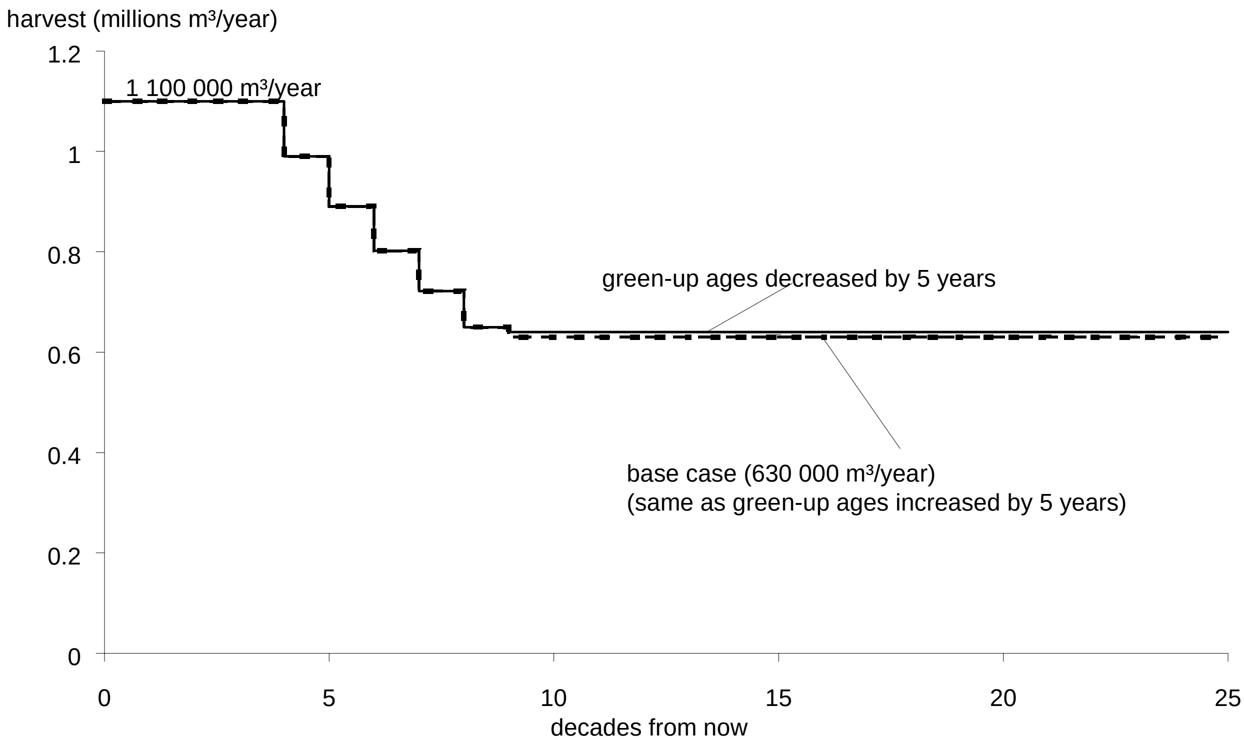

Figure 21. Harvest forecasts if green-up ages are changed by 5 years — Kispiox TSA, 1996.

Decreasing green-up ages by 5 years results in a slightly higher long-term harvest level of 640 000 cubic metres per year. A shorter green-up age decreases the time required before further harvesting can occur in an area; thus, this decrease mostly affects the two VQO zones, which are the only zones for which timber supply is initially constrained by green-up requirements in the base case. The increased harvesting in these zones accounts for most of the 10 000 cubic metre increase in the long-term harvest level.

Overall, short-term timber supply is not sensitive to changes in green-up age because initially, the amount of area covered by stands that are not greened-up in all management zones, except for the VQO zones, is considerably less than the maximum area allowed. The long-term harvest level can be increased mostly because if green-up ages are decreased, more timber can be harvested from the two VQO zones.

5.9 Uncertainty in the method used to represent adjacency objectives

The *Code* requires that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. In addition, to ensure that harvesting does not become overly concentrated in any area, an adjacency objective was developed to set a maximum limit on the overall area that has not reached the greened-up condition. This analysis employs a forest cover requirement to represent the adjacency objectives, where a maximum of 33% (3 passes) of the timber harvesting land base within a zone can be covered with stands that have not met the greened-up condition. Because the forest cover requirement is an approximation, it is not certain how accurately it reflects how adjacency objectives affect timber supply. There is some evidence that 4 or 5 passes may be required to meet most adjacency objectives (Nelson and Errico, 1993).

The base case harvest forecast can be maintained under both a 4-pass and a 5-pass harvesting system. However, there is an impact on the base case timber supply forecast if a forest cover requirement approximating a 6-pass harvesting system is used (Figure 22). Under a 6-pass harvesting system, the current harvest level cannot be maintained. A harvest level of 1 000 000 cubic metres per year (9% below the base case) can be maintained for 4 decades, if followed by declines of 10% per decade to a long-term level which is 10 000 cubic metres less than the base case long-term level. The decreased harvest is a result of a slower harvest rate since a maximum of 16.7% of the area would be allowed below the green-up height, as compared to 33% in the base case.

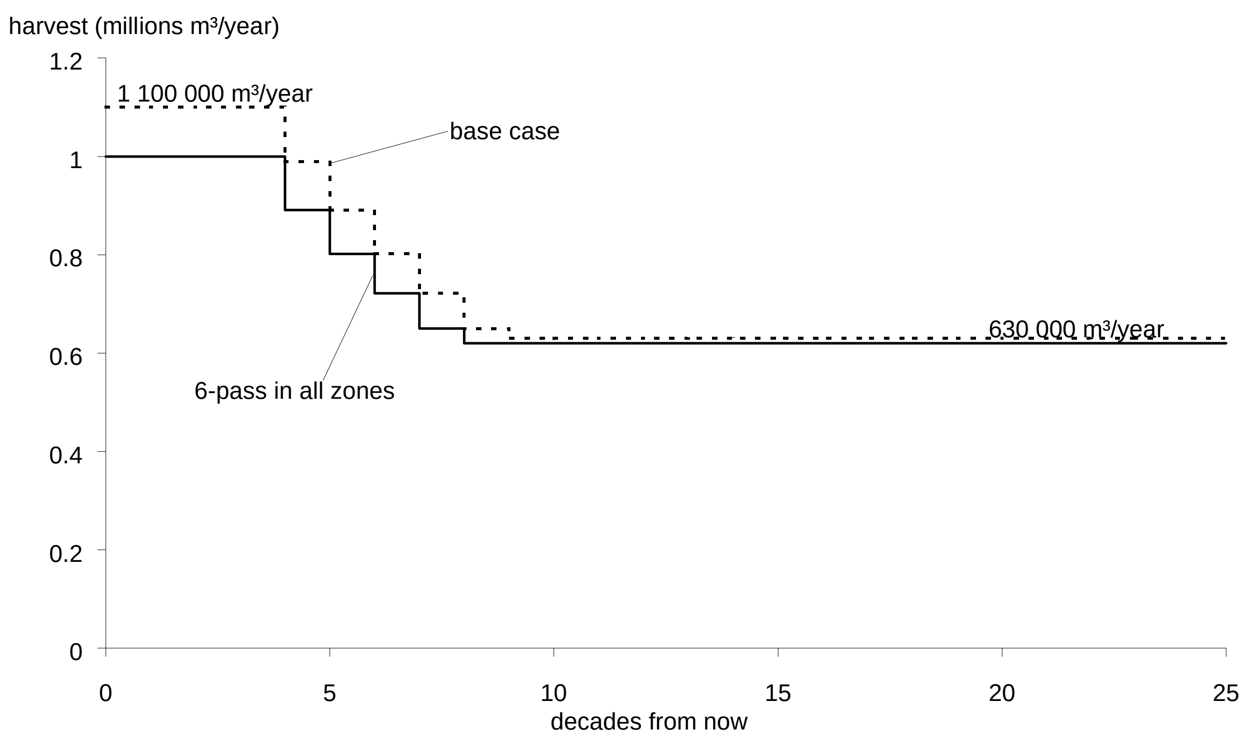

Figure 22. Harvest forecast with a 6-pass harvesting system — Kispiox TSA, 1996.

5.10 Uncertainty in site productivity

The productivity of a site largely determines how quickly trees will grow, and therefore affects expectations of timber volumes in regenerated stands, and the age at which those stands will reach both merchantable size and green-up height. The most accurate assessments of site productivity come from stands between 30 and 150 years old. Estimating site productivity in both younger and older stands can be more difficult. Growth in younger stands often depends on recent weather, stocking, and competition from other vegetation as much as on site quality. Older stands have not been managed for specific stocking levels, and trees used to measure site productivity may have grown under intense competition or may have been damaged, and therefore do not reflect actual site potential. The current age composition of the forest (Figure 5) shows that 67% of the forest contains stands which are outside the 30-150 year range, and thus have some uncertainty associated with their assigned site productivity values. Site productivity affects regenerated stand volumes, green-up age and minimum harvestable age, each of which have been examined individually in previous sections.

Section 5.4, "Uncertainty in minimum harvestable ages," examined the effect of uncertainty in minimum harvestable ages. Uncertainty in regenerated stand volume estimates was explored in Section 5.3, "Uncertainty in regenerated stand volume estimates," and the effect of different green-up ages was tested in Section 5.8, "Uncertainty in green-up ages." This section examines how timber supply is affected by the combined changes in regenerated stand volumes, minimum harvestable ages and the amount of time required to meet green-up conditions.

Figure 23 shows that if regenerated stand volumes are 20% less than estimated in the base case, minimum harvestable ages are increased by 20 years and green-up ages are 5 years longer than base case ages, then the current harvest level can be maintained for only 2 decades before declining to a long-term harvest level approximately 21% below the base case level. When considered separately, an increase of 5 years in green-up ages results in no change from the base case harvest forecast (Figure 21), a 20% lower regenerated stand volume results in a harvest forecast in which the long-term level is 18% lower than in the base case (Figure 15), and an increase in minimum harvestable ages by 20 years (Figure 16) decreases the amount of time the initial harvest level can be maintained to 2 decades, rather than 4 decades. The combined effect of these factors is a reduction in the long-term harvest level by an extra 3% over the individual factors. This shows that the effects of the factors considered are not simply additive, and that care must be exercised when interpreting the combined effect of several factors on timber supply.

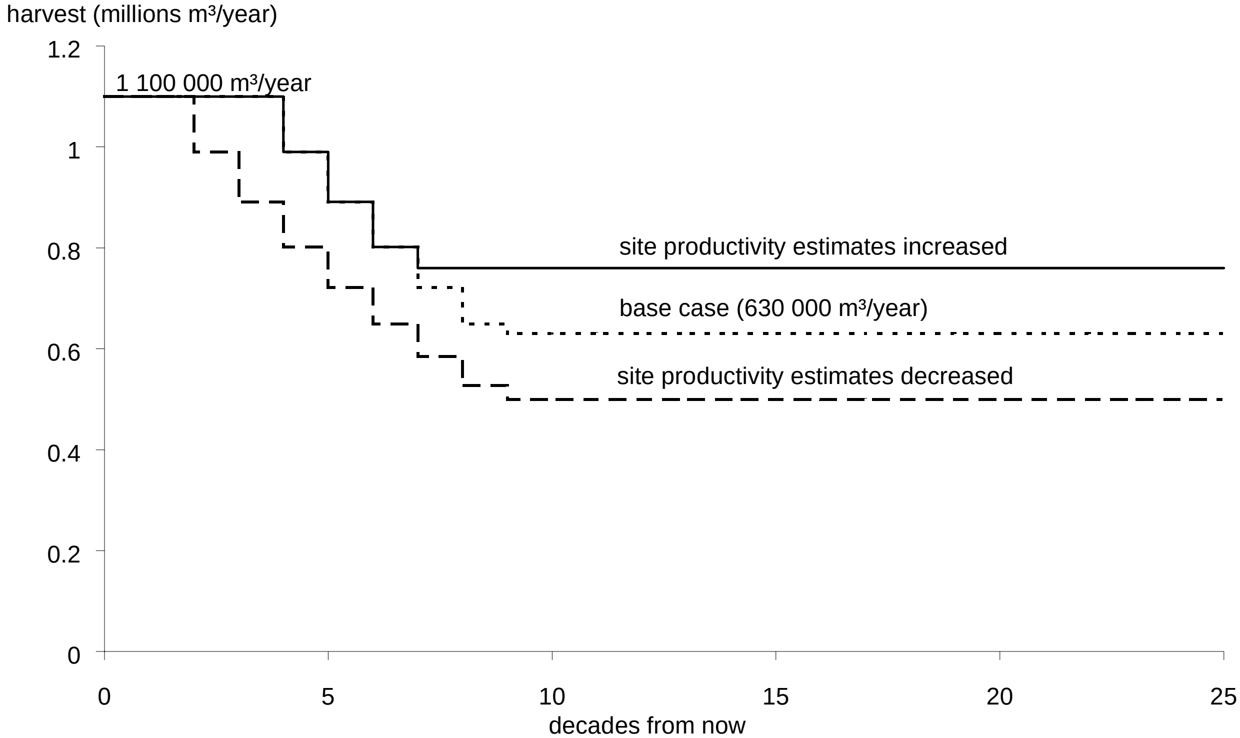

Figure 23. Harvest forecast with site productivity estimates changed, affecting regenerated stand volumes, minimum harvestable ages and green-up ages — Kispiox TSA, 1996.

If, as a result of higher site productivity than estimated in the base case, regenerated stand volumes are actually 20% greater, minimum harvestable ages are 20 years less than in the base case and green-up ages are 5 years less than base case ages, then the harvest forecast is similar to the base case except that the long-term harvest level is 21% higher and is attained 2 decades earlier. When considered separately, a decrease of 5 years in green-up ages results in a slight (10 000 cubic metres) increase in the long-term harvest level (Figure 21), a 20% higher regenerated stand volume results in a harvest forecast in which the long-term level is 19% higher than in the base case (Figure 15), and a decrease in minimum harvestable ages by 20 years has no effect on the base case harvest forecast (Figure 16). In this sensitivity analysis, the combined effect of these factors, which are affected by site productivity estimates, seems additive.

6 Summary and Conclusions

The results of this analysis indicate that the current AAC of 1 100 000 cubic metres in the Kispiox TSA can be maintained for 4 decades before declining at 10% per decade to the long-term harvest level of 630 000 cubic metres per year. This harvest forecast was obtained using current forest inventory and timber growth information, and assuming continuation of current forest management practices. The large amount of existing forest greater than 120 years old provides significant flexibility in timber supply, and as a result, varying most of the factors in the sensitivity analyses has little impact on the harvest forecast.

The base case harvest forecast is most sensitive to uncertainty in estimates of existing stand volumes. If existing stand volumes are overestimated by as much as 20%, the initial harvest level must drop by 10% immediately to avoid serious shortfalls in the future. Conversely, if existing stand volumes are underestimated by as much as 20%, then the current harvest level can be maintained for 8 decades before beginning the transition to the long-term harvest level. While there is no evidence to suggest that existing stand volumes are overestimated, the sensitivity of the harvest forecast to suggest that this should be monitored.

Timber supply is also sensitive to the size of the timber harvesting land base. If the northern portion of the Kispiox TSA (comprising 24% of the timber harvesting land base) is removed, then harvest levels must decline immediately to 1 000 000 cubic metres per year. This decline continues at 10% per decade until the long-term level of 500 000 cubic metres per year, 21% below the base case level, is reached in 8 decades. There has been very little harvesting in this portion of the Kispiox TSA to date, and if the difficulties in accessing this area continue, harvest levels will have to decline much earlier and to a lower level than projected in the base case.

Uncertainty in site productivity estimates has a significant impact on medium- and long-term harvest levels. Uncertainty in site productivity was approximated in the analysis by varying minimum harvestable ages by 20 years, green-up ages by 5 years, and regenerated stand volumes by 20%. If site productivity is lower than estimated, the current harvest level could still be maintained for 2 decades due to the large amount of mature existing stands.

Minimum harvestable ages, green-up ages and regenerated stand volumes were also investigated separately to determine their impacts on timber supply. Varying regenerated stand volumes by 20% has a corresponding effect on long-term timber supply. If regenerated stand volumes are increased by 20%, the long-term harvest level is increased by 19% to 750 000 cubic metres per year. If regenerated stand volumes are decreased by 20%, the long-term harvest level is decreased by 18% to 515 000 cubic metres per year.

Increasing green-up ages by 5 years has no impact on the base case harvest forecast because harvesting is not limited by the green-up objectives in any of the zones, except for the VQO zones. Decreasing green-up ages by 5 years slightly increases the long-term harvest level by enabling increased harvesting in the VQO zones.

Decreasing minimum harvestable ages by 20 years does not affect the base case harvest forecast because minimum harvestable ages did not limit timber supply in the base case. Increasing minimum harvestable ages by 20 years causes the decline to the long-term level to start after decade 2 rather than after decade 4 as in the base case in order to reserve enough existing growing stock until second-growth stands became harvestable.

Approximately 12% of the timber harvesting land base is being managed for visual quality (3% retention and 9% partial retention). Adjusting the VQO requirements, in effect, adjusts for each zone the percentage which can be below the green-up height, and therefore adjusts the amount of harvesting which is permitted in the zones over time. If the VQO requirements are tightened, the current harvest level can be maintained for only 3 decades before declining to a long-term harvest level 5% lower than in the base case. Relaxing the VQO requirements extends the current harvest level to 5 decades, followed by a decline to a long-term harvest level 5% higher than in the base case.

6 Summary and Conclusions

Uncertainty in forest cover requirements for hydrologic green-up, as modelled in this analysis, does not affect the timber supply forecasted in the base case. However, if an old-growth requirement is modelled which requires 6% of the timber harvesting land base to be covered by forests older than 200 years of age, the current harvest level can be maintained for only 3 decades before declining to a long-term level 5% lower than in the base case.

Forest cover guidelines used to represent adjacency objectives have very little impact on base case harvest levels. The base case harvest projections can be achieved under both 4-pass and 5-pass forest cover requirements. If a 6-pass harvesting system is required to meet adjacency objectives, then the current harvest level must decrease immediately to 1 000 000 cubic metres per year. This harvest can be maintained for 4 decades before declining to a slightly lower long-term harvest level than in the base case.

In conclusion, this analysis indicates that using current forest management, inventory and growth and yield information, the current harvest level can be maintained for the next 40 years. Several uncertainties important to timber supply can affect this projection. The greatest impact on short-term timber supply arises from uncertainty about existing stand volumes and uncertainty about access to the northern portion of the Kispiox TSA.

7 References

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8 Glossary

Allowable annual cut (AAC)
The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with *Section 7* of the *Forest Act*.

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

Culmination age
The age at which a timber stand reaches its highest 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 adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.

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

Forest cover objectives
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.

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 adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green-up)**.

Forest ecosystem network
A Forest Ecosystem Network (FEN) is a planned landscape zone which serves to maintain or restore the natural connectivity within a landscape unit. The goal of a Forest Ecosystem Network is to maintain a network of old growth and special habitats (such as riparian areas, wetlands, calcareous and serpentine bedrock exposures) in their natural state.

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 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.

8 Glossary

Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Hydrologic green-up (height)	The height a stand must reach for it to provide the same timing and quantity of water yields as the previous old-growth stand it replaces.
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.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base and includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
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.
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 tree stems of desirable species. Stocking standards are set by the B.C. Forest Service, Silviculture Branch. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective)**.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Site index	A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 6* of the *Forest Act.*
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.

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

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

APPENDIX A

Description of Data Inputs and Assumptions

Introduction

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

A.1 Zone and Analysis Unit Definition

A.1.1 Zone characteristics

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

2. Babine special management — to protect and buffer river-based resource values around the land set aside as the Babine wilderness area. Clearcut size will be limited to 15 hectares or less. At least 30% of the forested area must be greater than 140 years old, and a maximum of 33% could be less than 19 years old.

3. Retention VQO — areas of high visual value were grouped. These are areas adjacent to lakes and other thoroughfares which are highly visible due to slope and forest cover. Timber harvesting may be present but is not to be noticeable to the average viewer. After applying various factors as outlined later in the appendix, an overall forest cover requirement was derived allowing a maximum of 2.6% of the area to be below 6 metres in height (29 years old).

4. Partial retention VQOs — areas of moderate visual value were grouped. Timber harvesting may be visible in these areas but not be dominant on the landscape. After following a procedure identical to that performed for the retention zone, a forest cover guideline was developed that allows a maximum 12.1% of the forest in the zone to be below 6 metres in height (28 years old).

5. Babine SBS — areas within the Babine sub-drainages classified as Sub-Boreal Spruce biogeoclimatic zone. Management objectives for this zone are to have a maximum of 50% of the zone in forest less than 20 years old, and a minimum of 30% of the forest older than 80 years. The general adjacency requirement for 3-pass harvesting was used for this zone since it is a more restrictive forest cover guideline where a maximum of 33% of the forest area can be less than 20 years old.

6. Babine ESSF — areas within the Babine sub-drainages classified as Englemann Spruce/Subalpine Fir biogeoclimatic zone. Management objectives for this zone were to have a maximum of 30% of the zone in forest less than 21 years old, and a minimum of 50% of the forest older than 80 years.

7. Seven Sisters — an area in the southern part of the Kispiox TSA where harvesting is deferred until the end of 1996 to allow for completion of local planning. This deferral was not modelled in the analysis because it is only a few months before the end of 1996. A maximum of 33% of the forest in the zone could be less than 17 years old. In order to meet the hydrologic green-up requirement a minimum of 30% of the forest must be greater than 28 years old.

8. Upper Kispiox — an area in the northern part of the Kispiox TSA where harvesting is deferred until the end of 1996 to allow for completion of local planning. This deferral was not modelled in the analysis for the same reason as above. The adjacency requirement meant that a maximum of 33% of the forest in the zone could be less than 19 years old, while the hydrologic green-up requirement meant that a minimum of 48% of the forest must be greater than 33 years old.

9. Atna/Shelagyote — one of three areas in the Kispiox TSA where the emphasis is on the maintenance of scenic resources, backcountry recreation and habitat for grizzly bears and mountain goats. Since the forested area outside the timber harvesting land base in this zone met the hydrologic green-up requirements for the zone, a default requirement of a minimum of 12% of the timber harvesting land base to be greater than 6 metres (36 years old) was applied. A maximum of 33% of the forest could be less than 21 years old.

10. East Kispiox/Kuldo — the second of the three areas managed in the same manner as zone 9. The adjacency requirement translated into a maximum of 33% of the forest could be less than 19 years old. Hydrologic green-up age was 34 years.

11. Rocher Deboule — the third of the three areas managed in the same manner as zone 9. The adjacency requirement translated into a maximum of 33% of the forest could be less than 15 years old. Hydrologic green-up age was 25 years.

12. High deer winter range — an area in the Kispiox TSA identified as deer winter range. At least 6% of the area identified will be maintained in forest greater than 150 years old. A maximum of 33% of the forest in the zone could be less than 15 years old.

13. Integrated resource management west — areas west of the Skeena River and south of the Babine River where general integrated resources guidelines apply. A maximum of 33% of the area may be less than 3 metres in height (17 years) and a minimum of 49% was required to be greater than 6 metres in height (28 years old).

14. Integrated resource management east — areas east of the Skeena River and north of the Babine River where general integrated resources guidelines apply. A maximum of 33% of the area may be less than 3 metres in height (19 years) and a minimum of 54% was required to be greater than 32 years old.

The forest inventory data were grouped into the above zones in the order listed. For example, an area may possess visual quality objectives, wildlife objectives and be adjacent to the Babine River. Given the order, the area would be placed into the Babine special management zone. Zones with more restrictive forest cover requirements were generally placed earlier in the order. The deer winter range zone was not affected by its position in the above list because it was generally mutually exclusive of the other zones.

A.1 Zone and Analysis Unit Definition

A.1.2 Analysis unit characteristics

Due to the variety of tree species and growing sites found in the forest, stands were grouped into analysis units. The basis for each unique analysis unit was predominant species (inventory type group) and site quality (site index range). Whereas zones are defined as forests with a common forest management objective, analysis units are forests with a similar species composition and growing site. Each zone may have any combination of analysis units and an analysis unit can straddle any combination of zones. For example, analysis unit 1 occurs in all zones except zones 9 and 10.

Each analysis unit is assigned its own timber volume projection or yield table. All the timber volume tables used in this analysis are listed at the end of this appendix. The volume curves for analysis unit 1 in zones 4 and 7 were significantly lower than the curves for the other zones even though the site indices for this analysis unit among the zones were similar. Volume table 91 is the table used to project the timber volume for analysis unit 1 in zones 4 and 7. Similarly, volume table 94 is the table used to project the timber volume for analysis unit 4 in zones 5 and 6, and volume table 984 is the table used to project the timber volume for analysis unit 84 in zones 5 and 6.

Table A-1. Analysis unit characteristics

Analysis unit	Species	Inventory type groups	Productivity rating assigned[a]	Site index range (metres @ 50 years)	Age range (years)
1	Hemlock	12, 13, 14, 15, 16, 17	good	> 15	all
2	Hemlock	12, 13, 14, 15, 16, 17	poor	7 - 15	all
3	Balsam	18, 19, 20	good	> 15	all
4	Balsam	18, 19, 20	poor	5 - 15	0-140
84	Balsam	18, 19, 20	poor	5 - 15	140+
5	Cedar	9, 10, 11	good	> 15	all
6	Cedar	9, 10, 11	poor	9 - 15	all
7	Spruce	21, 22, 23, 24, 25, 26	good	> 15	all
8	Spruce	21, 22, 23, 24, 25, 26	poor	8 - 15	all
9	Pine	28, 28, 30, 31	good	> 15	all
10	Pine	28, 29, 30, 31	poor	7.5 - 15	all
11	Deciduous	35, 41	good	> 14	< 40

(a) Stands with site indices lower than the cut-off for poor sites were treated as low sites and were excluded from the timber harvesting land base.

A.1 Zone and Analysis Unit Definition

Table A-2. Distribution of area in the current timber harvesting land base by zone and analysis unit

		Zone (hectares)			
	Analysis unit	**Babine special management**	**VQO retention**	**VQO partial retention**	**Babine SBS**
Naturally regenerated stands[a]	1	195	1 268	3 342	116
	2	502	5 891	12 643	144
	3	720	27	479	1 388
	4	392	143	212	1 605
	84	1 447	2 136	2 390	8 586
	5	0	36	224	0
	6	0	27	123	0
	7	673	270	1 640	1 255
	8	1 084	220	502	1 251
	9	121	295	1 943	975
	10	184	72	505	576
	11	0	24	124	0
Managed stands	1	0	17	502	235
	2	0	1	270	155
	3	0	23	206	70
	4	0	0	0	0
	84	0	0	151	170
	5	0	6	104	45
	6	0	0	43	0
	7	0	131	1 024	323
	8	0	4	137	27
	9	0	124	876	118
	10	0	0	513	4
	Total	5 319	10 714	27 951	17 042

continued

Note: Columns may not sum exactly due to rounding.

(a) Volume projections for naturally regenerated stands were obtained using the Variable Density Yield Prediction (VDYP) yield model. The Table Interpolation Program for Stand Yields (TIPSY) model was used to project volume estimates for managed stands. See Tables A-13. and A-14. for volume estimates for naturally regenerated stands and managed stands.

A.1 Zone and Analysis Unit Definition

Table A-2. Distribution of area in the current timber harvesting land base by zone and analysis unit

	Analysis unit	Zone (hectares)				
		Babine ESSF	Seven Sisters	Upper Kispiox	Atna Shelagyote	East Kispiox Kuldo
Naturally regenerated stands[a]	1	38	1 433	40	0	0
	2	315	4 346	7 140	0	394
	3	310	1	48	0	0
	4	409	31	2	0	0
	84	21 877	515	3 421	155	347
	5	0	46	0	0	0
	6	0	79	0	0	0
	7	14	32	153	0	0
	8	546	20	405	3	0
	9	536	330	0	0	0
	10	173	127	0	0	0
	11	0	0	0	0	0
Managed stands	1	183	187	0	0	0
	2	121	20	0	0	0
	3	98	37	0	0	0
	4	0	0	0	0	0
	84	167	0	0	0	0
	5	35	0	0	0	0
	6	0	0	0	0	0
	7	332	61	0	0	0
	8	66	46	1	0	0
	9	111	79	0	0	0
	10	76	4	0	0	0
	Total	25 407	7 393	11 211	158	741

continued

Note: Columns may not sum exactly due to rounding.

(a) Volume projections for naturally regenerated stands were obtained using the Variable Density Yield Prediction (VDYP) yield model. The Table Interpolation Program for Stand Yields (TIPSY) model was used to project volume estimates for managed stands. See Tables A-13. and A-14. for volume estimates for naturally regenerated stands and managed stands.

Table A-2. Distribution of area in the current timber harvesting land base by zone and analysis unit (concluded)

		Zone (hectares)				
	Analysis unit	**Rocher Deboule**	**Deer Winter**	**IRM West**	**IRM East**	**Total all zones**
Naturally regenerated stands[a]	1	158	110	18 384	422	25 506
	2	262	147	67 351	18 829	117 964
	3	46	0	2 418	467	5 905
	4	0	0	1 096	144	4 033
	84	68	3	25 996	18 707	85 649
	5	11	35	607	0	957
	6	0	0	500	0	729
	7	141	92	8 015	134	12 419
	8	15	11	3 903	564	8 524
	9	135	104	5 842	169	10 449
	10	15	1	1 050	96	2 799
	11	0	104	1 059	0	1 310
Managed stands	1	0	10	4 205	157	5 494
	2	0	0	2 167	106	2 840
	3	0	0	930	42	1 406
	4	0	0	0	0	0
	84	0	0	1 388	113	1 989
	5	0	0	630	30	850
	6	0	0	62	0	105
	7	0	98	11 306	80	13 353
	8	0	0	3 243	0	3 523
	9	0	26	7 956	77	9 366
	10	0	0	2 144	6	2 747
	Total	851	739	170 249	40 142	317 915

Note: Columns may not sum exactly due to rounding.

(a) Volume projections for naturally regenerated stands were obtained using the Variable Density Yield Prediction (VDYP) yield model. The Table Interpolation Program for Stand Yields (TIPSY) model was used to project volume estimates for managed stands. See Tables A-13. and A-14. for volume estimates for naturally regenerated stands and managed stands.

A.2 Definition of the Timber Harvesting Land Base

A.2.1 Land not managed by the B.C. Forest Service

Ownership codes on the inventory file are used to determine which areas are not under B.C. Forest Service jurisdiction. Only the 62 C and 69 C ownership codes (where the C stands for contributing) are considered for inclusion as productive Crown land within this analysis.

Table A-3. Ownership codes for the Kispiox TSA

Description	Ownership code	Area (hectares)	Per cent
Crown grant	40N	24 477.9	2.00
Indian reserve	52N	9 811.5	0.80
Use, recreation and enjoyment of public (UREP)	61C/N	2 117.5	0.17
Forest management unit	62C	1 162 498.2	95.08
Provincial park class A	63N	384.7	0.03
Wilderness area	68N	14 950.9	1.22
Government reserve	69C	5 614.1	0.46
	69N	603.5	0.05
Woodlot licence	77N	2 150.7	0.18
Miscellaneous lease	99N	14.6	0.01
Total		1 222 623.6	100.0

A.2.2 Non-forest land

Non-forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) areas do not contribute to the timber harvesting land base. These categories include areas of sparse alpine forest, ice, swamp, water, and rock.

A.2.3 Non-commercial (brush) cover

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

A.2.4 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of the environmental sensitivity for concerns such as avalanche, recreation and sensitive soils. A portion of areas classified as highly sensitive (E_1) were excluded from the timber harvesting land base according to Table A-4. Areas of moderate sensitivity (E_2) were not removed from the timber harvesting land base.

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

ESA_1 code	ESA description	Per cent area unavailable
A	Avalanche	100
C	Critical slope stability	100
P	Regeneration	100
S	Soils	90
R	Recreation	100
SP	Soils and regeneration	95
SH	Soils and water	100

A.2.5 Babine riparian reserves and Forest Ecosystem Networks (FEN)

The Local Resource Use Plan (LRUP) for the Babine area recommended reserve zones around all creeks in the area. Kispiox Forest District staff calculated this area to be 5218 hectares. The LRUP also identified 2180 hectares to be reserved as forest ecosystem networks.

A.2.6 Other riparian and wetland reserves

Elsewhere in the Kispiox TSA, reserve zones of 50 metres around all double-line creeks, 30 metres around all single line creeks, 10 metres around all lakes greater than 5 hectares in size, and 10 metres around all wetlands greater than 5 hectares in size were identified. This amounted to reserves of 4226 hectares for riparian areas, 201 hectares for lakes, and 2255 hectares for wetlands. In addition, a 994 hectare buffer around the Telegraph Trail was excluded from the timber harvesting land base.

A.2.7 Inoperable areas

The inventory file contains an operability classification for the Kispiox TSA. All areas that were inoperable (OPERABLE = I or OPERABLE = N) were removed from the timber harvesting land base.

A.2.8 Visual quality preservation areas

Staff in the Kispiox Forest District identified 345 hectares that had very high visual quality value and recommended removal from the timber harvesting land base.

A.2.9 Low productivity areas

Areas of forest where the productivity, as measured by site index, was considered too low to grow trees of a merchantable size within a reasonable time. Table A-1. above lists the low site cut-off used for the various analysis units.

A.2.10 Non-merchantable forest types

There is currently very little (0.5% of total billed harvest in 1995) harvesting occurring within deciduous leading stands or removal of the deciduous components of coniferous leading stands. Deciduous leading stands older than 40 years are excluded from the timber harvesting land base completely while the deciduous components of mixed coniferous existing stands is excluded in yield curve creation. Table A-5. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

Table A-5. Non-merchantable forest cover considered unavailable for timber harvesting

	Criteria					
Netdown	**Inventory type group**	**Age class**	**Height class**	**Stocking**	**Site**	**Per cent area excluded**
Low site	Stands with site indices lower than the minimum set in Table A-1.				low	100
Deciduous	36, 37, 38, 39, 40, 42	all	all	all	all	100
Deciduous	35, 41	> 2	all	all	all	100
Stocking of pine	28-31	all	all	3, 4	all	100
Stocking of others	All except 28-31	all	all	2	all	100
Height class for pine	28-31	> 5	< 3	all	all	100
Height class for others	All except 28-31	> 7	< 3	all	all	100

A.2 Definition of the Timber Harvesting Land Base

A.2.11 Existing unclassified roads and future roads

Many roads, trails and landings constructed for forest access and harvesting are not large enough to be classified in the inventory file. Kispiox Forest District staff estimated unclassified roads and trails to be 3.4% of the operable area that is accessed. From a soil conservation survey conducted in the fall of 1995, staff estimated productive land lost to landings to be 1.6% of the operable area. The same survey estimated dispersed disturbance due to harvesting activities to be 4.2% of the operable area. Thus, existing roads, trails, landings and dispersed disturbance have been accounted for by removing 9.2% of the timber harvesting land base that is currently less than 40 years old. (The Kispiox TSA has a forest harvesting history of approximately 40 years.) Areas for future roads, trails, landings and site disturbance are removed within the B.C. Forest Service simulation model by applying a 9.2% reduction to all areas presently older than 40 years of age, upon harvest of those areas.

A.2.12 Babine wilderness area

An area of forest (8778 hectares) on either side of the Babine River approved by Cabinet as a protected area. Since this area was last in the order for removal from the timber harvesting land base, only 2703 hectares remained for removal after all the previous land withdrawals.

A.3 Forest Management Assumptions

A.3.1 Not satisfactorily restocked (NSR) areas

A certain amount of area within the forest inventory file has been classified as not satisfactorily restocked (NSR). The NSR can actually be split into three categories: backlog NSR and current NSR. In order to include this area in the timber harvesting land base, a zone and analysis unit designation was required. A summary of NSR by zone indicated that 70% of the NSR is found in the IRM west zone, 9% in the Babine SBS zone, 8% in the VQO partial retention zone, 6% in the IRM east zone, and 6% in the Babine ESSF zone. The following table shows how land classified as NSR in the inventory file is now treated in this analysis. The NSR area is evenly distributed in 1-year age classes from age -4 (backlog) through to age +5 years.

Table A-6. Not satisfactorily restocked areas

Analysis unit	Backlog (hectares)	Current NSR (hectares)	Total (hectares)	Per cent
Hemlock good	1 189	1 419	2 608	26
Hemlock poor	807	920	1 727	17
Balsam good	177	520	697	7
Balsam poor old	871	1 016	1 887	19
Cedar good	236	265	501	5
Spruce good	582	747	1 329	13
Pine good	593	694	1 287	13
Total	4 455	5 581	10 036	100

A.3.2 Regeneration assumptions

Table A-7. shows the species regenerated after harvesting occurs in existing analysis units in the Kispiox TSA. All sites are planted, with an expected average regeneration delay of 2 years. A 5-year regeneration delay was used for hemlock good sites to allow for natural ingress of hemlock. Where an analysis unit is converted from an existing species to another species upon regeneration, a site index conversion equation was applied, when available, to derive an estimate of the growth of the regenerated species.

Table A-7. Regeneration assumptions by analysis unit

		Species regenerated (per cent of area)					
Existing analysis unit		Spruce	Pine	Hemlock	Balsam	Cedar	Regeneration delay
1	Hemlock - good	30	25	45	0	0	5
2	Hemlock - poor	10	70	20	0	0	2
3	Balsam - good	50	0	0	50	0	2
4	Balsam - poor	20	60	0	20	0	2
84	Balsam - poor old	20	60	0	20	0	2
5	Cedar - good	25	0	0	0	75	2
6	Cedar - poor	0	0	0	0	100	2
7	Spruce - good	100	0	0	0	0	2
8	Spruce - poor	100	0	0	0	0	2
9	Pine - good	0	100	0	0	0	2
10	Pine - poor	0	100	0	0	0	2

A.3 Forest Management Assumptions

A.3.3 Existing managed stands

The existing stands within the Kispiox TSA have not all been naturally regenerated. Stands less than 20 years old are generally managed stands that have been created through clearcutting and planting. All stands less than 20 years are assumed to be growing on managed stand yield tables as shown in Table A-8. There is no managed analysis unit 11 for deciduous stands. Natural stands grown on volume curve 11 will return to curve 11 after treatment.

Table A-8. Existing managed stands by analysis unit

Analysis unit	Area (hectares)
1 Hemlock - good	2 887
2 Hemlock - poor	1 113
3 Balsam - good	709
4 Balsam - poor	102
5 Cedar - good	349
6 Cedar - poor	105
7 Spruce - good	12 025
8 Spruce - poor	3 523
9 Pine - good	8 080
10 Pine - poor	2 747
Total area currently under management (not including NSR)	31 640

A.3.4 Minimum harvestable ages for each analysis unit

Minimum harvestable ages define the earliest age at which stands in a particular analysis unit may be harvested. This does not imply that areas must be harvested at this age. For this analysis, minimum harvestable ages were defined as the age at which 95% of the maximum average growth rate (culmination of mean annual increment or CMAI) is reached. Table A-9. lists the minimum harvestable ages used in this analysis.

A.3 Forest Management Assumptions

Table A-9. Minimum harvestable age for each analysis unit

Analysis unit	Minimum harvestable age (years)			
	Existing stands		Regen stands	
	Table	Age	Table	Age
Hemlock good	1	110	101	95
Hemlock poor	2	140	102	95
Balsam good	3	115	103	90
Balsam poor	4	145	104	100
Balsam poor (140+)	84	160	184	130
Cedar good	5	95	105	90
Cedar poor	6	110	106	110
Spruce good	7	120	107	85
Spruce poor	8	160	108	135
Pine good	9	100	109	65
Pine poor	10	130	110	90
Deciduous	11	105	11	105
AU 1 in zones 4 & 7	91	110	-	-
AU 4 in zones 5 & 6	94	145	-	-
AU 84 in zones 5 & 6	984	170	-	-

Note: Stands currently represented by Table 91 will be treated as regenerated analysis unit 1 after harvesting. Similarly, Table 94 stands will become regenerated analysis unit 4; and Table 984 stands will become regenerated analysis unit 84.

A.3.5 Forest cover requirements

The computer model used (FSSIM Version 4.3) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition (usually defined by the height of young trees), or the minimum required area of old-age forest, or both. Experience has shown that a certain number of entries or passes into an area may be necessary to meet adjacency guidelines. Forest cover guidelines can approximate the effect of adjacency guidelines, as well as broader forest level goals, using green-up or old-age requirements. For this analysis forest cover requirements were assigned based on the *Kispiox Land and Resource Management Plan*, the visual quality management guidelines provided by the Range, Recreation and Forest Practices Branch of the B.C. Forest Service and the professional judgment of the Kispiox Forest District staff. The green-up height for each zone has been translated into an area-weighted green-up age based on the estimated growth of the stands found in each respective analysis unit.

As explained under Section 5.7, "Uncertainty in the requirement for old growth," the hydrologic green-up requirement was modelled in the base case instead of the old-growth requirement. Table A-10. shows the ages required to achieve the 6 metre hydrologic green-up in all zones except zones 2, 5, 6 and 12 where a greater age was specified to meet management objectives in these zones. The LRMP requirement that not more than 22% of the forested land in a watershed be below the hydrologic green-up height was interpreted to be the same as requiring that at least 78% of the forested area in the watershed be greater than the hydrologic green-up height. All forested land outside of the timber harvesting land base was assumed to be greater than 6 metres in height, fully dispersed within the zones and contribute towards the 78% of the forested land that must be maintained in the hydrologic green-up condition. As a result, the portion of the timber harvesting land base of each zone which had to be in forest greater than 6 metres high ranged from 66% to zero. Where the entire hydrologic green-up requirement could be met from forest outside of the timber harvesting land base in a zone, a default minimum of 12% of the timber harvesting land base of those zones were required to be in forest greater than 6 metres high.

A.3 Forest Management Assumptions

Table A-10. Forest cover requirements and green-up age

	Zone	Green-up age (years and height)	Maximum per cent allowed below this age	Current state (per cent)	Hydrologic green-up age	Minimum per cent required above this age	Current state (per cent)
2.	Babine special management	19 (3 metres)	33	0	140	30	73.03
3.	VQO retention	29 (6 metres)	2.64	3.85	none	none	
4.	VQO partial retention	28 (6 metres)	12.12	18.11	none	none	
5.	Babine SBS	20 (3 metres)	33	6.73	81	30	80.13
6.	Babine ESSF	21 (3 metres)	30	4.68	81	50	94.89
7.	Seven Sisters	17 (3 metres)	33	4.56	28	30	94.07
8.	Upper Kispiox	19 (3 metres)	33	0.01	33	48	99.99
9.	Atna/Shelagyote	21 (3 metres)	33	0	36	12	100
10.	East Kispiox/Kuldo	19 (3 metres)	33	0	34	12	99.42
11.	Rocher Deboule	15 (3 metres)	33	0	25	12	98.69
12.	Deer management	15 (3 metres)	33	24.15	150	6	17.96
13.	IRM west	17 (3 metres)	33	18.08	28	49	77.49
14.	IRM east	19 (3 metres)	33	1.52	32	54	97.59

The forest cover green-up objectives in the partial retention VQO zone and the retention VQO zone are currently in violation of the guidelines set out for visual quality objectives. While existing alterations in some landscapes may exceed new management objectives, visual quality objectives will be met once the regenerated stands reach visual green-up conditions.

A.3.6 Explanation of development of VQO forest cover guidelines

VQO guidelines were developed using the *Procedures for Factoring Recreation Input into Timber Supply Analysis.* An intensive mapping survey of the Kispiox TSA was used to create a visual field on the forest inventory file for each polygon. The field contained various factors connected to visual quality but the key issues for incorporating the information into this analysis were the visual quality category and the relative ranking of visual absorption capacity within the respective category. A weighted percentage disturbance was created with the latter information to produce a basic forest cover guideline for each category. This guideline was combined with the green to operable ratio, a factor which recognizes the contribution of unmerchantable forest component of the visual landscape and the dispersion class, a factor identifying the spatial distribution of the operable timber. The following table identifies the various factors and the resulting forest cover guideline.

A.3 Forest Management Assumptions

Table A-11. Forest cover guidelines by VQO class (percentages)

VQO category	Visual absorption capacity			Green to operable ratio	Dispersion factors			Forest cover guideline
	H	M	L		Dispersed	Clustered	Solid	
Retention	1.06	36.05	62.89	3.22	10	25	65	2.64
Partial retention	14.51	52.71	32.79	2.28	10	25	65	12.12

A.3.7 Utilization levels

The utilization level defines the maximum allowable stump height and minimum merchantable diameter by species and is used to calculate merchantable volume. A 10 cm diameter top and a 30 cm stump height is assumed for all species. The utilization level currently practiced for pine is a 12.5 cm diameter at breast height and 17.5 cm for all other species (i.e., spruce, balsam and hemlock).

A.3.8 Non-recoverable losses

For the Kispiox Forest District, which includes the Kispiox and Cranberry TSAs, the estimate for fire loss over the last 10 years has been 6329 cubic metres per year. The amount attributed to the Kispiox TSA is 5932 cubic metres per year. Even though the balsam bark beetle is the largest potential threat to non-recoverable wood volume loss, the actual losses to date have been negligible. Stem rots have been accounted for in the yield curves through the adjustments in the decay, waste and breakage factors applied to the curves. Unsalvaged wind damage in the Kispiox TSA is negligible. For the purposes of this analysis, non-recoverable losses have been estimated as 5932 cubic metres per year.

Table A-12. Unsalvaged losses

Cause of loss	Gross losses in cubic metres per year	Salvaged volumes (cubic metres per year)	Annual unsalvaged losses (cubic metres per year)
Insects			0
Fire	5 932	0	5 932
Wind damage			0
Total			5 932

A.4 Volume Estimates for Existing Stands

Tables A-13. and A-14. shows the existing and regenerated stand volume tables for all species and site types in the analysis. The appropriate regeneration delays are applied within the timber supply model and are not accounted for in these yield tables. Volume estimates for existing stands greater than 20 years old were derived using the VDYP (Variable Density Yield Projection Version 6.3b) model developed by the B.C. Forest Service, Resources Inventory Branch. Volume estimates for existing stands less than 20 years old and all future regenerated stands were obtained using the TIPSY (Table Interpolation Program for Stand Yields) for Windows model version 1.3 developed by the Research Branch of the Ministry of Forests. The operational adjustment factors (OAF) applied to regenerated stands are 15% for OAF 1 and 5% for OAF 2. OAF 1 is a reduction for unproductive areas (holes) such as rock outcrops, brush, etc. less than two hectares in size occurring in the forest canopy. OAF 2 is a reduction for losses towards maturity caused by insects and diseases. It is 0% at age zero and gradually increases to the percentages specified at age 100. This increase continues indefinitely.

In one-half of the harvesting blocks there is a requirement that trees be left standing which amount to approximately 5% of the timber volume. This is intended to satisfy stand level biodiversity requirements. This requirement was met in the timber supply model by reducing the wood volumes in all the following tables by 2.5%.

A.4 Volume Estimates for Existing Stands

Table A-13. Timber volume for existing stands by analysis unit

Age	Table 1	Table 91	Table 2	Table 3	Table 4	Table 94
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	0	0	0	0
40	0	0	0	0	0	0
50	2	2	0	5	0	0
60	34	29	2	29	8	6
70	93	78	19	65	27	25
80	145	121	57	102	56	48
90	191	160	96	138	88	75
100	233	195	131	168	115	97
110	269	225	162	194	140	117
120	300	251	191	219	163	136
130	329	274	216	241	185	153
140	354	294	239	262	205	168
150	380	316	263	283	225	185
160	403	336	283	302	244	201
170	424	353	302	320	261	215
180	442	368	320	337	278	229
190	459	382	335	353	293	243
200	473	394	349	368	308	255
210	486	404	361	381	321	267
220	499	415	374	395	334	279
230	511	425	386	408	347	290
240	522	434	398	420	359	301
250	532	443	410	431	371	311
260	541	451	421	443	382	322
270	550	458	431	453	393	331
280	556	463	439	455	396	333
290	561	467	447	457	399	334
300	566	471	454	459	401	335
310	571	475	460	461	404	336
320	576	479	466	463	406	337
330	580	482	472	464	408	338
340	584	485	477	466	410	339
350	588	488	482	467	411	340

continued

A.4 Volume Estimates for Existing Stands

Table A-13. Timber volume for existing stands by analysis unit

Age	Table 84	Table 984	Table 5	Table 6	Table 7	Table 8
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	0	0	0	0
40	0	0	0	0	0	0
50	0	0	1	0	0	0
60	2	1	31	4	4	0
70	12	8	66	32	30	1
80	30	23	98	61	76	10
90	56	46	127	87	118	26
100	79	65	153	111	155	53
110	100	83	173	129	186	80
120	120	99	188	144	213	106
130	139	114	200	157	237	130
140	156	128	210	167	257	151
150	174	143	226	181	277	172
160	190	157	241	195	293	190
170	206	171	256	208	307	207
180	221	184	269	220	319	222
190	235	196	281	231	330	235
200	249	208	293	242	339	248
210	262	220	304	251	347	258
220	275	231	316	261	354	269
230	287	242	326	270	361	278
240	298	253	339	281	367	287
250	310	263	351	292	373	295
260	321	273	363	303	378	302
270	331	282	375	313	382	309
280	333	283	376	315	385	314
290	336	284	377	317	388	319
300	337	285	378	318	391	323
310	339	286	379	320	393	327
320	341	287	380	321	395	331
330	342	287	380	323	397	334
340	344	288	381	324	399	337
350	345	289	382	325	400	340

continued

A.4 Volume Estimates for Existing Stands

Table A-13. Timber volume for existing stands by analysis unit (concluded)

Age	Table 9	Table 10	Table 11
10	0	0	0
20	0	0	0
30	0	0	0
40	0	0	0
50	12	1	3
60	51	5	36
70	89	24	81
80	122	53	125
90	151	79	166
100	176	103	202
110	198	125	233
120	219	145	258
130	238	163	278
140	255	181	294
150	271	197	308
160	282	209	319
170	291	219	328
180	298	227	333
190	303	233	336
200	305	237	339
210	305	239	340
220	307	242	343
230	310	246	345
240	313	249	347
250	316	252	349
260	318	255	352
270	321	258	353
280	323	261	354
290	324	263	355
300	326	265	356
310	328	267	357
320	329	268	358
330	331	270	358
340	332	271	359
350	333	273	359

A.5 Volume Estimates for Regenerated Stands

Table A-14. Timber volume for regenerated stands by analysis unit

Age	Table 101	Table 102	Table 103	Table 104	Table 184
10	0	0	0	0	0
20	0	0	0	0	0
30	0	2	0	3	1
40	8	17	10	21	7
50	51	45	60	48	22
60	118	79	132	87	41
70	192	117	198	122	71
80	259	146	258	157	100
90	316	174	323	191	126
100	371	198	369	222	153
110	418	220	402	251	176
120	456	244	428	278	199
130	488	266	449	299	221
140	519	284	466	317	243
150	545	299	480	331	263
160	568	312	490	343	278
170	590	324	499	353	292
180	610	334	506	361	302
190	626	344	507	369	311
200	640	352	508	375	319
210	651	359	508	380	326
220	662	366	508	385	332
230	671	372	508	389	337
240	679	377	507	392	342
250	687	381	506	395	346
260	694	385	505	397	350
270	700	389	503	398	353
280	706	393	502	399	355
290	711	396	499	399	357

continued

A.5 Volume Estimates for Regenerated Stands

Table A-14. Timber volume for regenerated stands by analysis unit (concluded)

Age	Table 105	Table 106	Table 107	Table 108	Table 109	Table 110
10	0	0	0	0	0	0
20	0	0	0	0	2	0
30	0	0	0	0	40	2
40	20	1	13	0	100	17
50	95	7	71	1	148	43
60	174	49	146	9	197	71
70	250	94	211	37	243	101
80	315	140	276	78	277	123
90	368	180	338	122	306	143
100	423	222	382	165	330	161
110	472	260	414	201	349	178
120	516	292	438	237	364	198
130	555	316	459	274	378	214
140	589	337	475	311	390	228
150	616	356	488	338	399	239
160	639	375	498	362	408	248
170	659	396	506	379	415	256
180	678	414	509	395	422	264
190	700	431	510	407	427	270
200	720	446	511	418	432	276
210	738	459	511	428	436	281
220	759	476	511	436	439	285
230	779	492	510	443	441	289
240	794	507	509	449	441	293
250	808	522	508	454	441	296
260	821	534	507	458	441	298
270	833	546	505	462	441	300
280	843	557	503	464	441	302
290	853	568	500	467	441	304