

Queen Charlotte TSA Timber Supply Analysis

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Ministry of Forests

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. They include guidelines for the protection of forest resources. Current management practices also include 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 the end of 1994. This also allows for an important part of these analyses — a process called *sensitivity analysis*. Sensitivity analysis is the assessment of how results might be affected by uncertainties. The sensitivity analyses can be used to examine the timber supply implications of uncertainty in or changes to the definition of current management practices. 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 timber supply analysis report is one of four documents that will be released for each TSA in the province as part of the Timber Supply Review. Two of these documents provide detailed technical information on the results of timber supply and socio-economic analyses. Another one summarizes this information to provide a focus for public discussions of possible timber harvest levels. The fourth 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 Queen Charlotte Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the next 250 years. 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 harvest forecasts in this 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 Queen Charlotte TSA covers a total area of about 465 000 hectares, of which about 61 000 hectares are considered available for timber harvesting under current management practices. The area is dominated by stands of older-aged western hemlock, western redcedar and Sitka spruce. The current AAC for the Queen Charlotte TSA is 514 335 cubic metres per year, apportioned to a mixture of temporary and replaceable licences.

Using current forest management assumptions, the analysis results indicate that the current harvest level must be reduced immediately by about 14% or 72 000 cubic metres per year to 442 000 cubic metres per year in order to avoid significant future shortfalls in timber supply. To continue to avoid major harvest shortfalls, the harvest forecast declines from this reduced initial harvest level by about 12% per decade over the next 6 decades to a low of about 205 000 cubic metres per year, which is 17% below

the steady long-term harvest level. In about 150-180 years, when timber harvesting is projected to occur in predominantly second-growth stands, the harvest level increases to the steady long-term harvest level of about 248 000 cubic metres per year.

The harvest level cannot be maintained at or above the steady long-term harvest level at all times, even if it is immediately reduced to the steady long-term level.

Several factors contribute to the decline in the timber supply forecast. The most important factor is that the base harvest forecast is well above the steady, long-term harvest level. In this situation harvest rates must decline towards the long-term level to avoid serious timber supply shortfalls in the future. Also contributing to the decline in timber supply, to some extent, are forest cover requirements for forest resources such as biodiversity and scenic values. However, it is important to note that even if these forest cover requirements are removed, the harvest forecast still shows a decline in the near future. An additional contributing factor is that existing forests are dominated by older stands on poor growing sites yielding lower than average volumes of timber.

Uncertainty in the data and assumptions used in the analysis may affect results. For example, the projected harvest forecast is increased slightly by relaxing forest cover requirements for visual quality and biodiversity. In general, changes in the expected yields of existing and regenerated stands as well as changes in the size of the timber harvesting land base has the greatest effect on both short- and long-term timber supply projections.

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Introduction

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

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

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions whether a stand is available for harvest often depends 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 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 the Chief Forester of British Columbia uses to determine an allowable annual cut (AAC)*.

Timber supply projections made for TSAs look far into the future — 200 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 Queen Charlotte TSA. Following a

brief description of the TSA in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methods 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 Queen Charlotte TSA

The Queen Charlotte TSA is situated in the Queen Charlotte Islands within the Vancouver Forest Region (see Figure 1). The Queen Charlotte Islands are a group of about 150 islands located 130 kilometres to the west of north coastal British Columbia. The TSA, which covers an area of about 465 000 hectares, is administered by the Queen Charlotte Islands Forest District office located in Queen Charlotte City. Most of the TSA land area is on two main islands; Graham Island to the north and Moresby Island in the south. The islands have a total area of about 1 018 000 hectares with parks and reserves accounting for 229 000 hectares (22%); tree farm licence (TFL) areas, 324 000 hectares (32%); and the remainder, 465 000 hectares (46%) as TSA.

Figure 2 shows the Queen Charlotte TSA is mainly located on the east and west sides of Graham Island with a much smaller portion on northwest Moresby Island. Graham Island is relatively flat and low in elevation on the eastern side while the centre of the island consists of the rolling uplands of the Skidegate Plateau. The west side is dominated by the Queen Charlotte Ranges. Moresby Island, with the exception of the northeast portion, is characterized by the high steep topography of the Queen Charlotte Mountains. The mountainous terrain affects the

amount and pattern of rainfall on the islands, with annual precipitation on the east coast averaging about 1300 millimetres and the west coast averaging over 4000 millimetres.

Sitka spruce predominate in the coastal and floodplain forests of the islands with western hemlock dominating in low- and middle- elevation forests. Western redcedar is present along with western hemlock in areas of increased moisture and nutrient levels.

Apart from a federal government military communications centre which is scheduled to close, the economies of the communities in the Queen Charlotte Islands are based on resource extraction. Timber harvesting and commercial fishing form the basis of the island's economy. Most of the timber harvested is shipped south for processing, however, there are several small sawmills and cedar shake or shingle mills operating and supplying local demand or markets off the island. Because of their isolation and associated access problems, relatively few tourists visit the islands. However, there is potential for steady growth in tourism as the planned development of facilities and transportation services in support of Gwaii Haanas/South Moresby Island National Park Reserve continues.

1 Description of the Queen Charlotte TSA

Figure 1. Map showing location of Queen Charlotte TSA within Vancouver Forest Region.

1 Description of the Queen Charlotte TSA

Figure 2. Map of Queen Charlotte TSA.

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 in 1993 by the B.C. Forest Service, Inventory Branch. 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, the area and the 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 (such non-contributing areas specific to the Queen Charlotte

TSA are described below). 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. It is within that integrated resource context that the timber supply is managed. The timber supply analysis in this report is consistent with this philosophy.

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 reducing the total land base according to specified management assumptions.

2 Information Preparation

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 timber 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.

Areas on which timber harvesting is not expected to occur, given current forest management in the Queen Charlotte TSA, are as follows:

- 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 or TFLs)
- non-forest areas — areas not occupied by productive forest cover (for example rock, swamp and alpine areas).
- problem forest types — forest types of poor timber quality or low timber volume that cannot be economically harvested as sawlogs. This includes sites with low timber growing potential (low site index*) and stands in which pine or alder is the dominant species.
- streamside management zones — forested buffers along fish-bearing streams to protect non-timber values.
- preservation visual quality objective (VQO)* — areas in which no visible alterations to the landscape are permitted.
- Skidegate Reserve expansion — area set aside for expansion of the Skidegate reserve.
- culturally modified trees — areas in which trees have been intentionally altered by aboriginal peoples as part of their traditional use of the forest.
- environmentally sensitive areas* — a proportion of the areas considered to be sensitive were deducted from the timber harvesting land base.
- inoperable areas* — areas defined as unavailable for harvest for terrain-related and economic reasons.
- roads, skid trails and landings — the area of existing forest roads is excluded from the timber harvesting land base. Future losses of productive forest land due to roads, trails and landings are projected and deducted over time as future harvesting occurs.
- not satisfactorily restocked* (NSR) areas — these areas are initially removed, but are considered available for timber production and are added back into the timber harvesting land base once prescribed treatment plans have been specified.

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.

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.

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 where timber harvesting may cause avalanches.

Inoperable areas

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

Not satisfactorily restocked

An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the 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

- timber licence reversions — throughout the next 25 years about 2200 hectares of timber licences will return to the Crown and become part of the timber harvesting land base. Harvesting volumes from these old tenure arrangements do not contribute to the AAC for the TSA. However, once they are harvested and satisfactorily restocked, these areas revert to the Crown and

future harvests from them will contribute to the AAC.

Table 1 summarizes the areas represented by each of the previous categories, leaving the land base upon which timber harvesting is expected to occur — the timber harvesting land base. A more detailed description of the categories and the rationale for reductions and additions is provided in Appendix A, "Description of Data Inputs and Assumptions."

Table 1. Timber harvesting land base, Queen Charlotte TSA

Classification	Area (hectares)	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total land base		464 827	100.0	
Not managed by BC Forest Service		26 518	5.7	
Non-forest		89 927	19.3	
Total productive forest managed by Forest Service (Crown Forest)		348 382	74.9	100.0
Reductions to productive forest:				
Problem forest types	142 085		30.6	40.8
Streamside management zones	3 471		0.7	1.0
Preservation VQO areas	5 893		1.3	1.7
Skidegate Reserve expansion	85		<0.1	<0.1
Culturally modified trees	250		0.1	0.1
Environmentally sensitive areas	5 738		1.2	1.6
Inoperable areas	127 943		27.5	36.7
Existing roads, trails, landings	1 033		0.2	0.3
Not satisfactorily restocked	2 261		0.5	0.6
Total current reductions	288 759	-288 759	62.1	82.9
Current timber harvesting land base:		59 623	12.8	17.1
Additions to productive forest:				
Not satisfactorily restocked	2 261		0.5	0.6
Timber licence reversions	2 161		0.5	0.6
Total additions		+4 422	1.0	1.3
Total current timber harvesting land base		64 045	13.8	
Future reductions to productive forest				
Future roads, trails, landings	3 687	-3 687		18.4
Long-term timber harvesting land base		60 358	13.0	17.3

2 Information Preparation

Figures 3 and 4 summarize the land base categories for the Queen Charlotte TSA. Figure 3 shows that about 75% of the TSA is Crown forest land of which 17% is available for timber harvesting (see Figure 4). Also, Figure 4 shows that the two

largest reductions to the timber harvesting land base are for inoperable areas and problem forest types. Overall, the timber harvesting land base accounts for about 14% of the total TSA land base (see Table 1).

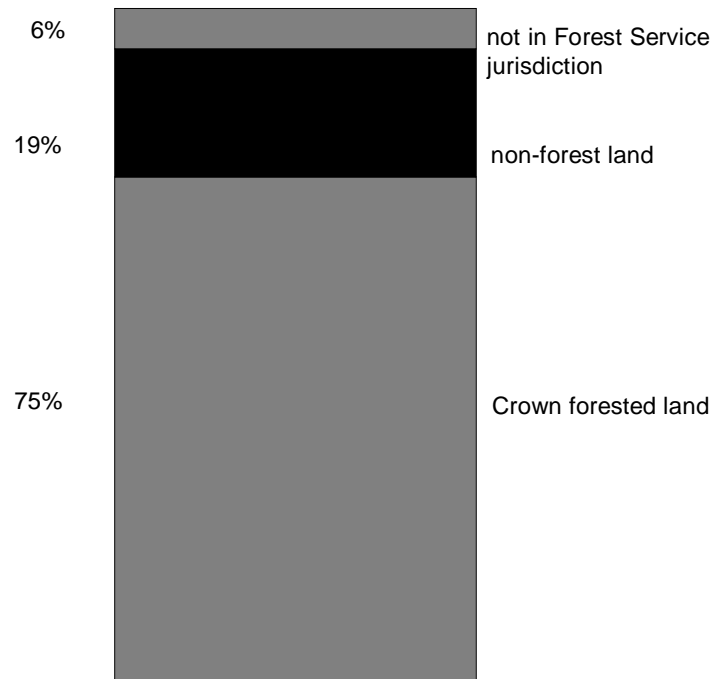


Figure 3. Classification of the total land base for the Queen Charlotte TSA.

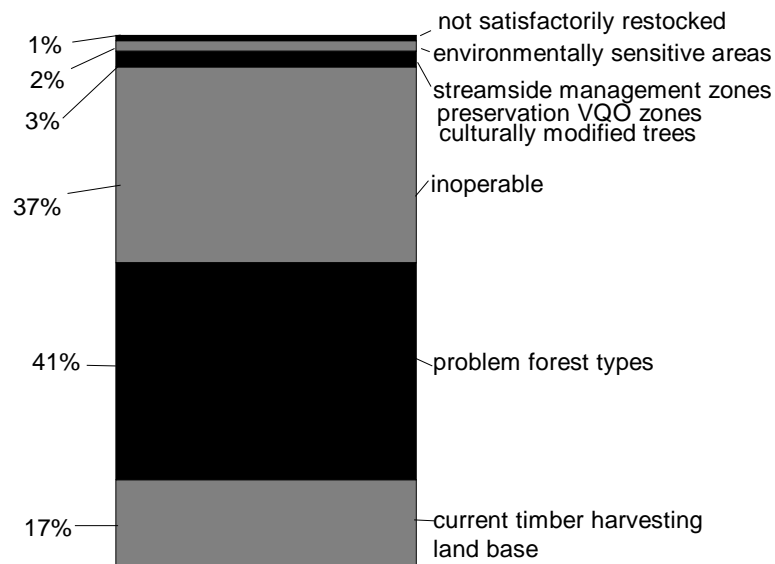


Figure 4. Crown forest land classification for the Queen Charlotte TSA.

2 Information Preparation

Figure 5 shows a breakdown of the timber harvesting land base by dominant tree species, quality of growing site and maturity. The timber harvesting land base in the Queen Charlotte TSA is comprised mainly of hemlock (49%), western redcedar (30%) and Sitka spruce (21%) with an extremely small (less than 1%) component of yellow cedar (included with

western redcedar in Figure 5). Note that a large proportion (75%) of the existing forest is classified as mature — over 120 years old, and of this, the majority (62%) occurs on the poorer growing sites. Medium and good site quality classes make up 29% and 9% of the area respectively.

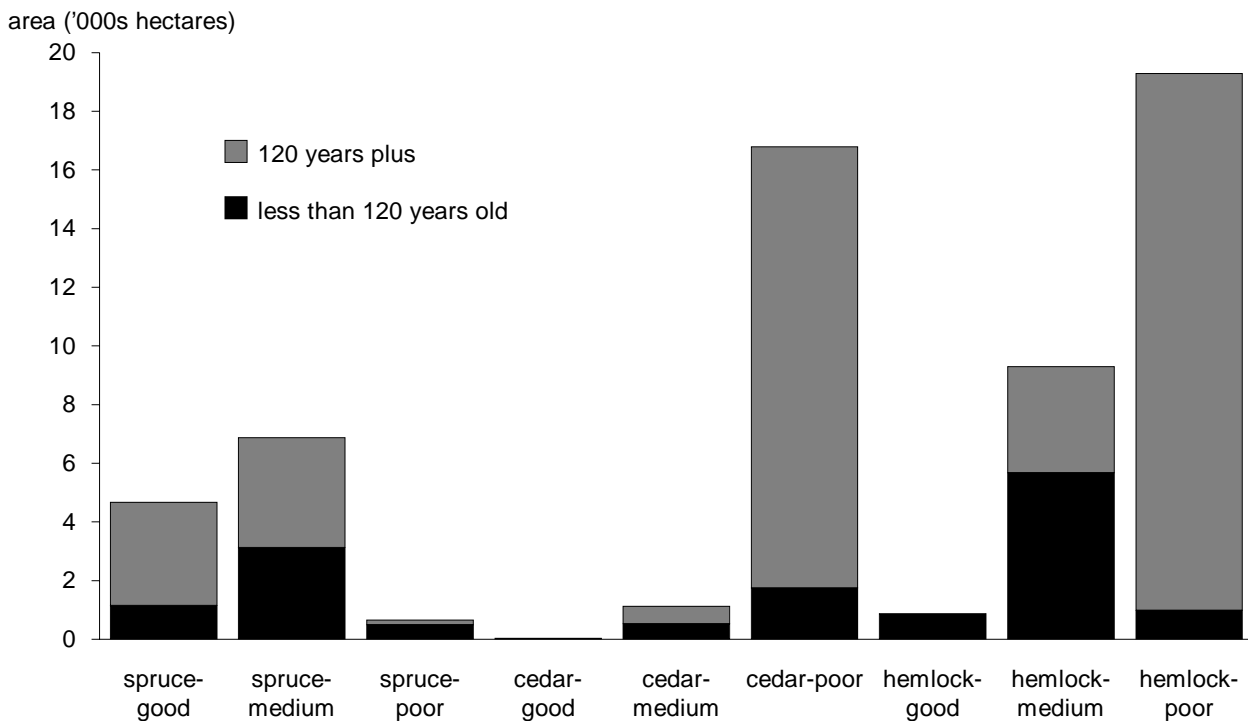


Figure 5. Area by dominant tree species, quality of growing site and maturity — timber harvesting land base, Queen Charlotte TSA.

2 Information Preparation

Figure 6 shows the age class distribution by dominant tree species for the timber harvesting land base. The mature timber (over 120 years) is mainly hemlock and cedar in the older age classes (200 years and older) and the 120-140 year range is almost entirely occupied by cedar (originating from wildfires in the 1870s). Hemlock and spruce dominate immature stands (under 120 years old), with hemlock in the majority.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of individual forest stands over time. The most common measure of the amount of standing timber is volume per 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 must be harvested and removed from a site. Utilization levels specify a maximum stump height and minimum diameters at the tree base and top.

Timber volumes applied to existing stands in this analysis are based on the Variable Density Yield Prediction (VDYP) model developed by the B.C. Forest Service, Inventory Branch. This model provides estimates of stand volume according to age. Timber volumes estimated for future stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service, Research Branch. Sensitivity analyses address the possibility that stand volumes may be different from those predicted.

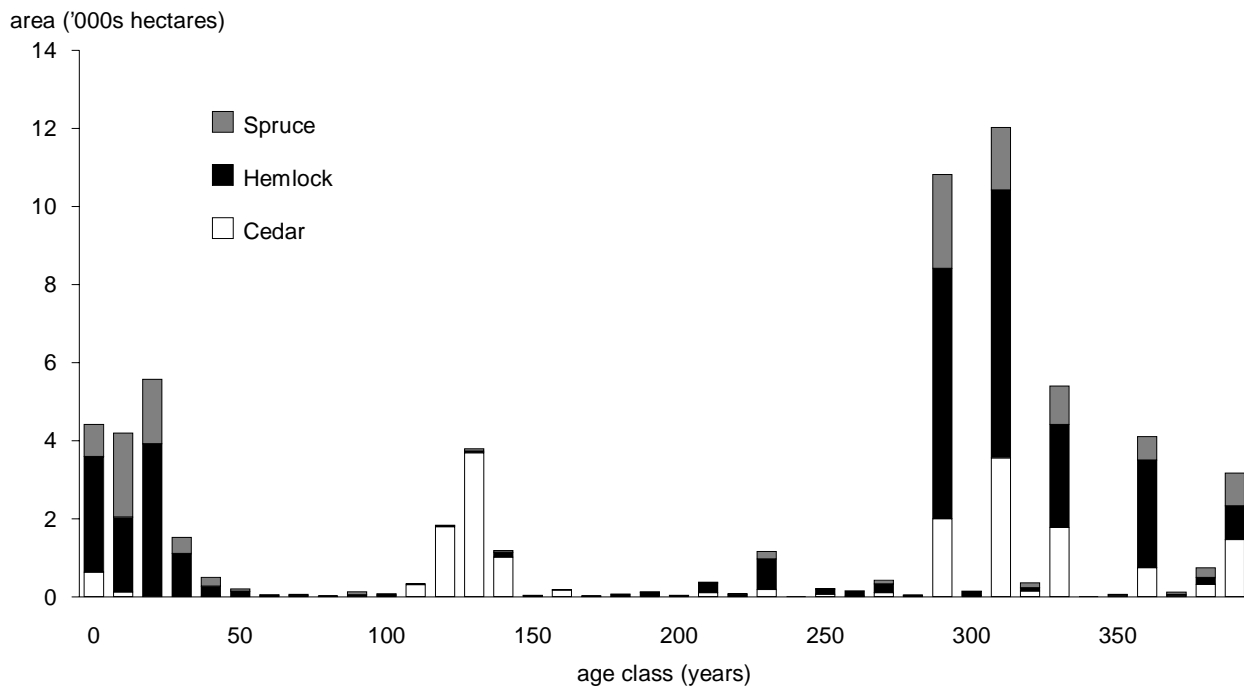


Figure 6. Current age class distribution by dominant tree species — timber harvesting land base, Queen Charlotte TSA.

2 Information Preparation

2.3 Management practices

Timber supply is directly connected to forest management activity. The focus of the Timber Supply Review is to describe the timber supply based on current management practices, as implemented in plans for the area. Staff in the Queen Charlotte Forest District and Vancouver Forest Region defined these practices as described in the following management assumptions*:

- basic silviculture levels — reforestation activities required to establish stands of acceptable species which have reached free-growing* conditions. All areas are managed using a clearcut harvesting* system and restocked by planting or natural regeneration.
- forest health and unsalvaged losses — expected losses due to insects, diseases, wildlife, fire and wind damage. For the Queen Charlotte TSA,

unsalvaged losses from insects is expected to be 3328 cubic metres per year and from wind damage, 3809 cubic metres per year. Losses to fire and disease are assumed to be negligible. The estimated losses due to insects and wind of 7137 cubic metres per year have been subtracted from all harvest forecasts* in this report.

- utilization levels — size limits for trees and logs that must be removed from the site.
- minimum harvestable ages — the time required for stands to grow to a harvestable size. The minimum harvestable age defines the lower limit for harvesting. Actual harvest age depends on many factors including the ages of other stands, limits on overall harvest level, and forest cover.
- rate of restocking of current and backlog not satisfactorily restocked (NSR) areas — the schedule of restocking for these areas.

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.

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.

2 Information Preparation

- forest cover objectives* — specify the desired distribution of areas by age class groupings. These objectives are used to specify general cutblock adjacency* requirements as well as desired conditions for wildlife habitat, old-growth, biodiversity*, and aesthetics. There are two types of forest cover objectives:
 1. Old-growth and biodiversity forest cover requirements — specify a minimum percentage of the forest that must be older than a prescribed age; and
 2. Green-up and adjacency forest cover requirements— allow no more than a specified percentage of the forest to be younger than green-up period. The green-up period represents the time it takes a stand to reach certain desired conditions (for example a particular height) before adjacent timber may be harvested. These desired conditions are to ensure the maintenance of water quality, wildlife habitat, soil stability or aesthetics.

A more detailed description of the management assumptions is provided in Appendix A, "Description of Data Input 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

Integrated management guidelines that specify the desired spatial relationship among cutblocks. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements. The objective is to ensure recently harvested areas are not adjacent to each other.

2.4 Management zones

In the Queen Charlotte TSA areas with particular visual quality, biodiversity, wildlife or fisheries values are identified. As our understanding of them improves, information about these forest values is updated and incorporated in the timber supply analysis. The objective of forest management in these areas is to maintain the identified values. In some cases no timber harvesting activities are permitted and the area is excluded from the timber harvesting land base. In recognition of the various forest management activities and objectives, the timber harvesting land base of the TSA has been separated into three forest management zones:

1. Retention visual quality objective (VQO)* zone — areas of high landscape value such as forested slopes facing viewpoint and recreational areas. Timber harvesting activities may be present but are not noticeable to the average viewer. The initial forest cover requirements allow no more than 5% of the forest to be less than 5 metres tall. This percentage is then adjusted to reflect the contribution of inoperable forested areas to the landscape. The old-growth/biodiversity forest cover requirements specify that at least 6% of the forested area in this zone be older than 150 years at all times.

Biodiversity (biological diversity)

Diversity of life in all its forms and levels of organization, including genes, species, ecosystems and the evolutionary and functional processes that link them.

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)

2 Information Preparation

2. Partial retention visual quality objective (VQO)*zone — areas of moderate landscape value. Timber harvesting activities generally match the landscape character and are noticeable but not intrusive. The initial forest cover requirements allow no more than 15% of the forest to be less than 5 metres tall. This percentage is then adjusted to reflect the contribution of inoperable forested areas to the landscape. The old-growth/biodiversity forest cover requirements specify that at least 6% of the forested area in this zone be older than 150 years at all times.
3. Integrated resource management zone — this area represents the balance of the timber

harvesting land base. The emphasis in this zone is timber harvesting with a management regime that integrates all resource values. Forest cover requirements allow no more than 25% of the forest to be less than 5 metres tall, whereas the old-growth/biodiversity forest cover requirements specify that at least 6% of the forested area in this zone be older than 150 years at all times.

Figure 7 summarizes the area breakdown by management zone. A more detailed description of the management zones is provided in Appendix A, "Description of Data Input and Assumptions."

Partial retention VQO

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

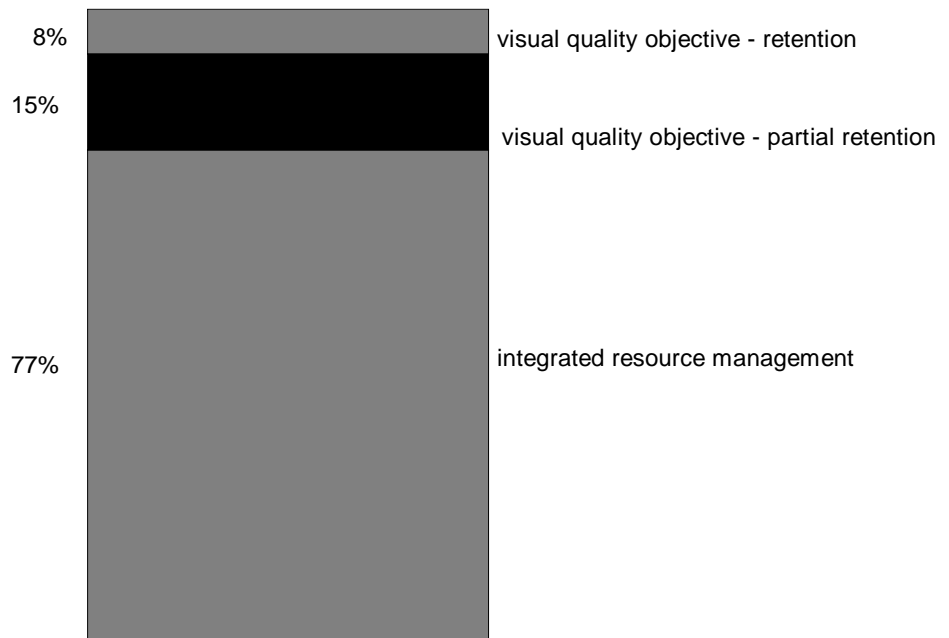


Figure 7. Proportion of the timber harvesting land base subject to each forest management consideration, Queen Charlotte TSA.

3 Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Queen Charlotte 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 distinguished from a growth and yield model, assists in determining how a whole forest (collection of stands) be managed in order 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 0 to 400 years. (Only the results for the first 250 years are shown graphically in this report because the harvest flow generally remains constant from 250 to 400 years from now).

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 B.C. 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 period, or that some minimum percentage of the forest must be older than a certain age 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 forest management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and 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 as recommendations of any particular AAC.**

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

4 Results

4.1 Base harvest forecast

The harvest forecast based on current forest management assumptions for the Queen Charlotte TSA is shown in Figure 8. This forecast will be referred to as the base harvest forecast and will be used as the basis for comparison for all other harvest forecasts in this report.

The base harvest forecast shows an initial rate of harvest of 442 000 cubic metres per year, which is about 14% lower than the current AAC. From this reduced initial rate of harvest, the harvest forecast declines 12% per decade for the next 6 decades to about 205 000 cubic metres per year — 17% below the steady long-term harvest level. The projected rate of harvest remains below the steady long-term level for 10 decades before rising over the next 2 decades to the steady long-term harvest level of 248 000 cubic metres per year. Overall, there is a 44% decline from the initial harvest level to the long-term level achieved in decade 18.

The base harvest forecast shown is only one of many possible harvest flows given current forest management assumptions. The harvest forecast shown in Figure 8 represents a balance between short- and long-term timber supply interests; attempting any of the alternate harvest flows that follow results in more severe timber supply declines in the short-term and/or greater shortfalls in the long term:

- starting the harvest forecast at a higher initial level;
- delaying the decline;
- reducing the rate of decline;
- decreasing the amount the harvest levels falls below the long-term level, or;
- decreasing the time in which the harvest remains below the long-term level.

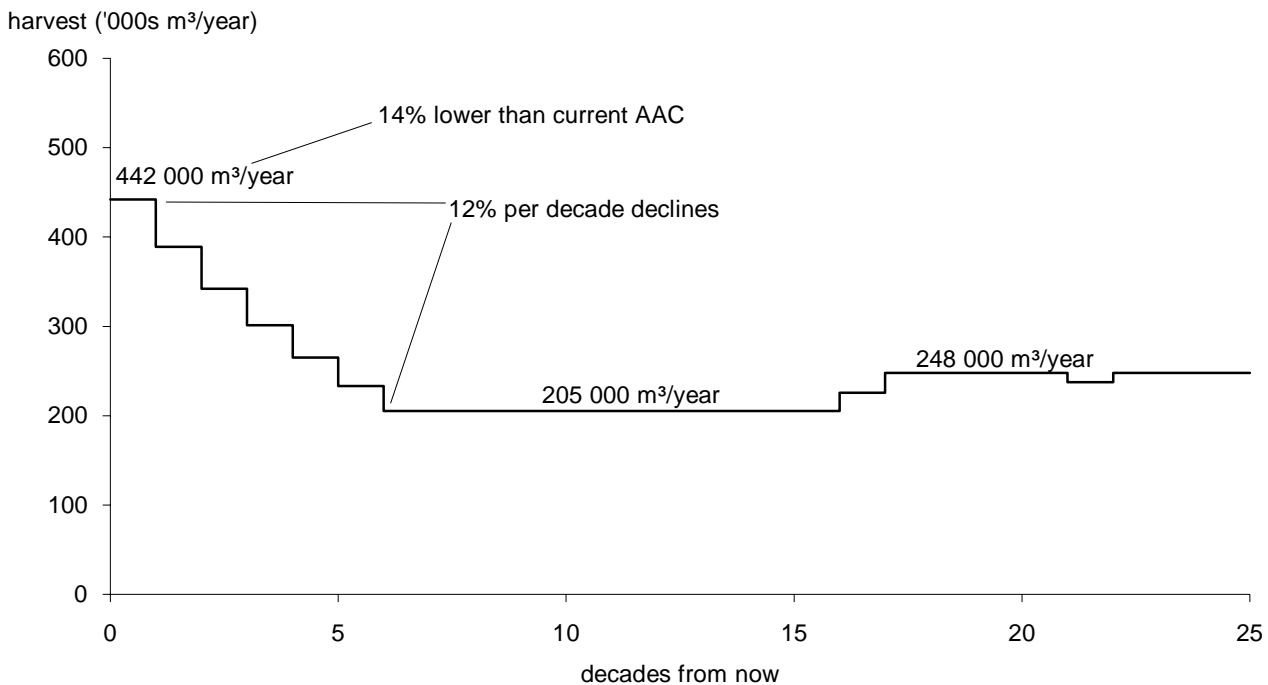


Figure 8. Base harvest forecast for the Queen Charlotte TSA.

4 Results

Alternate harvest flows will be discussed further in Section 5, "Timber Supply Sensitivity Analyses."

Several factors affect the timber supply forecast. Most importantly, the base harvest forecast in the short term is well above the long-term harvest level and must decline to avoid a future timber shortfall. In addition, as discussed in Section 2.1, "Land base inventory" and shown in Figure 6, the remaining older forests, in which most harvesting is expected to occur over the short term, are on poorer than average growing sites and will therefore yield lower than average volumes of timber. As well, the forest cover requirements for forest resources such as wildlife and scenic values have a minor effect on the rate at which these older, poor-site forests may be harvested. However, it is important to note that even if these forest cover requirements are removed, the harvest forecast will still show a decline in the near future (see Section 5.7, "Sensitivity to removing all forest cover requirements.")

The transition from harvesting existing (old-growth, poor-site) stands to second-growth stands occurs in decades 11 through 18 in the harvest forecast. The decline to a level below the long-term harvest level (decades 7 through 16) occurs because there is not yet sufficient timber available from second-growth stands to offset the decreasing volume available from existing stands. The shortfall in decade 22 is also caused by lack of available second-growth but it is compounded by the forest cover requirements to the retention VQO zone.

The long-term level is defined as the harvest that will maintain timber growing stock* at an even level so that harvesting can continue at a constant level in perpetuity (Figure 9). A continually declining growing stock would signify that timber is being harvested above the productive capability of the land. Figure 9 shows a declining total growing stock (from an initial level of about 29 million cubic metres) over

the first 100 years indicating that the timber inventory is decreasing, however, beyond 100 years, it is relatively constant (at about 16 million cubic metres), corresponding to the long-term harvest level. If harvests over the long term exceed the productive capability of the land, the growing stock would continue to decline, resulting in a shortage of available timber.

There is a substantial difference (44%) between the initial and long-term harvest levels in the base harvest forecast. The rate of decline from the initial level is dependent primarily on the amount of timber that is currently available to harvest, and on when second-growth (regenerated) stands reach a harvestable age. Figure 9 indicates the transition to harvesting second-growth stands begins about decade 11.

Another important feature to note in Figure 9 is the low level of available growing stock in decade 22. Available growing stock represents stands old enough to harvest but not required to meet the old-growth/biodiversity forest cover requirements. The decline of the available growing stock from an initial value of about 24 million cubic metres to a long-term level of, on average, 5 million cubic metres is similar to the decline of the total growing stock. The shortage of available growing stock in decade 22 combined with the harvest flow restrictions applied are the strongest influences on rates of harvest in preceding periods.

It is important that the long-term harvest level not be interpreted as being the same as a theoretical maximum sustainable harvest level based on the maximum mean annual increment (MAI)*. The theoretical level, about 268 000 cubic metres per year, is not achievable for several reasons.

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 stand age at which the MAI assumes its maximum value is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

4 Results

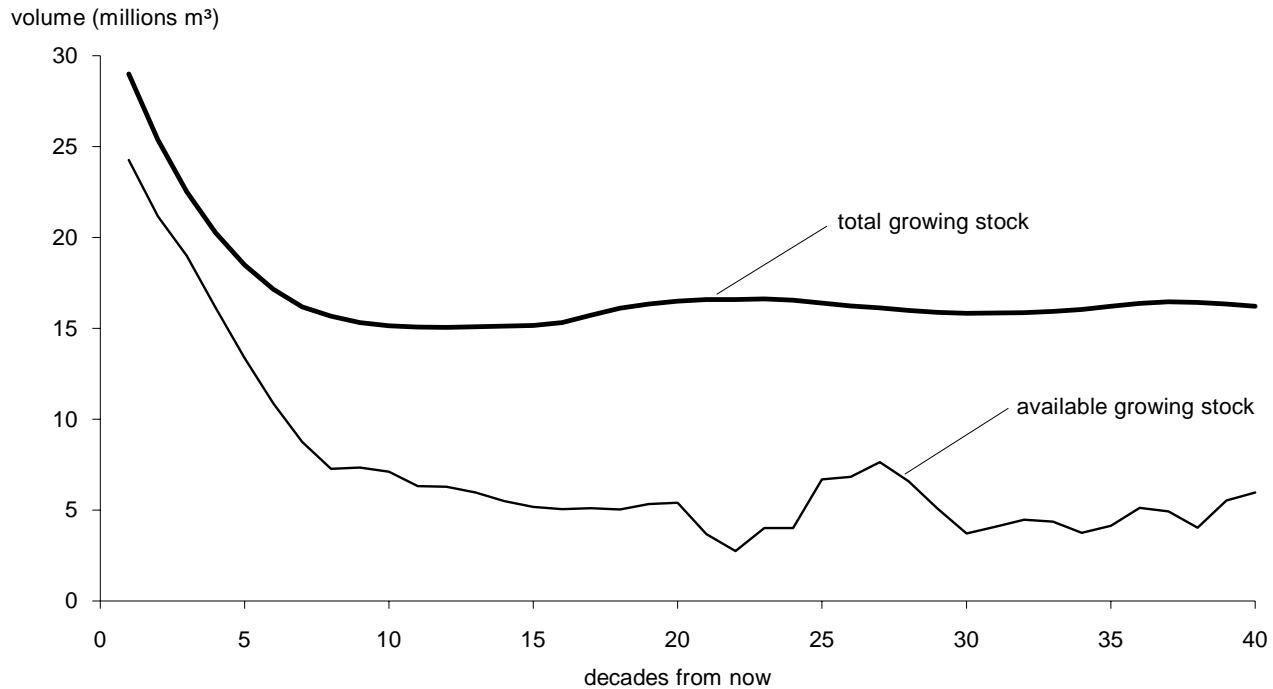


Figure 9. Total and available growing stock over time, Queen Charlotte TSA.

Areas are not necessarily harvested at ages which would maximize volume yield over the long term. This may result because of the applied minimum harvestable ages, forest cover objectives or the imposed harvest flow pattern. Also, harvest forecasts are reduced by the estimated volume losses to fire, insects, disease and other destructive agents.

Note that the harvest forecast shown here, as well as those in Section 5, "Timber Supply Sensitivity Analyses" provide an upper limit on timber supply, given the land base and management practices discussed earlier. **This forecast is for discussion**

purposes only and is not intended to suggest a particular AAC.

4.2 Age class distribution over time

Figure 10 shows the changes projected to occur in the age class distribution of stands in the Queen Charlotte TSA timber harvesting land base. Over the 250 year planning horizon, the older aged stands are harvested and the amount of area in each age class becomes more equal.

4 Results

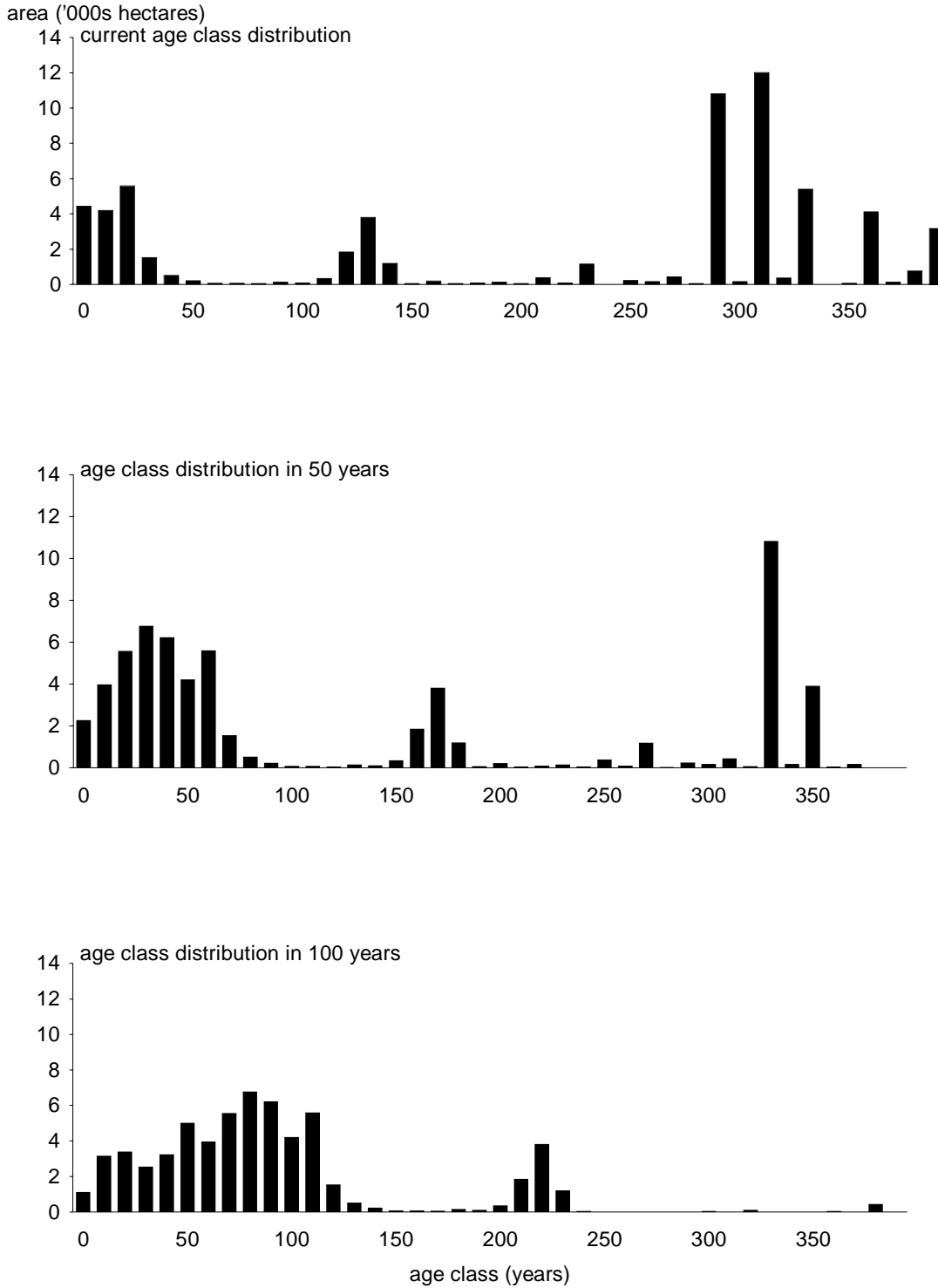


Figure 10. Changes in age class distribution over time, Queen Charlotte TSA. (continued)

4 Results

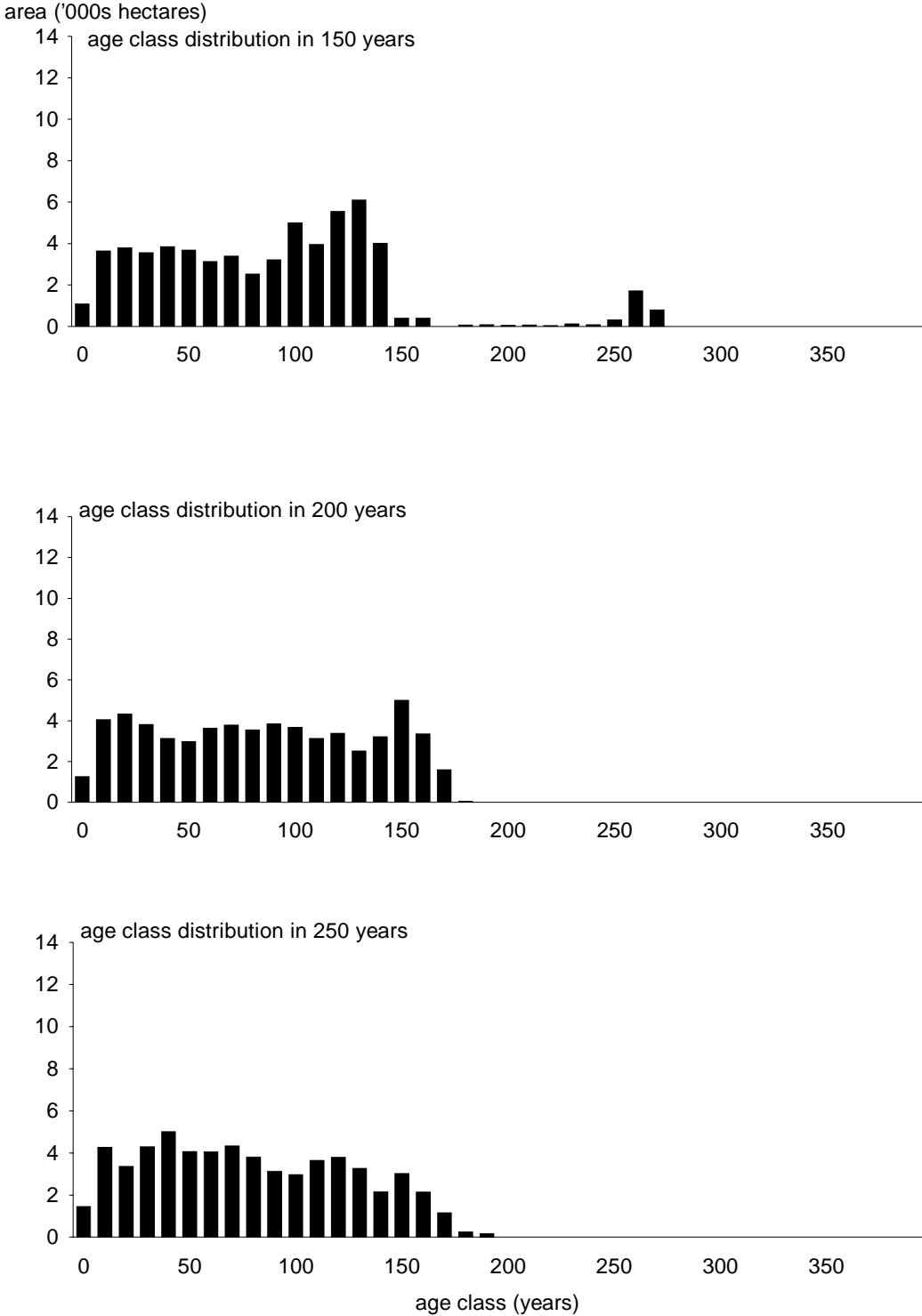


Figure 10. Changes in age class distribution over time, Queen Charlotte TSA (concluded).

4 Results

Initially, about 75% of the stands are over 120 years old and this predominance of old-growth timber allows higher initial harvest levels than in the long term. At 100 years, a relatively smaller area of mature stands exist, with stands under 120 years old predominating.

In 150 years, almost all of the existing older stands, except those needed for old-growth/biodiversity forest cover requirements, have been harvested and replaced with regenerated (second-growth) stands.

By 250 years, the age class distribution is relatively balanced in stands younger than 130 years old. The small proportion of timber over 150 years old represents the areas being managed to meet the old-growth/biodiversity forest cover requirements. This timber will eventually be harvested, but over an extended period of time. These older stands are harvested when regenerated stands pass 150 years of age, however, at all times there must be at least 6% of the timber harvesting land base with stands greater than 150 years old.

4.3 Annual area harvested, average volume per hectare, average harvest age

While the amount of area harvested annually fluctuates, general trends are evident (Figure 11). Annual area harvested starts at just over 600 hectares per year then declines to an average of about 350 hectares per year during decades 7 through 16. After decade 16, area harvested increases to an average of about 425 hectares per year. The initial decline in harvested area reflects the decreasing volume harvested in decades 2 through 6. This is followed by a relatively constant harvested area corresponding to the lower steady harvest level in decades 7 through 16 of the base harvest forecast. Annual area harvested increases in decade 17, about the time when the transition from harvesting existing old-growth stands to second-growth stands is complete and the long-term harvest level is reached.

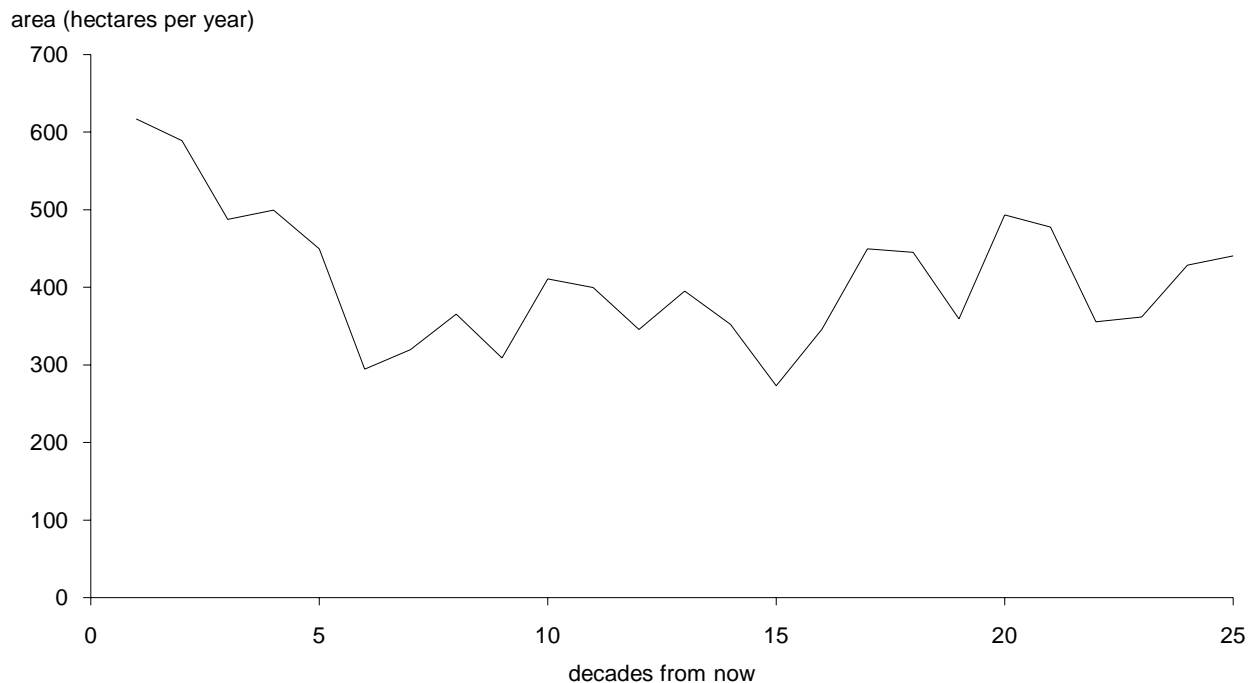


Figure 11. Area harvested annually, base harvest forecast, Queen Charlotte TSA.

4 Results

Figure 12 shows the changes in average volume per hectare (or yield) over time for the base harvest forecast. Much of the variability in average volumes per hectare over time is due to the harvest of similar types of stands. For example, the peaks at decades 5 and 15 represent the harvest of Sitka spruce on good and medium sites. The initial level of about 700 cubic metres per hectare declines to a long-term level of about 600 cubic metres after 11 decades. While second-growth stands, because of stand management practices, have a higher volume per hectare at mature ages, they are harvested at younger ages (Figure 13), and therefore slightly less volume per hectare is harvested than from existing older stands.

Average harvest age, shown in Figure 13, remains relatively constant at 350 years until decade 11 and then declines sharply to about 140 years. After

decade 17, average harvest age remains relatively constant at 150 years. It then increases to about 230 years in decade 16, the period in which the last of the existing old growth is harvested. At that point second-growth stands have aged sufficiently to satisfy the old-growth/biodiversity requirement making some of the oldest timber available for harvest.

Note that average harvest ages shown in Figure 13 are based on a declining harvest forecast in the short term (see Figure 8). A harvest forecast which does not decline as rapidly as the base harvest forecast will show an earlier decline in average harvest age and future harvest shortfalls. This is because the existing old-growth stands are harvested at a faster rate, implying younger stands are harvested sooner. Future harvest shortfalls result when the existing old growth is harvested before second-growth stands are ready for harvest.

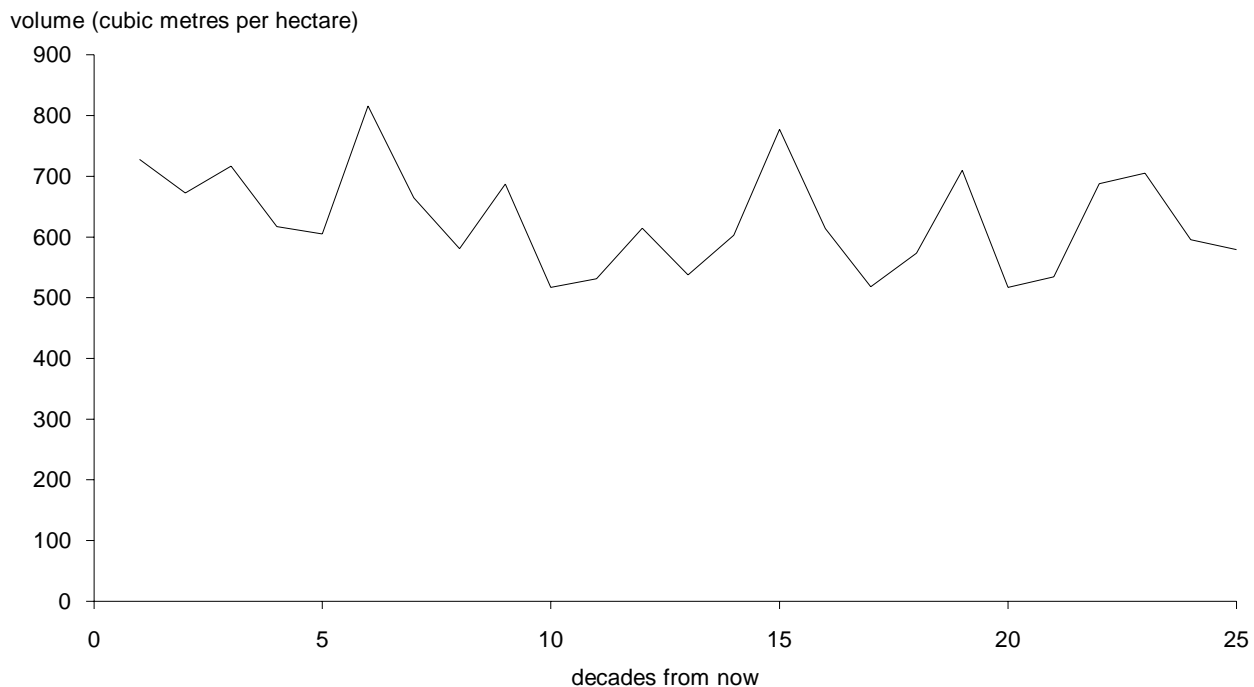


Figure 12. Average volume harvested per hectare over time, base harvest forecast, Queen Charlotte TSA.

4 Results

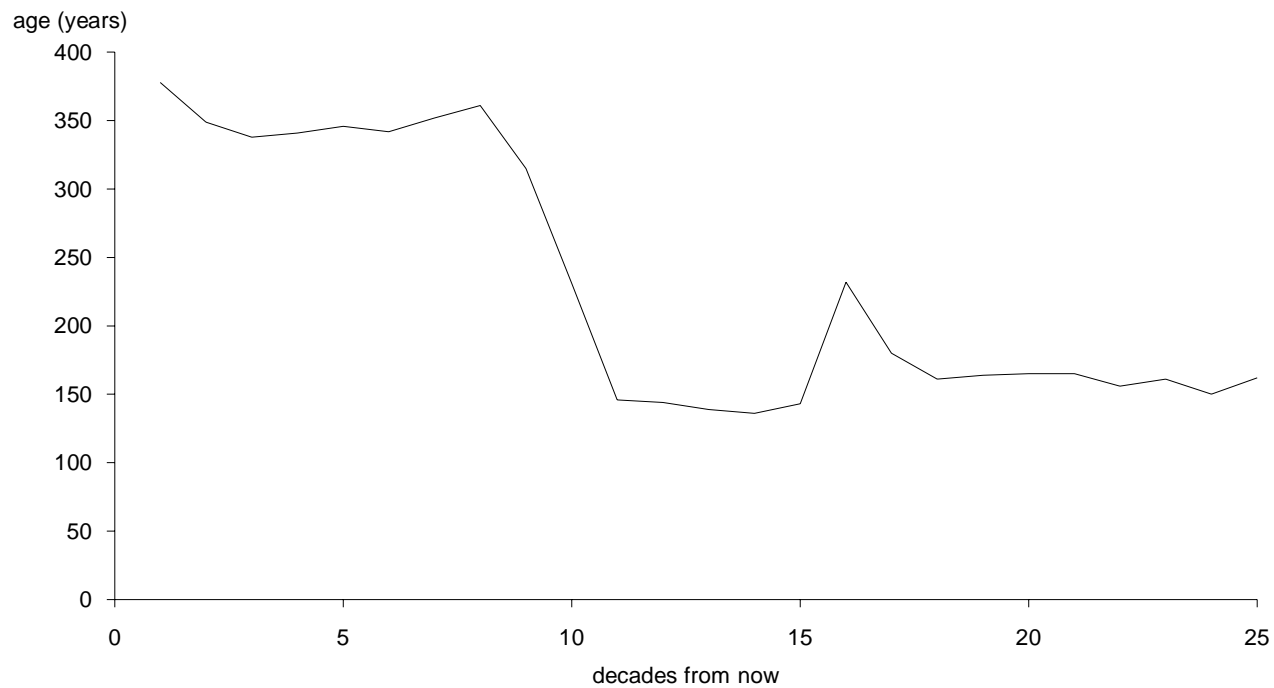


Figure 13. Average harvest age over time, base harvest forecast, Queen Charlotte TSA.

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 any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess its potential effects on values of interest, for example, timber supply. Every decision either implicitly or explicitly incorporates an attitude towards uncertainty. If we believe that existing information accurately reflects reality, we are being neutral to uncertainty, believing essentially that any inaccuracies probably balance out. Ignoring uncertainty is implicitly neutral. If maximizing timber supply were the goal, someone with an optimistic position 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 uncertainty and forest management to provide input.

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 most affect results. For example, it is possible that small inaccuracies in estimating some variables could have large effects on timber supply, or that fairly large inaccuracies in other variables could have negligible effects. Sensitivity analysis can therefore highlight priorities for collecting information for future analysis. It can also clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are outlined. The results that are based on current forest management assumptions are referred to as the base harvest forecast (shown in Figure 8).

5.1 Alternative harvest flows given the base forest management assumptions

For a given set of forest management assumptions, many different harvest flows are often possible. Given the same set of forest management assumptions, this section examines alternative harvest flows to that shown as the base harvest forecast.

The initial harvest level of the base harvest forecast, shown in Figure 8 and discussed in Section 4, "Results" is about 14% below the current AAC. The solid line in Figure 14 shows the result of trying to achieve a slightly higher starting harvest level while also maintaining a reasonable rate of decline. The starting harvest level is set at only 10% below the current AAC and the future rate of decline in the harvest level is also limited to 10% per decade. Although the decline to the drop below the long-term level is delayed 2 decades as compared to the base harvest forecast, there are timber supply shortfalls between decades 11 and 18 and again in decade 21. The transition from harvesting older stands to second-growth stands occurs in decades 10 through 17. An increased initial harvest in the older stands leaves little older timber to harvest in this period before the second-growth stands reach a harvestable age.

5 Timber Supply Sensitivity Analyses

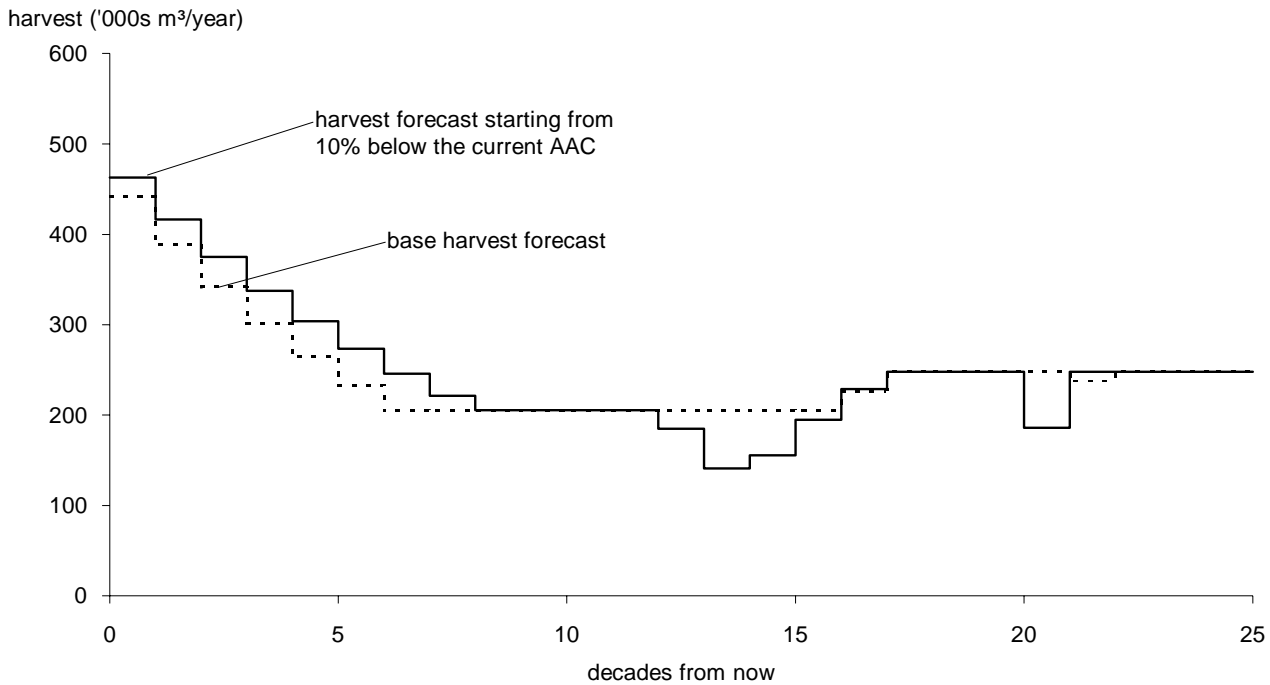


Figure 14. Harvest forecast with the initial harvest level set at 10% below the current AAC, Queen Charlotte TSA.

The shortfall occurring in decade 21 is caused by the greater amount of poor-productivity sites that become available for harvest (recall from Section 2.1, "Land base inventory" the majority of older existing stands are on poor growing sites). This shortfall is also evident in the base harvest forecast where it occurs a decade later and is not as dramatic.

The thin solid line in Figure 15 shows the harvest forecast if the initial rate of harvest is set at the current AAC of 514 335 cubic metres per year. To avoid a future timber supply shortfall, the harvest flow declines 15% per decade from decades 2 through 7 reaching a level 22% below the long-term harvest level as compared to 17% for the base harvest forecast. It then rises in decades 17 to 18, as in the base harvest forecast, to the long-term harvest level.

Figure 15 also shows the harvest forecast (thick solid line) if the initial rate of harvest is about 381 000 cubic metres per year — a level midway between the current AAC and the long-term harvest level. Beginning in decade 2, the harvest level declines by 10% per decade until reaching a level about 14% below the long-term harvest level. A timber supply shortfall is evident in decade 23, 5 decades after the harvest level increases to the long-term level. Another alternate harvest forecast with an

initial harvest level of 381 000 cubic metres per year, although not shown here, declines by 8% per decade from decades 2 through 9 to a level of 205 000 cubic metres (similar to the base harvest forecast). The harvest level then increases through decades 16 and 17 to the long-term harvest level, 1 decade earlier than in the base harvest forecast.

The harvest forecast if the initial rate of harvest is set at the steady long-term harvest level is shown by the solid line in Figure 16. The steady long-term harvest level cannot be maintained for the entire 250-year planning horizon. The timber supply shortfalls between decades 19 and 25 occur because during that period insufficient second-growth timber is available to maintain the long-term harvest level. This is due to a lower level of total growing stock during decades 13 through 17, the period in which the transition from harvesting existing old-growth stands to second-growth stands occurs.

The solid line in Figure 17 shows that in order to achieve a non-declining harvest forecast, the initial rate of harvest must be reduced to about 228 000 cubic metres per year, 56% below the current AAC and 8% below the steady long-term harvest level.

5 Timber Supply Sensitivity Analyses

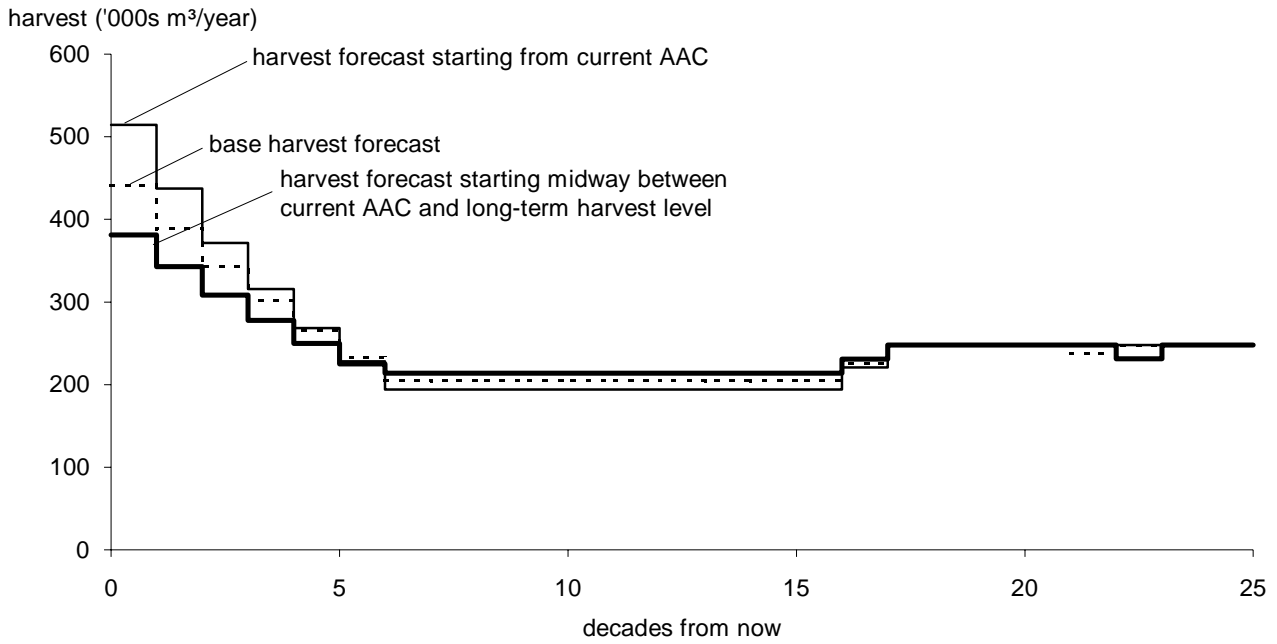


Figure 15. Harvest forecasts with initial harvest levels set at the current AAC and midway between current AAC and the long-term harvest level, Queen Charlotte TSA.

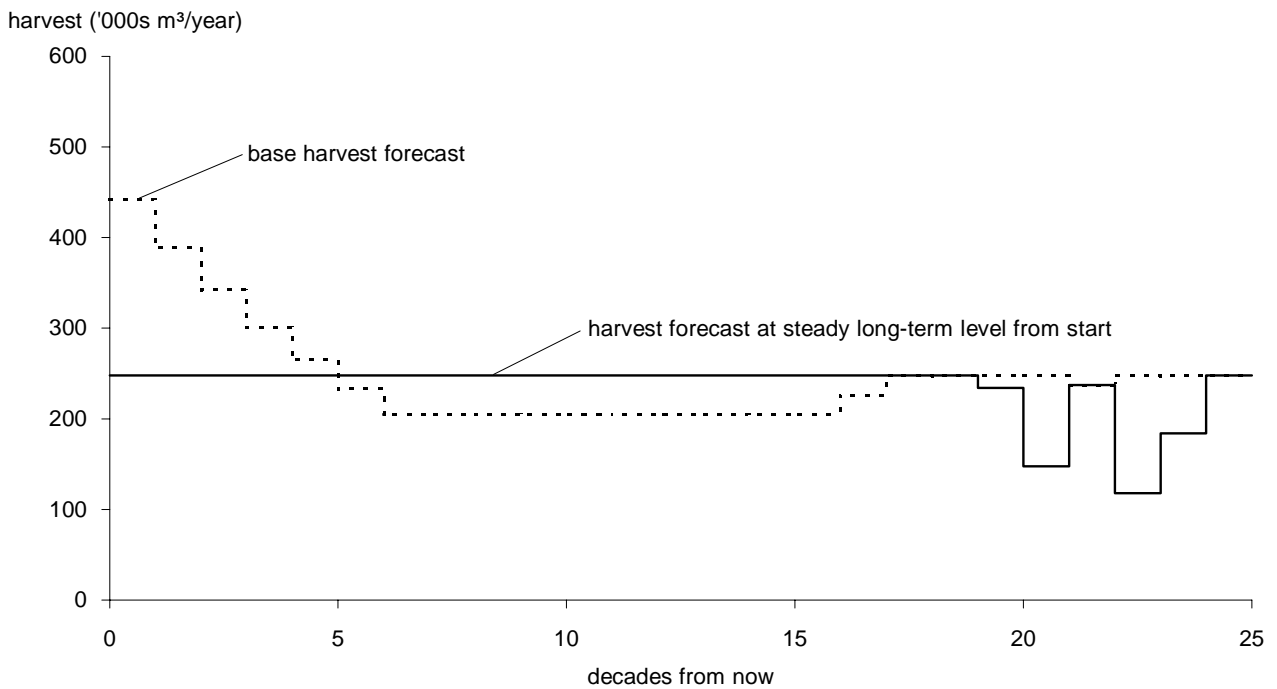


Figure 16. Harvest forecast with the initial rate of harvest set at the steady long-term harvest level, Queen Charlotte TSA.

5 Timber Supply Sensitivity Analyses

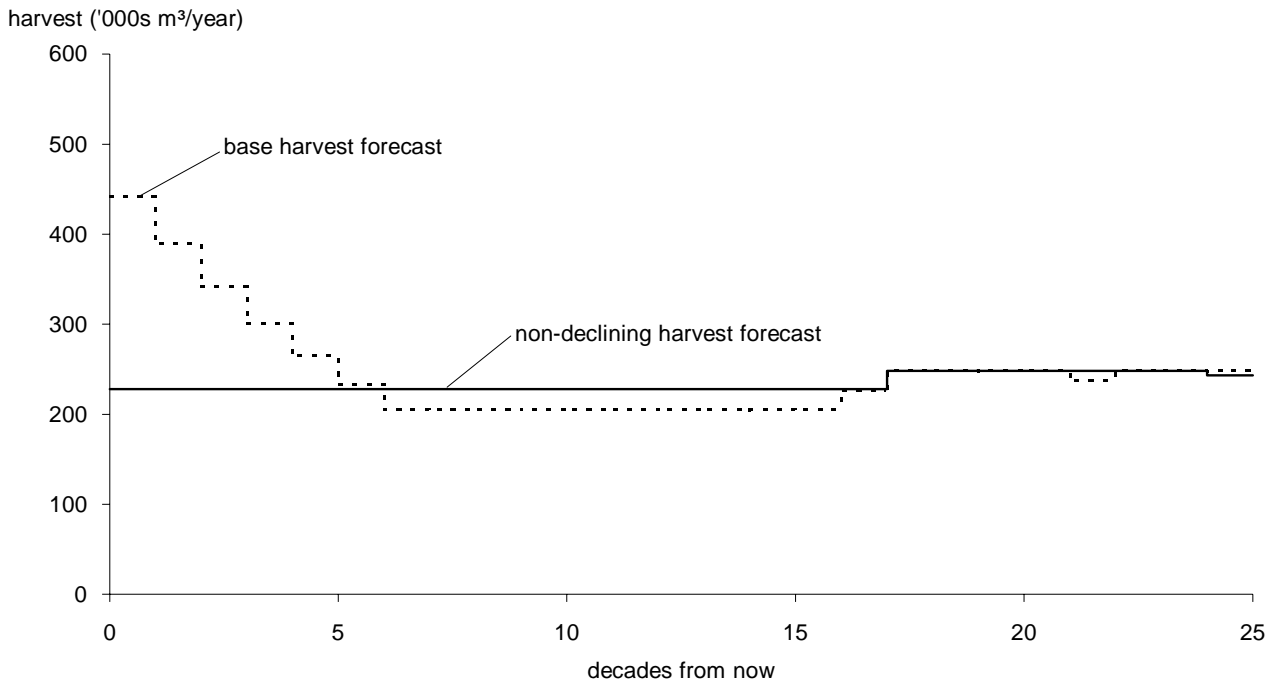


Figure 17. Non-declining harvest forecast, Queen Charlotte TSA.

5.2 Sensitivity to uncertainty in minimum harvestable ages

In the base harvest forecast, minimum harvestable ages were based on the age at which stands reach minimum volume and diameter requirements. Thus, uncertainty in stand yield estimates as well as future market conditions leads to uncertainty about the ages at which stands will be harvested. The minimum harvestable ages for each forest type ranged from a minimum of 100 years up to 150 years. The effects of varying minimum harvestable ages by 10 and 20 years are shown in Figures 18 and 19.

The effect on the harvest forecast if all minimum harvestable ages are 10 years older for all forest types is small, as shown by the thin solid line in Figure 18.

With an increase in minimum harvestable ages, less timber is available from regenerated stands early in the planning horizon. This decrease in the amount of timber available from regenerated stands causes a delay in the rise to the long-term level by 2 decades compared to the base harvest forecast. In addition, the shortfall in decade 22 in the base harvest forecast is avoided.

There is little effect on the harvest forecast if all minimum harvestable ages are 10 years younger (thick solid line Figure 18). It is identical to the base harvest forecast except the lowest harvest level is about 4% higher. While the minor shortfall at decade 22 does not occur there is another shortfall in decade 31 (not shown).

5 Timber Supply Sensitivity Analyses

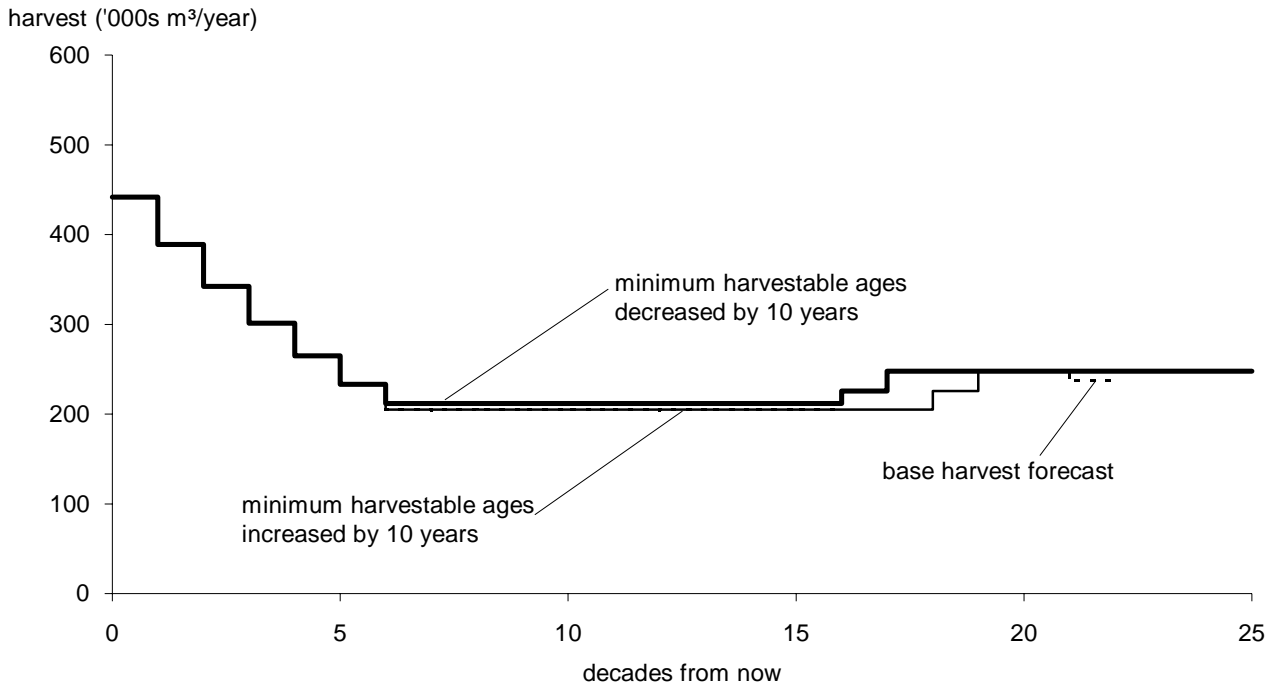


Figure 18. Harvest forecasts with minimum harvestable ages changed by 10 years, Queen Charlotte TSA.

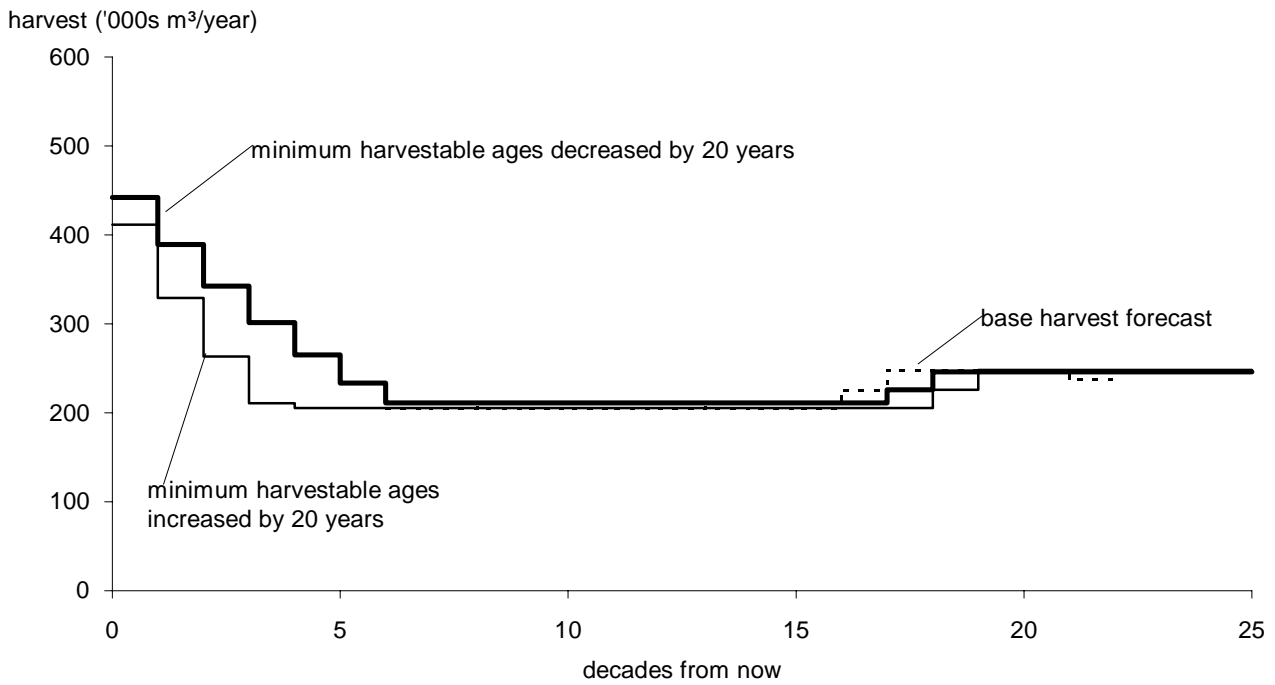


Figure 19. Harvest forecasts with minimum harvestable ages changed by 20 years, Queen Charlotte TSA.

5 Timber Supply Sensitivity Analyses

Varying the minimum harvestable ages by 10 years has no effect on the harvest flow for the first 6 decades because during that period average harvest ages are well above minimum harvestable ages (see Figure 13). In both cases the steady long-term level remains unchanged.

Increasing minimum harvestable ages by 20 years, as shown by the thin solid line in Figure 19, has a significant impact on the harvest forecast. The initial harvest level is about 6% below that of the base harvest forecast (or 20% below current AAC) and then declines 20% per decade for the next 3 decades. In addition, the rise to the long-term level is delayed by 2 decades. Extending the minimum harvestable age results in less timber being above that age and thus less timber available for harvest in the first 6 decades. Also, there will be fewer stands available for harvest during the transition period between older stands and second-growth stands, decades 12 to 20, and more volume must be reserved from earlier periods.

Decreasing minimum harvestable ages by 20 years, as shown by the thick solid line in Figure 19, is similar in effect to decreasing minimum harvestable ages by 10 years but increases the time to reach the long-term harvest level by 1 decade. Also, the long-term harvest level is 1% lower than in the base harvest forecast. This difference is too small to appear in Figure 19. Both of these effects are due mainly to the harvest of regenerated stands before they have reached the age of maximum average growth (culmination age*).

5.3 Sensitivity to uncertainty in green-up periods

The required green-up periods used in the base harvest forecast are the estimated number of years before the trees on a previously harvested area reach a required height. Uncertainty in the required green-up period stems from both the uncertainty in stand height growth rates as well as the subjectivity of

the height requirement before a stand achieves green-up conditions. The following sensitivity analysis examines the effect that uncertainty in the required green-up period has on the harvest forecast.

The thick solid line in Figure 20 shows the harvest forecast if all green-up periods are 10 years shorter. The decrease in the required green-up period increases the availability of areas for timber harvesting over time, mainly in the retention VQO zone. The initial harvest level increases to about 452 600 cubic metres per year; 2% higher than the base harvest forecast but still 12% below the current AAC. The projected harvest level still declines by 12% per decade after the first decade, just as in the base harvest forecast, and the extent of the decline to below the steady long-term level is the same, but a decade later. The steady long-term harvest level is the same as the base harvest forecast but the rise to it occurs a decade later in order to avoid a timber supply shortfall in decade 22.

There is a greater effect on the harvest forecast if all green-up periods are 10 years longer (thin solid line in Figure 20). In the base harvest forecast green-up and adjacency forest cover requirements for the partial retention VQO and integrated resource management zones are not constraining on the rate of harvest. However, increasing the required green-up period constrains the rate of harvest in those zones for the short term. The initial rate of harvest must be reduced to about 432 000 cubic metres per year, 2% lower than in the base harvest forecast and 16% below the current AAC. The rate of decline remains at 16% per decade until decade 6 when the harvest is below the long-term level. In decade 17, the harvest increases to a slightly lower long-term level than the base harvest forecast. Increasing the green-up ages by 10 years has little effect in the long term. The steady long-term harvest level is only about 2% below the long-term level in the base harvest forecast.

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.

5 Timber Supply Sensitivity Analyses

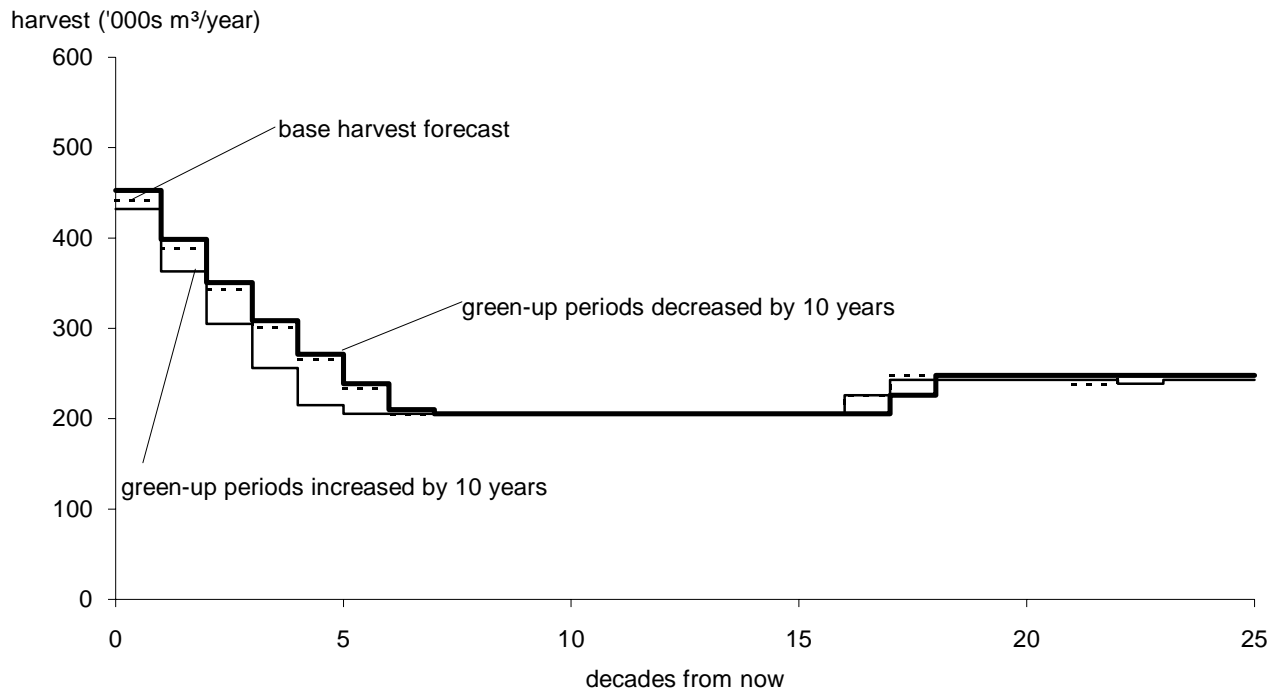


Figure 20. Harvest forecasts with green-up periods changed by 10 years, Queen Charlotte TSA.

Although not shown here, the base harvest forecast is generally less sensitive to changes in green-up ages of 5 years. Decreasing green-up ages by 5 years results in a harvest forecast similar to that for the 10 year decrease — the initial harvest level is 11% below current AAC with 11% per decade declines to below the long-term level with the rise to the long-term harvest level occurring 2 decades later. The harvest forecast in which green-up ages are increased by 5 years is virtually identical to the short term of the base harvest forecast — a 15% initial drop from current AAC, instead of 14%, followed by a 12% per decade rate of decline to below the long-term harvest level. In the long term, there is a 2 decade delay in the rise to the long-term harvest level.

5.4 Sensitivity to cutblock adjacency requirements

In the base harvest forecast, forest cover requirements used to model cutblock adjacency and green-up in the integrated resource management zone were based on the assumption that a maximum of 25% of the timber harvesting land base may be forested with stands less than 5 metres tall at any time (see Sections 2.3, "Management practices" and 2.4, "Management zones"). This requirement is commonly referred to

as a 4-pass harvesting system because it allows 100% of the forest to be harvested over four entries (passes) into the area. This forest cover requirement should be viewed only as an **average** forest cover requirement that applies to areas with no overriding management concerns such as visual quality or wildlife habitat. Site specific forest cover requirements will vary from this average requirement. Uncertainty in the average forest cover requirement used to model cutblock adjacency and green-up in this analysis stems from these site specific variations from the average.

The purpose of this sensitivity analysis is to examine the effect of altering the adjacency forest cover requirements to no more than 20% (5-pass) and 33% (3-pass) of the integrated resource management zone area to be forested by stands below the green-up height (5 metres). The old-growth/biodiversity forest cover guidelines are unchanged.

This forest cover requirement was not a limiting factor in the base harvest forecast; the area of the integrated resource management zone forested with stands less than 5 metres in height never exceeded 18% of the total area of the zone throughout the harvest forecast.

5 Timber Supply Sensitivity Analyses

As a result, the harvest forecast was not changed by relaxing the forest cover requirement to allow more of the area (33%) to be covered with stands less than 5 metres tall, or tightening the requirement to no more than 20%.

5.5 Sensitivity to green-up forest cover requirements

Forest cover requirements in the base harvest forecast have some uncertainty because it is not possible to define the exact forest structure needed to meet the management objectives for a particular area. For this sensitivity analysis the old-growth/biodiversity forest cover requirements are left unchanged and the green-up forest cover requirements changed by 5% across all zones concurrently.

The thin solid line in Figure 21 shows the harvest forecast if all the forest cover requirements are relaxed so that an additional 5% of each area may be younger than green-up age at any time. The initial rate of harvest of about 452 600 cubic metres per year is only about 2% higher than in the base harvest forecast. However, the rise to the long-term level occurs a decade later. The increased availability of areas for timber harvesting over the short term is limited mainly to the relaxing of forest cover

constraints in the retention VQO zone. The partial retention VQO or integrated resource management zones are not constraining throughout the harvest forecast. Note that this is a similar situation (and identical harvest forecast) as in Section 5.3, "Sensitivity to uncertainty in green-up periods", in which green-up ages were decreased by 10 years.

The thick solid line in Figure 21 shows the harvest forecast if all forest cover requirements are tightened so that 5% less of an area may be younger than green-up age at any time. The initial rate of harvest is unchanged from the base harvest forecast at 14% below current AAC. However, the harvest level declines at a faster rate (14% instead of 12% per decade) to a level below the long-term level. This level is 3% below the base harvest forecast. In addition, the rise to a slightly lower long-term harvest level occurs 1 decade later than the base harvest forecast. The steady long-term level of about 239 000 cubic metres per year is 4% lower than in the base harvest forecast. The decreased amount of timber harvested in the retention VQO areas causes increased volumes to be taken from the other 2 zones. In order to avoid a timber shortfall in the future, the long-term timber harvesting level must decrease.

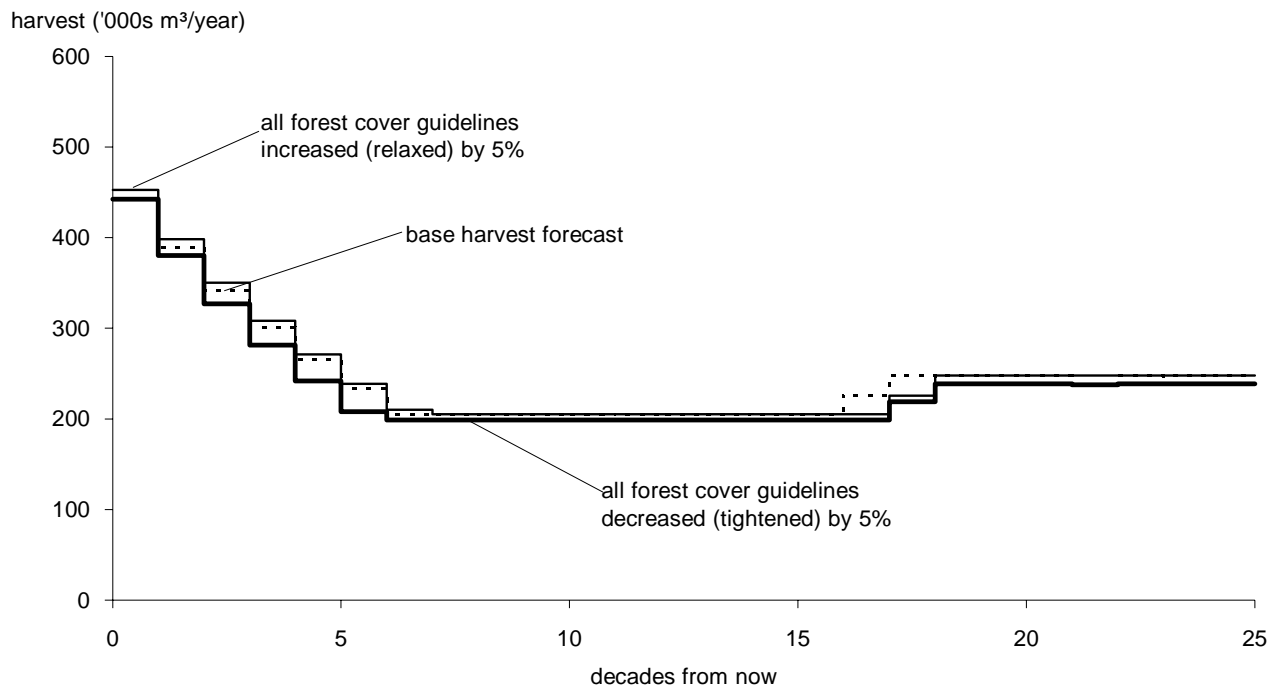


Figure 21. Harvest forecasts with forest cover requirements changed by 5 years, Queen Charlotte TSA.

5 Timber Supply Sensitivity Analyses

5.6 Sensitivity to the old-growth cover requirement

Concern for biodiversity has resulted in a desire to maintain at least 6% of the forests of the timber harvesting land base at an age older than 150 years. This requirement was based on preliminary B.C. Forest Service studies of the size of Forest Ecosystem Networks* needed to satisfy the draft Coastal Biodiversity Guidelines. Given this uncertainty, this sensitivity analysis examines the effect of changing the old-growth forest cover requirement on the base harvest forecast.

Figure 22 shows harvest forecasts for three different old-growth requirements: 0% (no requirement), 4% and 8% of the forests of the timber harvesting land base must be maintained at ages older than 150 years. The harvest forecast for an 8% forest cover requirement (long dashed line, Figure 22) is nearly identical to the base harvest forecast except the rise to the long-term level is delayed by 2 decades and the timber supply shortfall does not occur in decade 22. While the short-term harvest level is not impacted, a long-term harvest shortfall is avoided by extending the period below the long-term harvest level.

Forest Ecosystems Networks

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.

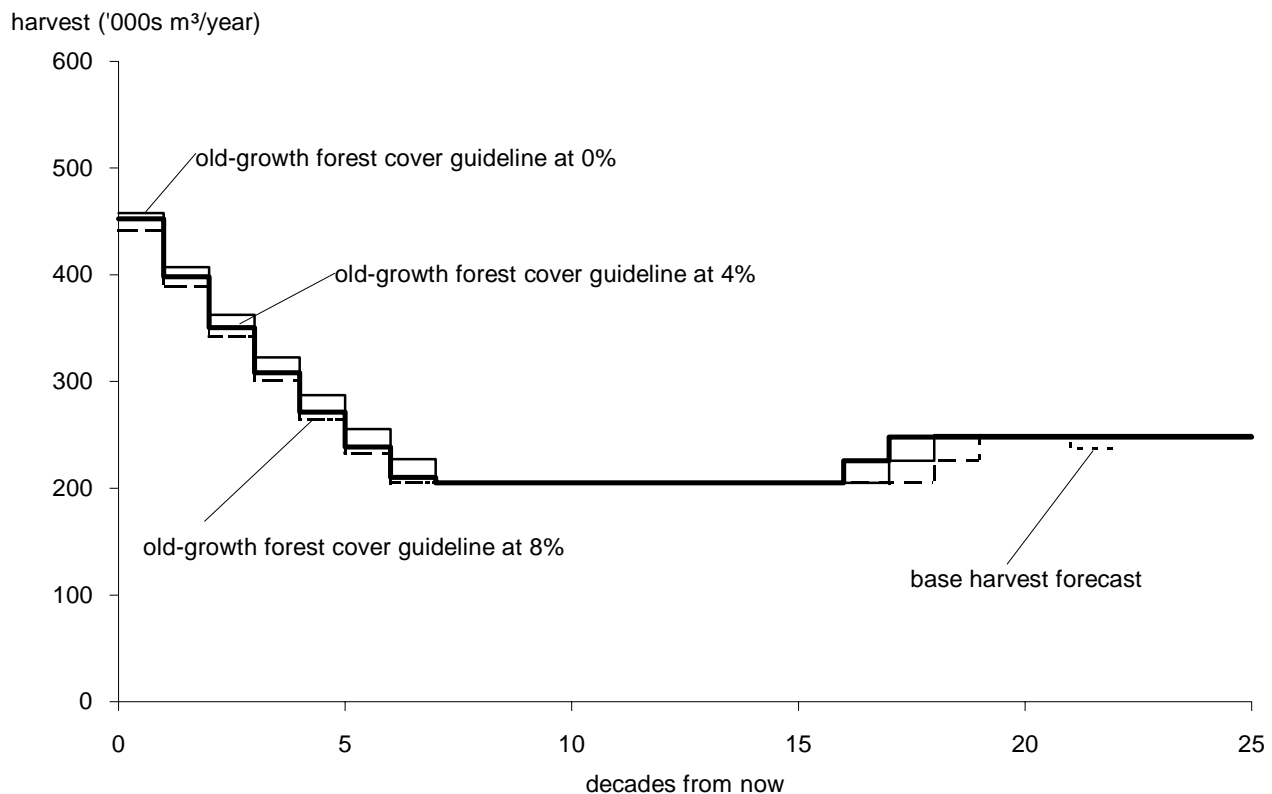


Figure 22. Harvest forecasts with changes to the old-growth/biodiversity requirement, Queen Charlotte TSA.

5 Timber Supply Sensitivity Analyses

The thin solid line in Figure 22 shows the effect of essentially removing the forest cover requirement by setting it to 0%. This allows a slightly higher initial harvesting rate (only 11% below the current AAC) than in the base harvest forecast, followed by 11% per decade declines and a 1 decade delay in the rise to the long-term level. The more constraining 4% old-growth forest cover requirement (thick solid line, Figure 22) starts at 12% below current AAC and declines at a rate of 12% per decade thereafter, rising to the long-term level at the same time as the base harvest forecast. In both instances, the minor shortfall, seen in the base harvest forecast, does not occur in decade 22.

5.7 Sensitivity to removing all forest cover requirements

The following sensitivity analysis examines the effect on the harvest forecast of removing all forest cover requirements for management of visually sensitive areas, cutblock adjacency and green-up and maintenance of old-growth/biodiversity. The solid

line in Figure 23 shows the harvest forecast with all forest cover requirements removed. The initial rate of harvest is about 457 800 cubic metres per year, or 11% below the current AAC and 3% higher than the base harvest forecast. After the first decade, the rate of harvest declines by about 11% per decade to below the long-term level 1 decade later than in the base harvest forecast. The forecast then follows the base harvest forecast very closely for the remainder of the planning horizon — decreasing to below the long-term level, about 2% above that of the base harvest forecast. It then increases to a long-term level less than 1% above the base harvest forecast. This increase in the short-term harvest forecast is due largely to the removal of the forest cover requirements for the retention visual quality zone and removal of the requirement to maintain old-growth. Removing the forest cover requirements makes more areas available for harvest in the short term, whereas there is virtually no change in the long-term level indicating that it is affected little by the requirements.

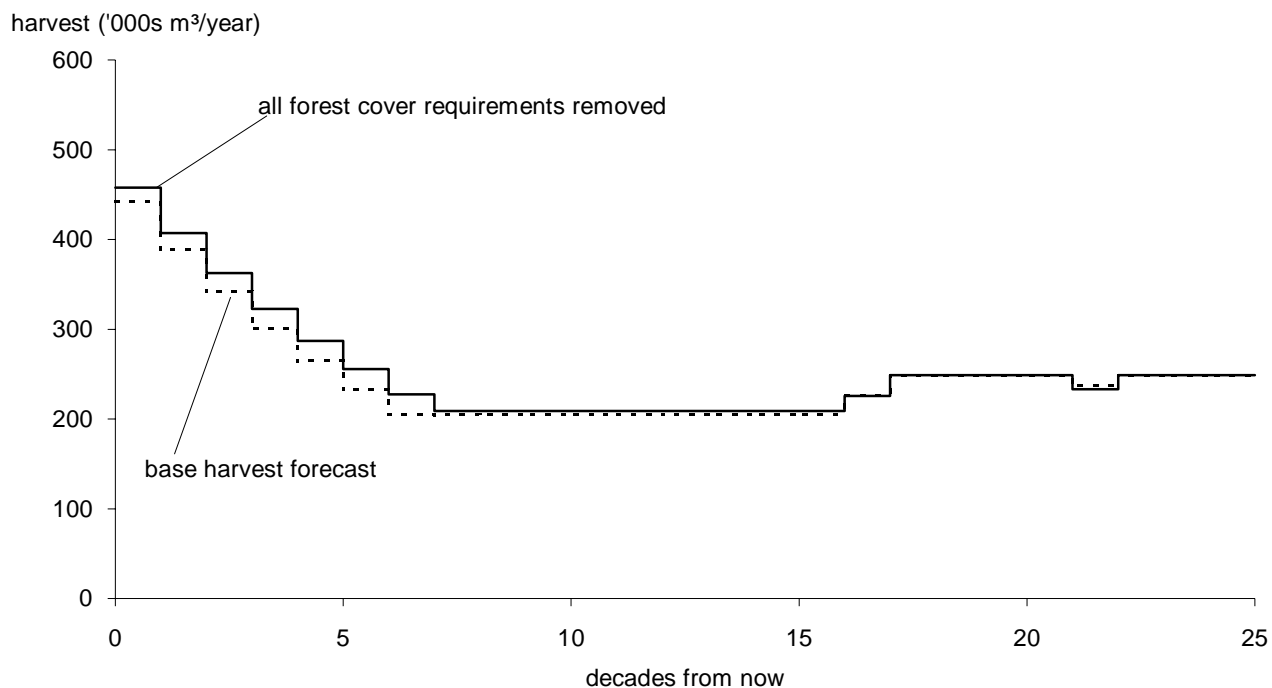


Figure 23. Harvest forecast with all forest cover requirements removed, Queen Charlotte TSA.

5 Timber Supply Sensitivity Analyses

5.8 Sensitivity to uncertainty in existing stand yield estimates

Timber yield estimates have a degree of uncertainty due to such factors as the statistical process used to develop growth and yield models, uncertainty in the forest inventory, and changing timber utilization standards. The following sensitivity analyses examine the effect on the harvest forecast of uncertainty in the volume of timber that currently exists on the timber harvesting land base.

The thin solid line in Figure 24 shows the effect on the harvest forecast if the estimated timber yields from existing stands are 10% greater. This change allows an increase in the short-term harvest forecast, as might be expected. Note that changing existing stand yield estimates do not affect the long-term harvest level because volume estimates for regenerated stands are not changed. If a decline to below the long-term level is accepted, as in the base harvest forecast, the increase in existing available timber is evident as an increased short-term harvest level. The current AAC (about 514 000 cubic metres per year) can be harvested for the first decade followed by 11% per decade declines to below the long-term level at decade 9. This series of declines takes 2 decades longer than in the base harvest forecast. In the long term, this harvest forecast is identical to the base harvest forecast except that the minor shortfall in decade 22 does not occur. Although not shown, an alternative harvest forecast follows the base harvest forecast for the first

6 decades, then declines to a lower level of about 226 000 cubic metres per year instead of 205 000 cubic metres per year for the base harvest forecast. Then in decades 13, 5 decades sooner than the base case it rises to the long-term harvest level of 248 000 cubic metres per year. In this case, the increase in available timber is indicated by a decrease in both the amount and duration the harvest forecast falls below the long-term level.

The thick solid line in Figure 24 shows the harvest forecast if the estimated timber yields from existing stands are 10% less. This change has a direct effect on the short-term harvest forecast simply because of the direct reduction in the existing mature inventory of timber that is ready for harvest. In addition, reducing the volume of timber per hectare harvested requires more forest area to be harvested in order to achieve a given harvest level than would be required using the base harvest forecast yield estimates. Thus, the second-growth stands are harvested earlier and any attempt to reach the long-term level earlier results in harvest shortfalls later in the planning horizon. The initial rate of harvest is 14% lower than in the base harvest forecast (28% lower than the current AAC). The harvest rate must then decline to below the long-term level by 15% per decade. It then rises to the long-term level in decades 17 and 18, the same as the base harvest forecast. The harvest level below the long-term level is about 6% lower than the base harvest forecast and the steady long-term harvest level is unchanged.

5 Timber Supply Sensitivity Analyses

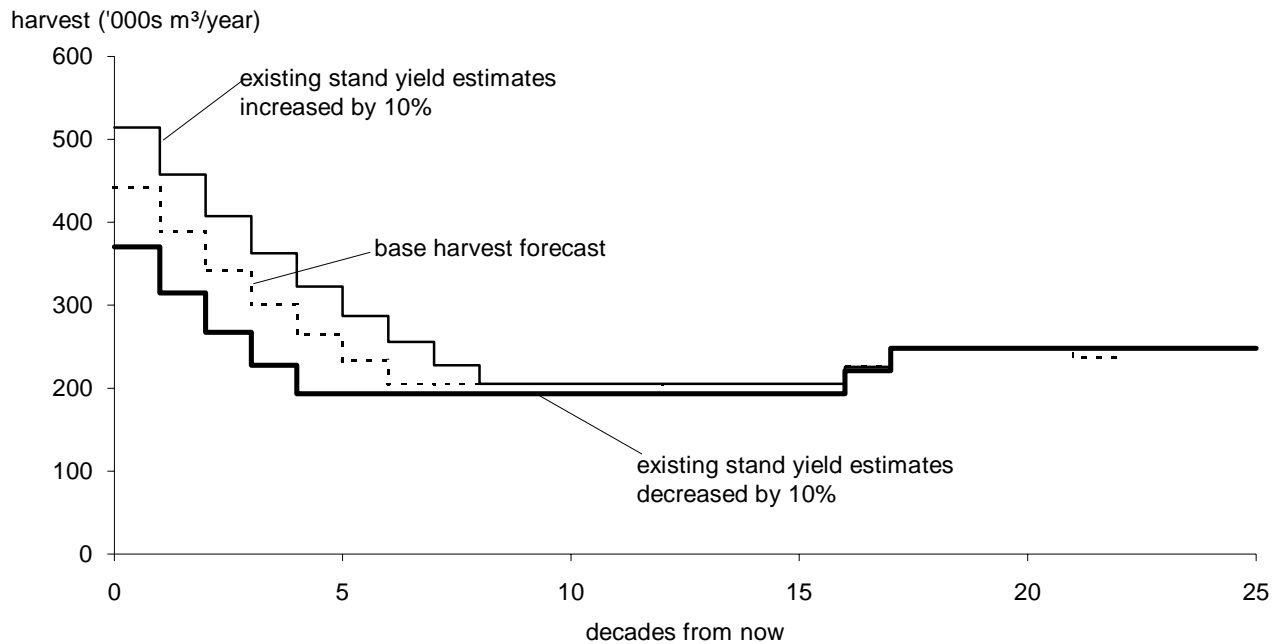


Figure 24. Harvest forecasts with existing stand yield estimates changed by 10%, Queen Charlotte TSA.

Figure 25 shows the harvest flow if the estimated timber yields from existing stands are 20% greater (thin solid line). The initial harvest level at the current AAC (about 514 000 cubic metres per year) is held for 1 decade after which the harvest level drops 12% each decade to the long-term harvest level of about 248 000 cubic metres per year. Note that, due to the availability of timber for harvest, the short-term harvest forecast does not decline below the long-term level at any time in the harvest forecast. Two alternatives are presented in Figure 25 if timber yields from existing stands are decreased by 20%. The first alternative, the long dashed line of Figure 25, shows a starting harvest level of about 411 000 cubic metres per year (6% below the base harvest forecast), followed by 15% per decade declines for 6 decades to a lower level of 160 000 cubic metres per year (instead of about 205 000 cubic metres per year for the base forecast).

It then rises in decades 17 and 18 to the long-term harvest level. The thick solid line in Figure 25 shows the second alternative in which a steady, non-declining harvest forecast starts at 180 000 cubic metres and rises to the long-term harvest level in decades 18 and 19. This forecast has a relatively minor shortfall in decade 25.

An additional alternative was examined for both of the previous sensitivities (existing stand yield estimates altered 10% and 20%) in which minimum harvestable ages were decreased by 10 years in order to see if any timber supply shortfall in the short term could be made up by earlier harvesting of second-growth (regenerated) stands. Decreasing minimum harvestable ages had no effect on the harvest forecasts described previously. This was due mainly to the fact that average harvest ages are relatively high throughout the short term when changes in existing yields have their greatest effect.

5 Timber Supply Sensitivity Analyses

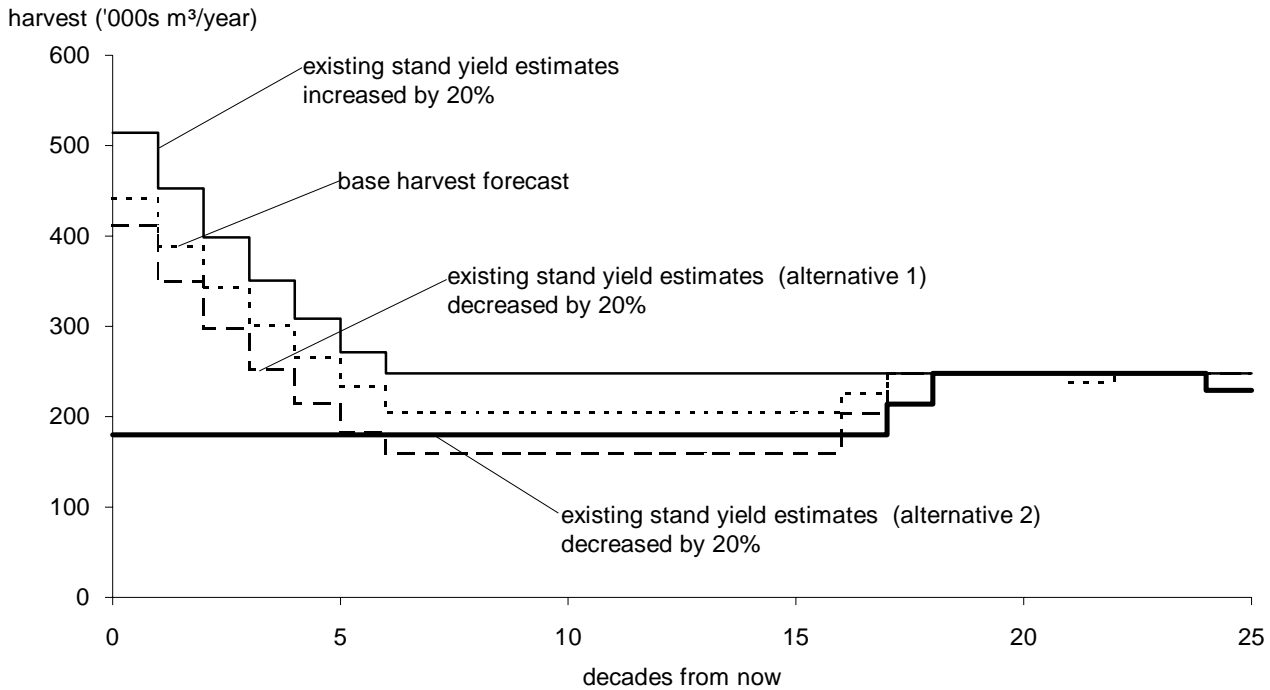


Figure 25. Harvest forecasts with existing stand yield estimates changed by 20%, Queen Charlotte TSA.

5.9 Sensitivity to uncertainty in regenerated stand yield estimates

Uncertainty in regenerated stand yield estimates is due to numerous factors such as using inventory data from existing mature forests to predict the growth and yield of future regenerated stands, uncertainty about the effect of replacing existing forests with different tree species after harvesting, and the effects of soil degradation, forest insects and disease on future forest productivity.

The following sensitivity analyses examine the effect that uncertainty in the estimated yields from regenerated stands has on the harvest forecast.

The thin solid line in Figure 26 shows the effect on the base harvest forecast if estimated timber yields from all regenerated stands are 20% greater. The short-term harvest forecast shows no impact as the increased yields do not apply to most of the existing (older age class) stands harvested during that time. In general, increased yields from regenerated

(second-growth) stands do not show their effect until about decade 18 when the last of the older stands have been harvested. Thus, in the long term, when virtually all harvesting occurs in regenerated stands, the harvest level is increased from the base case by about 21% to nearly 300 000 cubic metres per year.

The thick solid line in Figure 26 shows the effect on the harvest forecast of decreasing all regenerated stand timber yield estimates by 20%. While this change affects mainly the steady long-term harvest level, which is reduced by about 21% from the base harvest forecast, a slight upward effect on the short-term level is evident. The initial harvest level is 2% higher than in the base harvest forecast starting at 12% below current AAC followed by 12% declines per decade as in the base forecast. This slight gain in volume available in the short term is due to the harvest forecast dropping to and remaining at a steady long-term level. This level is slightly lower than the base harvest forecast in decades 8 through 16 and therefore less timber must be reserved to avoid a future shortfall.

5 Timber Supply Sensitivity Analyses

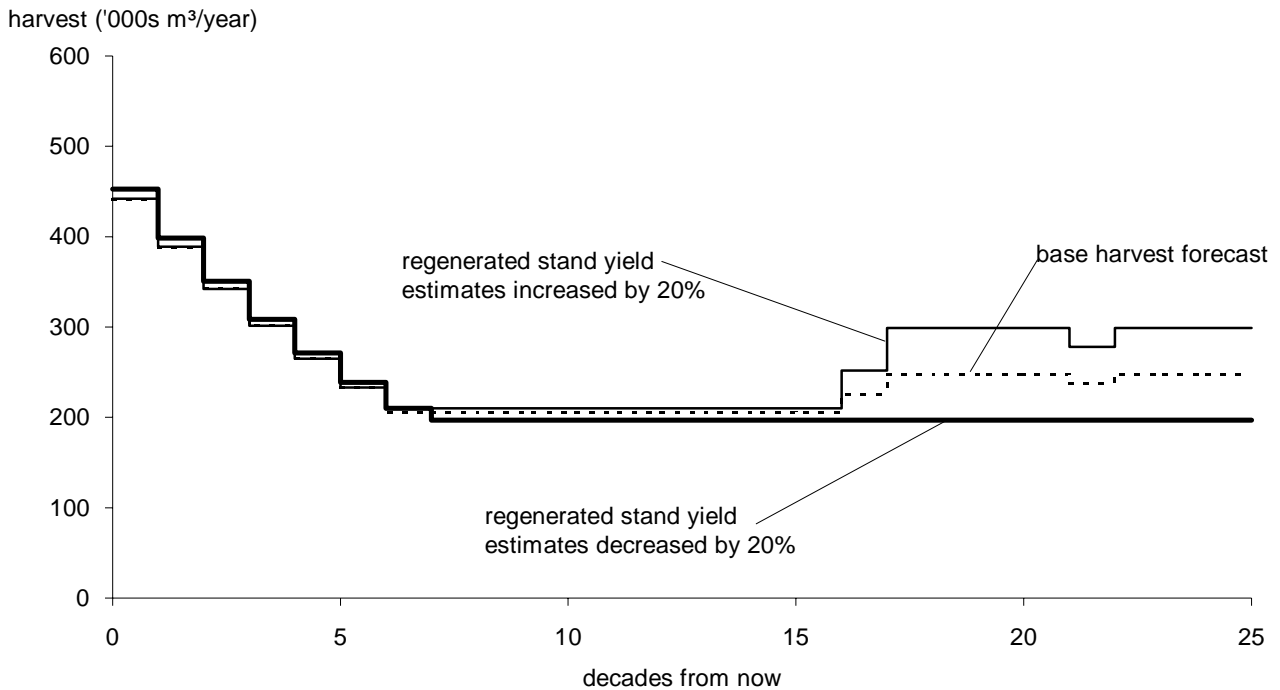


Figure 26. Harvest forecasts with regenerated stand yield estimates changed by 20%. Queen Charlotte TSA.

A second alternative was examined to see if lower minimum harvestable ages would allow some increase in harvest levels in earlier decades. The thin solid line in Figure 27 shows the effect on the harvest forecast of increasing regenerated yield estimates 20% and decreasing minimum harvestable ages by 10 years. There is no change in the short-term harvest level. It is identical to the harvest forecast with only yield estimates increased (thin solid line in Figure 26) — which is identical to the short term of the base harvest forecast. However, in the long term, the harvest level achieved in decades 6 through 16 is 4% higher than in the case of increasing yield estimates alone (Figure 26). Also, the steady long-term harvest level is about 1% lower and does not have the harvest shortfall at decade 22.

The thick solid line in Figure 27 shows the effect of both decreasing regenerated yield estimates by

20% and decreasing minimum harvestable ages by 10 years. The initial harvest level is 11% below current AAC and declines 11% per decade to a steady long-term level of about 194 000 cubic metres per year in decade 9. In the case where only yield estimates are reduced by 20% (the thick solid line in Figure 26), the starting harvest level is 12% below current AAC and declines 12% per decade before reaching the long-term harvest level of about 197 000 cubic metres per year. This level is 2% higher than the long-term level of the harvest forecast with both decreased minimum harvestable ages and regeneration yield estimates. These results are somewhat counter-intuitive in that lower harvest levels in the future permit slightly higher harvest levels now. The reason this happens is that less timber needs to be reserved from the short term to avoid future supply shortfalls.

5 Timber Supply Sensitivity Analyses

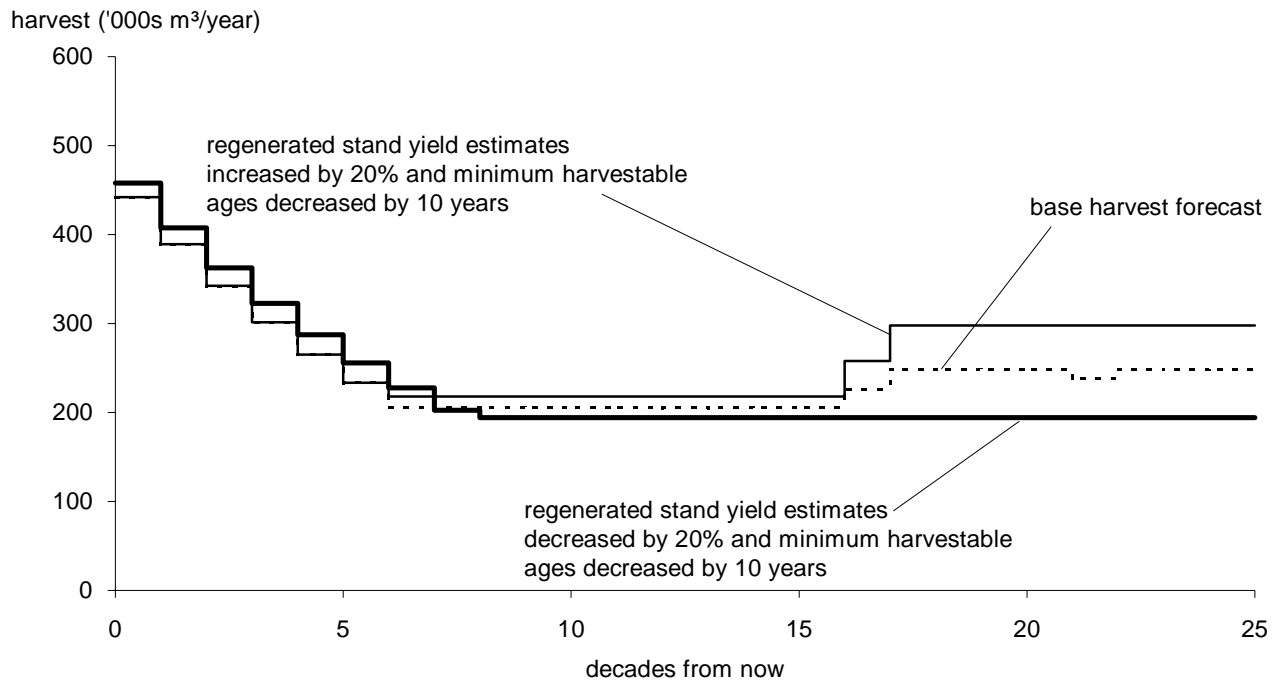


Figure 27. Harvest forecasts with regenerated stand yield estimates changed by 20% and minimum harvestable ages decreased by 10 years, Queen Charlotte TSA.

Although not shown here, changing regenerated stand volume estimates by 10% has no effect in the short term. However, when regenerated stand volume estimates are increased by 10%, the long-term harvest level increases about 10% starting in decade 17. When regenerated stand yields are decreased by 10%, the long-term harvest level decreases by 11% starting in decade 22.

5.10 Sensitivity to changes in the area of the timber harvesting land base

The area that is assumed to be suitable and available for timber harvesting is one of the primary inputs into a timber supply analysis. In the Queen Charlotte TSA, the timber harvesting land base could be larger or smaller than expected if any of the areas contributing to reductions or additions listed in Table 1 are different. There are a number of reasons that these areas could be different from what is expected. For example, the timber harvesting land base could be increased by improved timber harvesting techniques and equipment, or as a result

of increases in the value of currently unmerchantable forest types.

Conversely, the timber harvesting land base could be smaller than expected if, for example, harvesting costs increased, reducing the economic feasibility of harvest operations, or if guidelines to protect sensitive soils are inadequate in meeting their objectives, and additional protection is necessary. The following sensitivity analysis examines the effects on the harvest forecast of the uncertainty associated with the size of the timber harvesting land base.

The harvest forecast associated with a timber harvesting land base which is 20% larger (across all forest management zones) is shown by the thin solid line in Figure 28. The initial harvest rate is at the current AAC (about 514 000 cubic metres per year) and the rate of decline in the harvest forecast is 10% per decade to a level of about 246 000 cubic metres per year in decade 8. The harvest forecast then rises in decade 17 to a steady long-term level of about 298 000 cubic metres, 20% higher than in the base harvest forecast. A timber supply shortfall, slightly larger than in the base harvest forecast, also occurs at decade 22.

5 Timber Supply Sensitivity Analyses

The thick solid line in Figure 28 shows the effect on the harvest forecast of a timber harvesting land base which 20% smaller. The starting harvest level is 20% below the current AAC (6% below the base harvest forecast) and then declines by 15% per decade to below the long-term level in decade 7. From this low level of about 158 000 cubic metres per year, 23% below the corresponding period of the base harvest forecast, the harvest level rises in decade 18 to a steady long-term level 21% below that of the base harvest forecast.

Although not shown, changing the area of the timber harvesting land base by 10% had similar

effects on both the short- and long-term harvest forecasts. A 10% larger land base allows a starting harvest forecast of 10% below current AAC, with 10% declines per decade and eventually an increase to a long-term level about 10% above that of the base harvest forecast. Similarly, a 10% smaller land base allows the same initial harvest level (14% below current AAC) as the base harvest forecast. However, this is followed by 14% declines to a level below the long-term harvest. Beginning in decade 18 the harvest level increases to a steady long-term level of about 233 000 cubic metres per year, 11% below the base harvest long-term level.

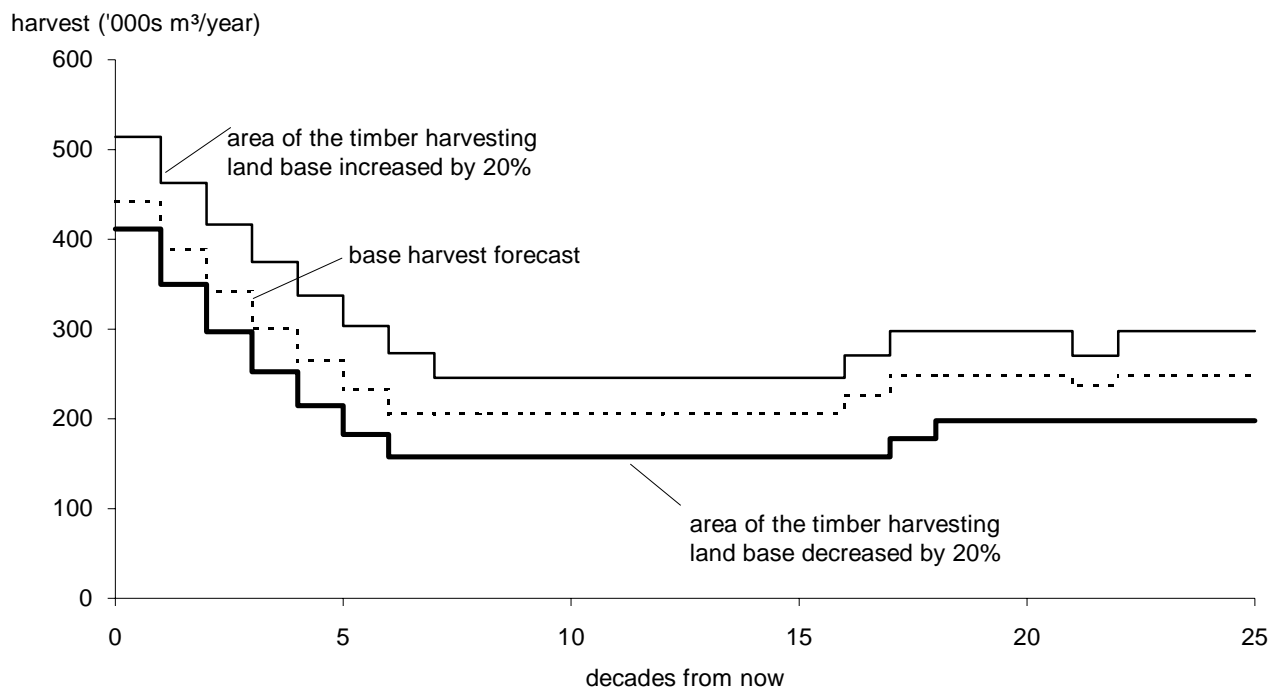


Figure 28. Harvest forecasts with the area of the timber harvesting land base changed by 20%, Queen Charlotte TSA.

6 Summary and Conclusions

The base harvest forecast presented in this analysis indicates that maintaining the current timber harvesting levels in the Queen Charlotte TSA, even for 1 more decade, will cause a shortfall in the timber supply in the future. Given current management assumptions, an initial harvest of 442 000 cubic metres per year (14% below the current AAC of 514 335 cubic metres per year) can be maintained for 1 decade. After the first decade, the harvest level declines 12% per decade until decade 7. From decade 7 through 16 it is 205 000 cubic metres per year; in decades 17-18 it reaches the long-term level of 248 000 cubic metres per year. The long-term level is slightly under half the current AAC. It was not possible, under current management assumptions, to forecast a harvest level that does not fall below the long-term harvest level. Any forecast without this decline results in an acute shortage of available timber in the future.

Attempts to reduce the amount by which the harvest falls below the long-term level shown in the base forecast result in a harvest forecast that starts below the long-term level at 228 000 cubic metres per year and increases to the long-term level of 248 000 cubic metres per year in decade 18.

Several factors contribute to the decline in the timber supply forecast. The most important factor is that the base harvest forecast is well above the steady, long-term harvest level. In this situation harvest rates must decline towards the long-term level to avoid serious timber supply shortfalls in the future. Also contributing to the decline in timber supply, to some extent, are forest cover requirements for forest resources such as biodiversity and scenic values.

However, it is important to note that even if these forest cover requirements are removed, the harvest forecast still shows a decline in the near future. An additional contributing factor is that existing forests are dominated by older stands on poor growing sites yielding lower than average volumes of timber.

This analysis employs the best current estimates for all variables used to describe forest management in the Queen Charlotte TSA. Nevertheless, varying degrees of uncertainty surround most of the estimates. The results of sensitivity analysis indicate that the short-term harvest forecast could be increased from the base harvest forecast by relaxing all forest cover requirements or removing them completely. However, the improvements were generally small and the initial harvest levels were still well below the current AAC. Sensitivity analyses also show that even when assuming a 20% increase in the timber harvesting land base or existing stand yield estimates, the current AAC could only be maintained for 1 decade before declining if more severe timber shortfalls are to be avoided in the future.

The short-term timber supply is particularly sensitive to changes in the existing timber harvesting land base and yield estimates for existing stands. Harvest levels over this period are also moderately sensitive to longer green-up periods and older minimum harvestable ages.

The long-term harvest level is highly sensitive to changes in yield estimates of regenerated stands and changes in the area of the timber harvesting land base and also moderately affected by changes in existing stand yield estimates.

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 <i>Section 7</i> of the <i>Forest Act</i> .
Biodiversity (biological diversity)	Diversity of life in all its forms and levels of organization, including genes, species, ecosystems and the evolutionary and functional processes that link them.
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	Integrated management guidelines that specify the desired spatial relationship among cutblocks. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements. The objective is to ensure recently harvested areas are not adjacent to each other.
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 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 ecosystems networks	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.
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.

8 Glossary

Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
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.
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 stand age at which the MAI assumes its maximum value is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Not satisfactorily restocked	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the 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.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see visual quality objective)
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity. (see visual quality objective)
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.

8 Glossary

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 reducing the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with <i>Section 6</i> of the <i>Forest Act</i> .
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.

Appendix A

Data 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 data set for the timber supply analysis of the Queen Charlotte TSA. The information represents current forest management in the area. Current forest management can be defined as the set of land-use decisions and forest and stand management practices that are currently implemented and enforced. Forest management practices and land-use decisions that may be intended for the future, but are not currently implemented and enforced, have not been included.

A.1 Zone and Analysis Unit Definition

A.1.1 Definition of management zones

For the purpose of the timber supply analysis, the timber harvesting land base is broken down into units with similar forest management concerns. These units are referred to throughout this appendix as zones. The purpose of dividing the timber harvesting land base into zones is to facilitate modelling of the forest management concerns specific to each zone (i.e. concerns about visual quality of the landscape). The three mutually exclusive zones used in the timber supply analysis for the Queen Charlotte TSA are listed below:

Zone 1 is the retention Visual Quality Objective (VQO) zone — areas of high landscape value such as forested slopes facing viewpoint and recreational use areas, mainly along waterways in the Queen Charlotte Islands. Forest management activities may be present but not visually apparent in this zone.

Zone 2 is the partial retention Visual Quality Objective (VQO) zone — areas of moderate landscape value, generally forest management activities match the landscape character and are noticeable but not intrusive.

Zone 3 is the integrated resource management zone — this zone includes all areas that are not assigned to the zones listed above, and as such, represents the balance of the timber harvesting land base. The emphasis in this zone is timber harvesting with a management regime that integrates all resource values.

Table A-1. lists the gross area in hectares in each of the zones by operability class. The distribution of Zone 1 (retention VQO) and Zone 2 (partial retention VQO) areas throughout the various operability categories is derived from a 1993 district VQO study. Zone 3 (IRM) is the residual area after areas have been assigned to the two VQO zones. Proportional area multipliers were calculated based on the numbers in Table A-1. and then multiplied by the area of each polygon in the inventory file, by operability class, to apportion it across each zone. Operability class is recorded in the inventory file using the 'plancell' variable (see Section A.2.10. "Inoperable areas" for a description of the operability classes).

A.1 Zone and Analysis Unit Definition

Table A-1. Distribution of gross hectares in each zone by operability class

Operability class	Zone 1 (R-VQO)	Zone 2 (PR-VQO)	Zone 3 (IRM)	Total area (ha)
O111	5 283	9 874	52 768	67 925
O112	37	318	912	1 267
H112	281	1 245	6 300	7 826
O012	41	1 567	9 539	11 147
H012	0	894	1 937	2 831
I131	10 644	11 511	32 277	54 432
I132	5 107	15 711	68 740	89 558
I133	4 040	22 187	160 858	187 085
I134	398	3 896	16 567	20 861
Total area (ha)	25 831	67 203	349 898	442 932*

* entire TSA less operability classes E000 (excluded, parks etc.), W000 (water), Z999 (unassigned)

A.1.2 Analysis unit definition

Within each forest management zone, the area was divided into analysis units, based on leading tree species and site class, as shown in Table A-2. Separate yield curves (existing and regenerated) were produced for each analysis unit, and are shown in Table A-13. For the Queen Charlotte TSA analysis site groups were assigned using new site class 'nsite' or, where available, special site class 'ssite' values from the inventory file. Special site is a field-corrected site class that can be assigned when the normal site class does not accurately reflect site quality. The analysis units used, and the inventory file variables used to define them are shown in Table A-2.

Table A-2. Analysis unit definition

Analysis unit	Inventory type group	Site class
1 Spruce	21 - 26	all sites
2 Hemlock	12 - 17	good, medium
3 Hemlock	12 - 17	poor
4 Cedar	9 - 11	good, medium
5 Cedar	9 - 11	poor

A.1 Zone and Analysis Unit Definition

Table A-3. summarizes the area in the current timber harvesting land base by zone/analysis unit combinations. Note that not satisfactorily restocked (NSR) areas and timber licence reversions are subsequently added to give the total current timber harvesting land base.

Table A-3. Area by zone and analysis unit

Analysis unit	Zone 1 (R-VQO)	Zone 2 (PR-VQO)	Zone 3 (IRM)	Total area (hectares)
1 Sitka Spruce (GMP)	937	1 897	9 375	12 209
2 Hemlock (GM)	778	1 496	7 898	10 172
3 Hemlock (P)	1 463	3 082	14 749	19 294
4 Cedar (GM)	102	190	866	1 158
5 Cedar (P)	1 156	2 380	13 254	16 790
Total area (ha)	4 436	9 045	46 142	59 623

A.2 Definition of the Timber Harvesting Land Base

The timber harvesting land base was determined by first deducting from the total TSA area, all areas considered to be currently unavailable for timber production. All NSR area on the inventory file was also removed at this stage as a first step in updating the NSR figure. The NSR is then added back to establish the current timber harvesting land base. Harvesting operations will subsequently result in the removal of some of the initial area because of road construction and other long-term productivity losses. All these categories are summarized in Table 1 of the main report.

A.2.1 Non-Crown land

Non-Crown land is all land that is not administered or managed by the B.C. Forest Service and includes such categories as provincial parks, Indian reserves and areas under federal jurisdiction. This area, which is identified on the inventory file as Ownership Code not equal to 61 C, 62 C or 69 C, is excluded from the land base.

A.2.2 Non-forest land

Non-forest land includes lakes, swamps, mountains and alpine forest and is classified on the inventory file as 'type identity' code 6. These areas are completely removed from the land base.

A.2.3 Non-commercial cover

Areas with non-commercial cover (brush) were excluded. They are identified on the inventory file as 'type identity' code 5.

A.2.4 Problem forest types

This area consists of poor timber quality or low timber volume that cannot be economically harvested as sawlogs. This includes forest with low site index ('nsite' = L), and all pine ('type group' = 27-32) and alder ('type group' = 37-38) leading species stands. All problem forest types are excluded from the harvesting land base in this analysis.

A.2 Definition of the Timber Harvesting Land Base

A.2.5 Stream management areas

The distribution of gross area by operability class and zone for streamside management areas is shown in Table A-4. These exclusions are based on a district study that set aside forested streamside buffers (40 metres in width, i.e. 20 metres either side of the stream). These buffer areas are not available for timber harvesting.

Table A-4. Area by operability class and zone set aside for streamside management areas

Operability class	Zone 1 (R-VQO)	Zone 2 (PR-VQO)	Zone 3 (IRM)	Total area (ha)
O111	0	0	1 226	1 226
O112	0	0	38	38
H112	0	0	50	50
O012	0	0	129	129
H012	0	0	53	53
I131	194	0	469	663
I132	0	0	610	610
I133	0	0	418	418
I134	0	0	284	284
Total area (ha)	194	0	3 277	3 471

A.2.6 Preservation VQO areas

These are relatively small areas in which landscape values are the prime consideration and outweigh other natural resource values. Table A-5. shows the gross area excluded by operability class and zone. Preservation VQO areas are assigned to the IRM zone in its capacity as residual area after retention and partial retention areas are removed.

Table A-5. Area by operability class and zone set aside for preservation VQO areas

Operability class	Zone 1 (R-VQO)	Zone 2 (PR-VQO)	Zone 3 (IRM)	Total area (ha)
O111	0	0	324	324
O112	0	0	0	0
H112	0	0	0	0
O012	0	0	0	0
H012	0	0	0	0
I131	0	0	3 598	3 598
I132	0	0	433	433
I133	0	0	1 412	1 412
I134	0	0	126	126
Total area (ha)	0	0	5 893	5 893

A.2 Definition of the Timber Harvesting Land Base

A.2.7 Skidegate Reserve expansion

An area of 85 hectares was set aside in the retention and partial retention VQO zones (age class=2 hemlock, G/M site class) for the expansion of the reserve.

A.2.8 Culturally modified trees

In some coastal areas of the Queen Charlotte Islands trees, primarily cedar, have been altered by aboriginal peoples as part of their traditional use of the forest including bark collection, plank splitting, and canoe construction. Preservation of these trees will impact harvest levels. Lacking a detailed inventory, an estimated area of 250 hectares are set aside in zone 3 (IRM), in cedar G/M site class over 250 years in age.

A.2.9 Environmentally sensitive areas (ESAs)

Environmentally sensitive areas include areas which have moderate to high non-timber values such as wildlife, water and areas which are prone to excessive site degradation if harvested because of geological and topographical conditions. Table A-6. shows the percentage area reduction by ESA category. These reductions were applied to all operability categories except I131 - Sensitive site, this reduction was applied in Table A-7. (following).

Table A-6. Per cent area reductions for environmentally sensitive areas

ESA code	ESA description	Per cent area reduction
Ep 1	high concern for regeneration problems	0
Ep 2	moderate concern for regeneration problems	0
Er 1	high recreation value	0
Er 2	moderate recreation value	0
Eh 1	high watershed values or concerns	100
Ew1	high wildlife value	100
Ew 2	moderate wildlife value	50
Es 1	high soil sensitivity	90
Es 2	moderate soil sensitivity	50

No reductions were applied for Ep codes since regeneration is achieved in the time frame specified in the Vancouver Forest Region stocking standards. No reductions are applied for Er codes since recreation concerns are addressed in area reductions and forest cover requirements for the retention and partial retention zones.

A.2 Definition of the Timber Harvesting Land Base

A.2.10 Inoperable areas

Inoperable land is that part of the forested area that is not likely to be accessible for timber harvesting because of the combination of rough terrain, difficult access and economic factors. Per cent area reductions by operability category (Table A-7.) were derived from detailed field and office reviews of a number of selected, representative mapsheets and the results extrapolated to the entire TSA. In addition, the areas on Reef Island (mapsheets 103B083) and Langara Island (mapsheets 103K025, 103K026) are excluded as well as operability classes E000 - Excluded (e.g. parks) and W000 - Water.

Table A-7. Per cent area reductions by operability class

Operability class	Description	Per cent area reduction
O111	operable conventional	14
O112	operable unconventional	22
H112	operable helicopter	28
O012	marginal	85
H012	marginal helicopter	90
I131	sensitive site	93
I132	uneconomic	98
I133	non productive/low site	100
I134	inaccessible	90

A.2.11 Existing unclassified roads, trails and landings

Past timber harvesting operations have resulted in a loss of productive forest land. However many of the existing roads, trails, landings and related disturbances are not accounted for in the inventory file. To account for this loss in the area available for timber harvesting a 7.2% reduction was applied to all areas younger than 28 years (i.e. stands originating after 1965). Stands harvested before 1965 (assumed average year) were primarily harvested using water based harvesting systems and no permanent access roads were created.

A.2.12 Not satisfactorily restocked areas

The total area of not satisfactorily restocked (NSR), both backlog and current, is 2261 hectares. This area is assumed to be restocked within one decade from now, based on regeneration delay, and is added back into the timber harvesting land base as indicated in Table A-8. NSR area is distributed in the same proportion as zones and analysis units occur in the timber harvesting land base.

Table A-8. NSR area additions to timber harvesting land base

Analysis unit	Zone 1 (R-VQO)	Zone 2 (PR-VQO)	Zone 3 (IRM)	Total area (ha)
1 Sitka Spruce (GMP)	5.4	11.0	56.1	72.5
2 Hemlock (GM)	122.6	250.0	1 275.4	1648.0
3 Hemlock (P)	9.8	20.0	102.0	131.8
4 Cedar (GM)	24.5	50.0	255.1	329.6
5 Cedar (P)	5.9	12.0	61.2	79.1
Total area (ha)	168.2	343.0	1 749.8	2261.0

A.2 Definition of the Timber Harvesting Land Base

A.2.13 Future roads, trails and landings

There will also be losses in productive area as future harvesting occurs. All existing stands currently over 28 years old will be subject to these losses which are assumed to be 7.4%. The area that will eventually be lost is not initially excluded from the land base. The B.C. Forest Service timber supply model simply reduces the areas by 7.4% the first time all stands currently over 28 years old are harvested.

A.2.14 Timber licence reversions

These areas revert to the Crown using the schedule shown in Table A-9. Timber licences are not considered to be part of the timber harvesting land base until reversion, after which all harvests contribute to the harvest forecast.

Table A-9. Timber licence reversions

Analysis unit	Zone 1 (R-VQO)			Zone 2 (PR-VQO)			Zone 3 (IRM)			Total area (ha)
	years until reversion									
	0-5	6-15	16-25	0-5	6-15	16-25	0-5	6-15	16-25	
1 Sitka Spruce (GMP)	40	31	22	413	78	58	72	41	0	755
2 Hemlock (GM)	265	9	68	260	136	101	0	245	100	1 183
3 Hemlock (P)	0	0	0	0	0	0	0	0	0	0
4 Cedar (GM)	0	0	0	0	16	54	0	111	43	224
5 Cedar (P)	0	0	0	0	0	0	0	0	0	0
Total area (ha)	433			1 116			612			2 161

A.3 Forest Management Assumptions

This section describes forest management as currently practiced in the Queen Charlotte TSA. The information was provided by the Queen Charlotte Islands Forest District staff.

A.3.1 Utilization levels

Harvesting is assumed to be carried out to a utilization level of 17.5 cm diameter at breast height (1.3 metres) for all timber types in the analysis (Sitka spruce, Western redcedar, Hemlock).

A.3.2 Utilization standards

Utilization standards are a maximum 30 cm stump height and a minimum 10 cm inside-bark diameter at tree top, less decay.

A.3.3 Minimum harvestable ages

Table A-10. lists the minimum harvestable age for each analysis unit. Minimum harvesting age was based on an overall stand volume, economic piece size and district staff experience.

Table A-10. Minimum harvestable age by species and site type

Species and growing site	Minimum harvestable age in years for existing stands	Minimum harvestable age in years for regenerated stands
Spruce, GMP	110	110
Hemlock, GM	100	120
Hemlock, P	130	150
Cedar, GM	100	120
Cedar, P	150	150

A.3 Forest Management Assumptions

A.3.4 Forest cover requirements

Table A-11. lists the forest cover requirements used to model current forest management objectives for each forest management zone. Forest management zones are defined in Section A.1.1, "Definition of management zones."

Table A-11. Forest cover requirements for each forest management zone

Forest management zone	Age 1	Maximum per cent area younger than age 1	Age 2	Minimum per cent area older than age 2
1 Retention - VQO	13	9	150	6
2 Partial retention - VQO	13	32	150	6
3 Integrated resource management	13	25	150	6

In forest management zone 3, forest cover requirements are determined by forest management prescriptions that roughly 25% of an area in which harvesting is occurring will be harvested with each subsequent harvest. After harvesting has occurred in an area no further harvesting is allowed to occur in adjacent forested areas until the regenerated stands on the previously harvested area have reached a height of 5 metres. The time required to reach this height is 13 years.

In zones that have visual quality objectives, the forest cover requirements are based on provincial guidelines for managing forest cover in visually sensitive areas. These guidelines define the maximum per cent of the landscape that may be non-greened-up, and the stand height required in order to be visually greened-up. The stand height required for visual green-up is 5 metres. The maximum per cent of the timber harvesting land base that may be less than age 1 in each zone is based on the following assumptions:

Retention VQO — 5% of the gross forested area may be less than 5 metres tall;

Partial retention VQO — 15% of the gross forested area may be less than 5 metres tall.

The above per cents are then adjusted using the methods outlined in the B.C. Forest Service, Recreation Branch Technical Report 1993:1, *Procedures for Factoring Recreation Resources into Timber Supply Analyses*. The gross green/operable ratio used in the calculation was determined separately for each zone, and default values for dispersion, identified in the technical report, were used to adjust the values to 9% and 32% in the retention VQO and partial retention VQO zones respectively.

A.3 Forest Management Assumptions

A.3.5 Unsalvaged losses

Unsalvaged losses are timber volumes destroyed by natural causes within the operable land base and not subsequently salvaged. These losses are in addition to 'endemic' losses, which are accounted for in existing stand yield curves. Estimated annual un salvaged losses are deducted from the gross harvested volume in the model to determine the net volume of timber that will be harvested over time. Table A-12. shows the estimated average annual unsalvaged losses in the Queen Charlotte TSA.

Table A-12. *Unsalvaged losses*

Cause of loss	Unsalvaged losses (cubic metres per year)
Insects	3 328
Windthrow	3 809
Total	7 137

A.3.6 Basic silviculture and regeneration assumptions

The following table shows the analysis units regenerated after harvesting occurs in existing analysis units. Managed stand yield tables (MSYTs) were created to reflect the proportions of analysis units converted to other analysis units and the percentages of stands that are assumed to be managed. The resultant MSYTs are listed in Section A.4, "Yield Tables for Existing and Regenerated Stands." The regeneration assumptions shown below apply to all three zones.

Table A-13. *Regeneration assumptions*

Existing analysis unit	Regenerated analysis units (with per cent)	Unmanaged per cent	Managed per cent	Initial density (stems/ha)	Regeneration delay (years)
1 S, GMP	1 (100%)	50	50	3 000	3
2 H, GM	1 (10%)	55	45	10 000	3
	2 (90%)	55	45	10 000	3
3 H, P	3 (100%)	95	5	10 000	5
4 C, GM	2 (70%)	55	45	10 000	3
	4 (30%)	55	45	10 000	3
5 C, P	3 (70%)	95	5	10 000	3
	5 (30%)	95	5	10 000	3

Note: high initial densities are due to an extremely high ingress rate.

A.3 Forest Management Assumptions

A.3.7 Yield assumptions

Yield tables for all existing stands were developed using the batch version of the Variable Density Yield Projection (VDYP) model provided by Ministry of Forests, Inventory Branch. All yield tables assume the utilization levels identified in Section A.3.1, "Utilization levels." The data for the VDYP model are from existing stand information on the 1993 inventory file, provided by Inventory Branch. For all existing stands, aggregated waste and breakage (W2B) factors are developed from the Inventory Metric Diameter Class Decay, Waste and Breakage Factors Manual (B.C. Ministry of Forests 1976). A single W2B factor is developed for each of two age ranges for each Public Sustained Yield Unit (PSYU), species, and utilization level. The alder volume in all mixed species stands has been excluded from existing yield tables.

Yield tables for all regenerated stands were produced using the Table Interpolation Program for Stand Yields (TIPSY) growth and yield model developed by Ministry of Forests, Research Branch. Mean area-weighted site indices of existing stands are assumed to apply to the regenerated stands as well. TIPSY reports potential yields for a specific site, species and management regime. Operationally these yields will be reduced if irregular stocking, disease, etc. reduce productivity. Operational adjustment factors (OAF's) alter the magnitude (OAF1) and shape (OAF2) of the base TIPSY yield curves. OAF1 reflects reduced productivity due to unproductive areas (e.g. swamps, rock outcrops) while OAF2 reflects losses towards maturity (e.g. diseases). For all regenerated stands, waste and breakage factors are assumed to be included in operational adjustment factor 2 used in the TIPSY model inputs. The specific operational adjustment factors used are:

Operational adjustment factor 1: 15%;

Operational adjustment factor 2. 5%.

A.4 Yield Tables for Existing and Regenerated Stands

Table A-14. shows the existing and regenerated stand yield tables for all species and site types in the analysis. The appropriate regeneration delays, as discussed in Section A-7., are applied within the timber supply model and are not accounted for in these yield tables.

Table A-14. Yield tables for all species/site types

Age	Spruce, all existing	Spruce, all regeneration
10	0	0
20	11	0
30	44	0
40	93	0
50	142	29
60	190	93
70	236	190
80	280	286
90	324	372
100	366	456
110	405	540
120	441	639
130	477	735
140	511	825
150	542	903
160	572	974
170	601	1053
180	628	1125
190	654	1188
200	679	1243
210	703	1292
220	726	1337
230	748	1380
240	769	1418
250	790	1453
260	807	1480
270	824	1501
280	840	1519
290	855	1536
300	870	1551
310	884	1551
320	898	1551
330	912	1551
340	925	1551
350	937	1551

continued

A.4 Yield Tables for Existing and Regenerated Stands

Table A-14. Yield tables for all species/site types

Age	Hemlock, GM existing	Hemlock, GM regeneration	Hemlock, P existing	Hemlock, P regeneration
10	0	0	0	0
20	7	0	1	0
30	64	4	5	0
40	161	68	23	0
50	249	174	70	3
60	324	280	120	29
70	390	382	165	65
80	447	482	206	114
90	497	568	241	165
100	541	656	273	214
110	580	736	301	258
120	614	813	325	298
130	648	879	351	335
140	679	934	374	372
150	707	985	396	406
160	733	1036	415	438
170	756	1082	433	465
180	778	1123	450	488
190	798	1163	467	510
200	816	1197	482	529
210	833	1229	497	549
220	849	1254	511	569
230	863	1275	525	588
240	877	1294	537	605
250	890	1311	549	621
260	900	1326	556	635
270	909	1343	563	649
280	918	1359	569	662
290	926	1372	575	675
300	934	1385	581	686
310	940	1385	586	686
320	947	1385	591	686
330	952	1385	596	686
340	958	1385	600	686
350	963	1385	604	686

continued

A.4 Yield Tables for Existing and Regenerated Stands

Table A-14. Yield tables for all species/site types (concluded)

age	Cedar, GM existing	Cedar, GM regeneration	Cedar, P existing	Cedar, P regeneration
10	0	0	0	0
20	1	0	0	0
30	23	3	1	0
40	97	55	15	0
50	171	151	54	8
60	242	256	100	39
70	307	347	143	89
80	368	440	183	143
90	418	521	217	199
100	461	600	247	251
110	500	672	273	296
120	530	738	294	335
130	569	803	320	373
140	603	859	342	409
150	632	908	362	441
160	658	954	378	469
170	679	997	392	495
180	701	1036	406	518
190	721	1072	419	542
200	741	1106	431	565
210	761	1137	444	586
220	784	1168	458	606
230	808	1193	473	625
240	830	1215	487	643
250	852	1235	500	660
260	858	1253	504	675
270	864	1269	508	689
280	870	1286	512	701
290	875	1302	515	713
300	880	1318	518	723
310	885	1318	521	723
320	890	1318	524	723
330	894	1318	526	723
340	898	1318	529	723
350	902	1318	531	723