

Kalum South Timber Supply Analysis

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Preface

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

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

Unlike past analyses, which normally assessed the implications of several forest management scenarios, this report focuses on a single scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area, and include guidelines for the protection of forest

resources, and official land-use decisions made by Cabinet. The current nature and capabilities of the local forest industry are also considered.

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province to be completed by the end of 1994. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called *sensitivity analysis*. Together, the sensitivity analyses and the assessment of the effects of current forest management on timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

This report is one of 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 paper 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 southern portion of the Kalum Timber Supply Area (TSA) and the Kitimat Municipality (Kalum South). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the both the short (next 20 years) and long (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

Kalum South consists of a total of about 550 000 hectares of land within the Skeena, Kitimat, Kitsumkalum, and Nass River drainages. About 104 000 hectares of the area are considered available for timber harvesting and production under current management practices. The area is heavily dominated by hemlock forests, with minor amounts of balsam, lodgepole pine, spruce, and cottonwood.

The results of this timber supply analysis suggest that a small reduction from the current harvest level in Kalum South (480 000 cubic metres per year) would be required in the short term to avoid either substantial harvest level reductions in the near future, or large timber shortages further into the future. Using current inventory and timber growth information, and assuming continuation of current forest management practices, a harvest of 464 000 cubic metres per year — 16 000 cubic metres per year or 3.3% below the current harvest — could be maintained for 10 years, followed by a 10% decline to 418 000 cubic metres per year for the next 10 years, and finally to a long-term level of 400 000 cubic metres per year 20 years from now. The current harvest of 480 000 cubic metres per year could be maintained only by dropping the harvest level by 80 000 cubic metres per year (16.7%) to the long-term level immediately after the next 10 years.

A harvest level between the current level and 464 000 cubic metres per year could be achieved by declining by more than 10% after the next 10 years. Under any of these regimes, most timber harvesting would occur in second growth by about 70 to 80 years from now.

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

Two important uncertainties which may affect future harvest levels are estimates of timber volumes in existing stands, and second-growth site productivity. Recent timber cruise figures suggest that timber volumes used for existing stands in the harvest forecast described above may overestimate actual volumes. If this is the case, an immediate drop in the harvest would be required to avoid significant future timber shortages.

While existing stands may have lower volumes, field observations suggest that second growth stands may have higher productivity than is being estimated from the existing inventory. Higher productivity second-growth stands would grow faster, produce higher volumes, and require less time to reach merchantable size than lower productivity stands. If second growth can be harvested at younger ages than currently assumed, the current harvest rate in existing old-growth forests could potentially be maintained. In the longer term — perhaps 80 to 90 years from now — harvests might be able to rise above the current level.

Sensitivity analysis shows that higher productivity from second growth may offset lower existing stand volumes. The degree to which second-growth volume production would have to increase above current estimates to offset a decreased estimate of existing timber volumes depends on: 1) how much lower existing stand volumes are than current inventory-based estimates; and 2) the time needed for second growth to reach merchantable conditions.

Executive Summary

Timber supply over the next few years is also sensitive to uncertainty in the size of the timber harvesting land base. Currently, a significant portion of Kalum South is classified as operable only for harvesting systems not conventionally used in the area, such as long-line skyline systems. If harvesting activities do not move into these areas, both short- and long-term timber supply would be significantly smaller than indicated in the base case results summarized above. Conversely, future economic factors may expand the land base available for harvesting, for example, if currently non-merchantable species become marketable, or if wood prices rise significantly. Whether or not the harvesting land base will expand in the future is unknown; however, it is clear that short-term harvests depend significantly on the use of timber in areas operable for non-conventional harvesting systems.

The uncertainties associated with existing timber volumes, site productivity and the land base have the greatest potential impact on future timber supply. However, several other factors can also affect the timber supply in the short or long term.

Uncertainty about minimum harvestable ages has a large effect on timber supply. Lower harvest ages would increase potential harvests, while higher ages would require either immediate harvest reductions, or reductions to well below the productive capacity of the land for several decades beginning about 20 years from now. There would be little long-term effect from harvesting at the range of ages tested.

Second-growth harvest ages are highly uncertain, since they depend on future markets and technology, and are affected by uncertain estimates of second-growth productivity. Until there is clear evidence that second-growth productivity differs significantly from estimates used in this analysis only increase in short-term timber supply stemming from optimistic estimates of productivity and harvestable ages should be approached with caution. A belief that minimum harvestable ages will be longer than assumed for this analysis would indicate a conservative, or cautious, viewpoint but would also be based on conjecture.

Uncertainty about both forest cover guidelines to protect visual quality, and the ages at which harvested

areas reach green-up conditions, particularly in visual quality management areas, have moderate effects on timber supply in the short term, and only small impacts over the long term. If visual quality could be maintained while placing fewer limitations on harvesting than assumed in this analysis, the timber supply would increase sufficiently to maintain current harvest levels for up to 20 years. Conversely, if maintaining visual quality required more restrictive guidelines, harvests would have to be reduced somewhat. Similarly, if green-up periods are 5 years less than assumed for the base case, the current harvest level for Kalum South could be maintained for another 10 years without causing future timber supply shortages. If the ages are 5 years longer, harvests would have to decline immediately to avoid future shortages.

Timber supply is affected only slightly by uncertainty in forest cover guidelines for old growth, the estimated age at which stands reach old-growth conditions, and the amount of commercial thinning.

In conclusion, this analysis based on current inventory and growth and yield information indicates that timber harvests in Kalum South will have to decline to the long-term growth potential of the land base over the next 10 to 20 years. Several uncertainties important to timber supply deserve attention both in discussions about short-term harvest levels, and in inventory and research over the next few years. First, indications from recent inventory work that existing merchantable timber volumes may be overestimated should be investigated. Second, field observations suggesting that second-growth productivity may exceed estimates based on the existing inventory require corroboration. Third, to maintain the timber supply indicated in this analysis, harvesting operations must move into areas operable for non-conventional harvesting systems. Finally, although the above three factors appear most important in defining the Kalum South timber supply, visual quality objectives also have moderate effects. It will be important to examine the visual quality management classification, forest cover guidelines, and desired green-up conditions and ages to ensure they accurately reflect demands and meet objectives.

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Introduction

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

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

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

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

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

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

Timber supply projections made for TSAs look far into the future — 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 southern portion of the

Kalum TSA. The analysis for the northern portion of the Kalum TSA, or Kalum North, was published in February 1993 followed by an Addendum Report published in August 1993. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. The report ends with a summary and conclusions.

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

Forest inventory

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

1 Description of the Southern Portion of the Kalum TSA

The southern portion of the Kalum Timber Supply Area, hereafter called Kalum South, lies within the Prince Rupert Forest Region (Figure 1), and is administered from the Kalum Forest District office in Terrace. Kalum South comprises a total of 549 762 hectares. Major rivers in the area include the Kitimat, Kalum, lower Nass, and southern Skeena.

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

The aboriginal communities of Lakalzap, Gitwinksihlkw and New Aiyansh are found in the Lower Nass area, Kitimat Village is located near the Kitimat Municipality; and the Kitselas and Kitsumkalum Indian Reserves are located near Terrace.

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

small portion of harvested timber is shipped to the lower mainland or to mills in adjacent TSAs.

The southern portion of the Kalum Forest District contains two Tree Farm Licences (TFL)*: TFLs 1 and 41. The timber supply in these areas is assessed as part of the TFL planning process, and is not examined in this report. The TFLs supply local mills with more of their timber needs than does the Kalum South. Some wood from the Kispiox TSA provides sawlogs to one mill in Terrace, and pulp chips to the mill in Port Edward. For a more detailed discussion of wood flows in the area, refer to, *The Northwest Forest Industry: an Overview of Current Wood Fibre Supply Consumption and Processing Capacity, 1993*.

Kalum South has highly variable topography, with fairly flat valley bottoms, rolling lower slopes, steep mid-slopes, and rugged, mountainous upper slopes. Steep terrain in the upper slopes, and sensitive soils in mid-slope gullies often preclude timber harvesting. Hemlock forests dominate the area, with balsam, lodgepole pine, western redcedar, and spruce also present.

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

Tree Farm Licence (TFL)

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

1 Description of the Southern Portion of the Kalum TSA

Figure 1. Map of the Prince Rupert Forest Region.

1 Description of the Southern Portion of the Kalum TSA

Figure 2. Southern portion of the Kalum 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 by the B.C. Forest Service Inventory Branch in 1993. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

Initially, this file is a representation of the land base for the entire TSA. It includes data for areas on which timber harvesting operations are not expected to take place, and therefore do not contribute to the timber supply of the area. Examples include land that has been set aside for a park, or areas occupied by power lines, highways or town sites (such non-contributing areas specific to the Kalum South 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. Within that integrated resource context, the timber supply is managed. The timber supply analysis discussed in this report is consistent with this philosophy.

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

Timber harvesting land base

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

2 Information Preparation

Areas on which timber harvesting is not expected to occur, under current forest management in the Kalum South, are:

- areas not managed directly by the B.C. Forest Service — these include non-Crown land, areas managed by other agencies (for example, parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licences or TFLs).
- non-forest areas — areas not capable of growing productive forest (for example rock, swamp and alpine areas).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- inoperable areas — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (for example presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- non-merchantable forest types* — areas occupied by timber stands of low volume or

non-merchantable species, or with low timber-growing potential.

- existing roads, trails and landings — forest land lost to future timber production due to past access development and harvesting.
- environmentally sensitive areas* — portions of the areas classified as sensitive are considered unavailable for timber harvesting.
- streamside buffers — to protect streamside and stream ecosystems.
- old-growth reserves — from the Thunderbird Integrated Resource Management Plan.
- future roads, trails, and landings — to account for future losses of productive land to development. These areas are initially included in the harvesting land base, and are removed as part of the first harvest.

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

Table 1 summarizes the areas in each category, and shows the area of the timber harvesting land base.

Operability

A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area. In Kalum South, operable areas are further classified as operable either for conventional systems (ground skidding, cable yarding and skyline systems with a maximum yarding distance of 750 metres) or non-conventional systems (skyline systems with a yarding distance of more than 750 metres, and helicopter systems).

Non-merchantable forest types

Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

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.

2 Information Preparation

Table 1. Timber harvesting land base for Kalum South

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area ^a
Total area on inventory file	549 762	100.0	
Not managed by B.C. Forest Service	46 189	8.4	
Non-forest	304 123	55.3	
Total productive forest managed by Forest Service (Crown forest)	199 450	36.3	
Reductions to Crown forest:			
Non-commercial cover (brush)	511	0.1	0.2
Inoperable	71 932	13.1	35.6
Aspen, birch, alder	5 249	1.0	2.6
Non-merchantable (low volume)	5 186	0.9	2.6
Low productivity	622	0.1	0.3
Existing roads	4 010	0.7	2.0
Integrated management			
Environmentally sensitive	8 157	1.5	4.0
Streamside buffers/old growth	2 306	0.4	1.1
Total current reductions ^b	- 97 973	17.8	48.5
Initial timber harvesting land base (includes 7 978 hectares not satisfactorily restocked* land ^c)	101 477	18.5	50.3
Additions:			
Timber licences ^d	+ 2 401	0.4	1.2
Total current timber harvesting land base	103 878	18.9	51.5
Future reductions:			
Future roads	- 4 742	0.9	2.3
Long-term timber harvesting land base	99 136	18.0	49.2

(a) For these percentages, productive forest area includes the 2401 hectares of timber licences in the harvesting land base.

(b) Reductions were performed in the following order — 1) not managed by Forest Service; 2) non-forest; 3) inoperable; 4) environmentally sensitive; 5) deciduous types; 6) non-merchantable; 7) low site; 8) existing roads; 9) streamside buffers and old-growth reserves.

(c) NSR includes: current NSR; backlog NSR; NSR due to natural disturbances; and some spruce plantations that have been damaged by the spruce leader weevil.

(d) Timber licences revert to Forest Service management after existing mature timber is harvested.

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

Figure 3 represents both the total Kalum South area, and the timber harvesting land base. The total area chart shows that slightly more than 90% of the Kalum South falls within B.C. Forest Service management, and of that area about 60% is classified as either non-forest or non-productive forest (i.e. very few trees). The other chart details

the categories of productive forest land not within the harvesting land base, and shows that almost half (50.3%) of the productive forest is considered available for timber harvesting. More than one-third of forest land in Kalum South is considered to be physically or economically inoperable at this time.

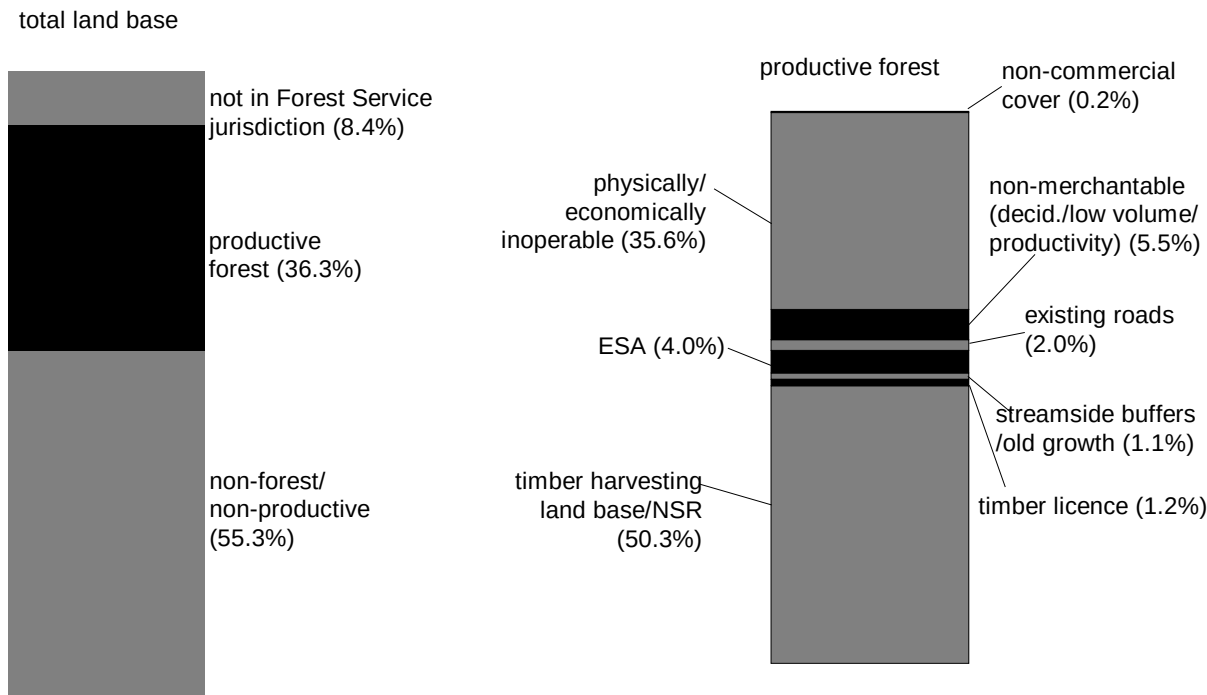


Figure 3. Classification of the total and productive forest land bases — Kalum South 1994.

2 Information Preparation

Several types of forested areas that fall outside the timber harvesting land base, including environmentally sensitive areas, streamside buffers, and old-growth reserves, contribute to management for non-timber values. These areas amount to 10 463 hectares, or 5.2% of the total forest area in Kalum South. In addition, some inoperable areas and non-merchantable forest

stands contribute to non-timber values and environmental protection.

Figure 4 shows the composition of the timber harvesting land base by tree species. The harvesting land base is dominated by hemlock-leading stands (81%), with balsam (8%), lodgepole pine (6%) and cottonwood (3%) as minor components. Western redcedar and spruce are present, but are only occasionally the dominant species in stands.

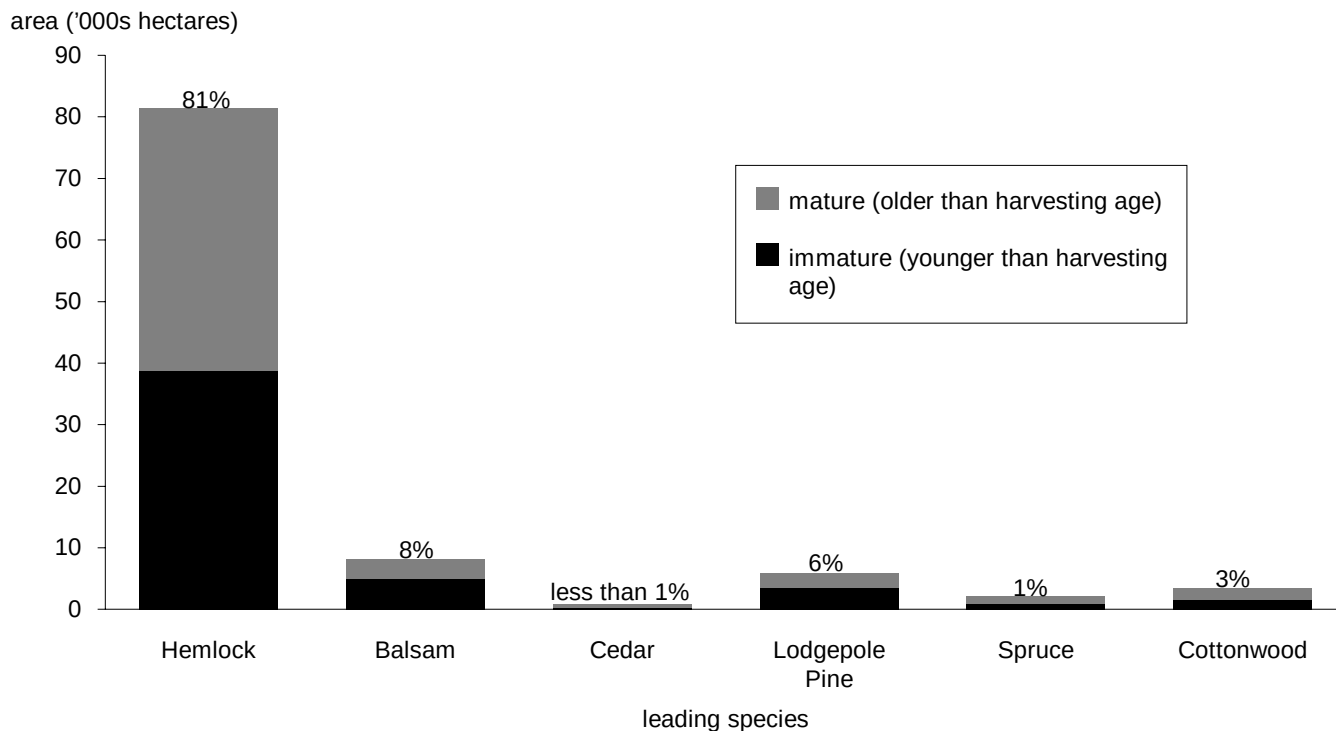


Figure 4. Area by dominant tree species — Kalum South timber harvesting land base, 1994.

2 Information Preparation

Figure 5 provides an overview of the distribution of timber growing potential within the harvesting land base, and the relative amount of young and old forest. Most good sites and about two-thirds of medium sites are immature, or younger than merchantable age. This site productivity distribution probably reflects both a

harvesting history that has concentrated on better quality timber sites, and the possible underestimation of site productivity of areas currently occupied by old growth. Overall, Kalum South is almost evenly split between immature (49.6%) and mature (50.4%) forest.

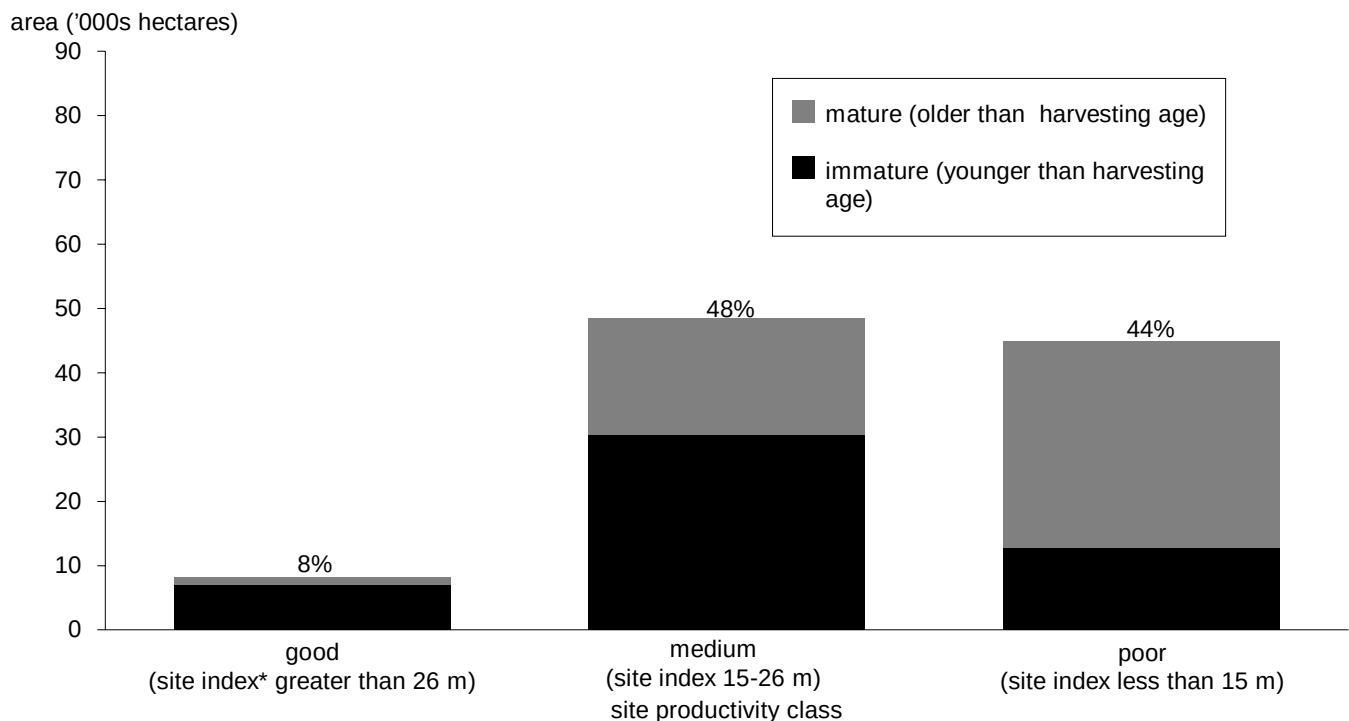


Figure 5. Area by maturity and site productivity — Kalum South timber harvesting land base, 1994.

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.

2 Information Preparation

The split between young and old forests is emphasized in Figure 6 which shows the current age composition of Kalum South. The age composition indicates that an important timber supply issue is

the allocation over time of the remaining old growth until currently young areas become old enough to harvest.

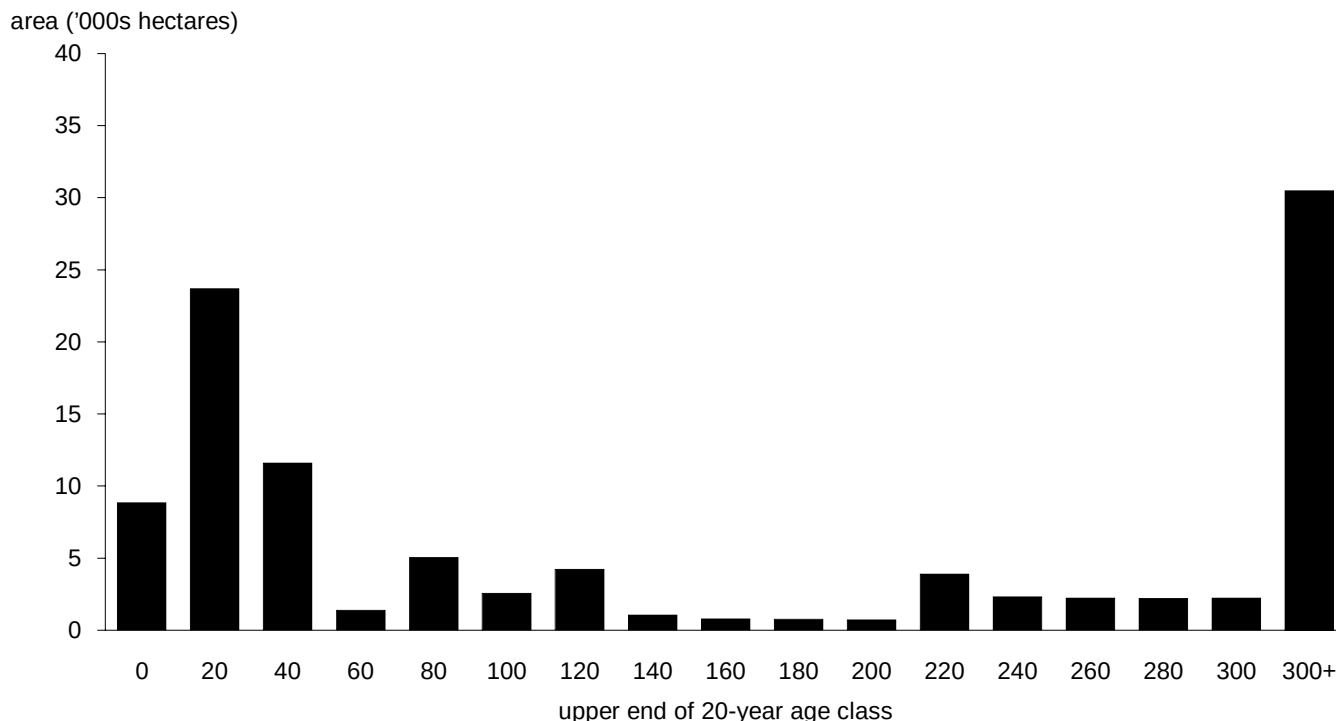


Figure 6. Current age composition — Kalum South timber harvesting land base, 1994.

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. See Appendix A, "Description of Data Inputs and Assumptions" for more details on utilization.

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 regenerated second-growth stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service, Research Branch. Sensitivity analysis addresses the possibility that stand volumes may be different from those predicted.

2 Information Preparation

2.3 Management practices

Timber supply is directly connected to forest management activity. The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region*, and the *British Columbia Coastal Fisheries/Forestry Guidelines* guide forest management practices in Kalum South. 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 Kalum Forest District and in the Prince Rupert Forest Region defined these practices as described in the following management assumptions*.

- Basic silviculture levels — reforestation activities required to establish free-growing stands* of acceptable tree species. Most areas in Kalum South are harvested using a clearcut harvesting* system and restocked by planting or natural regeneration.

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 stands

Stands composed of sufficient seedlings of an acceptable commercial species that are 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.

- Incremental silviculture* — juvenile spacing*, commercial thinning*, and pruning* are practiced in Kalum South. Most stands are juvenile spaced, which ensures young trees are well distributed to maximize growth. A portion of sites with good growing potential are commercial thinned, whereby some trees of merchantable size are removed to increase the growing space available for remaining trees. Trees on some good sites are pruned (have their lower branches removed) to improve timber quality. In this analysis, one-quarter of good sites are assumed to be commercial thinned; however, Kalum Forest District silviculture plans include thinning of three-quarters of good sites. The sensitivity analysis in Section 5.12, "Uncertainty about commercial thinning performance," addresses the effects of this difference.

Incremental silviculture

Forest management activities, beyond those necessary to establish a free-growing stand, undertaken to promote growth and increase timber values.

Juvenile spacing

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

Commercial thinning

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

Pruning

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

2 Information Preparation

- Forest health and unsalvaged losses — losses of merchantable timber to fire and wind damage are expected to be 9500 cubic metres per year. Losses to pests (insects, disease, animals) are assumed to be negligible.
- Stream and old-growth protection — 2306 hectares were removed from the harvesting land base to protect streamside areas throughout the Kalum South, and old-growth reserves defined in the Thunderbird Integrated Resource Management Plan. Additional requirements for old growth were represented by forest cover objectives (see representation of forest types below).
- Cutblock adjacency* and green-up* — the *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert*

Forest Region specify that previously harvested stands must reach a desired condition, or green-up (3 metres in height), before adjacent stands may be harvested. The Kalum Forest District also requires that a maximum of 40% of an area being developed for harvesting may be less than 3 metres tall. The purpose of the green-up period is to prevent timber harvesting from becoming overly concentrated in an area at any time.

- Representation of forest types — harvesting guidelines outline objectives to retain a minimum proportion of the harvesting land base in old-growth conditions (150 years or older) to help maintain some types of biological diversity.

Cutblock adjacency

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

Green-up

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

2 Information Preparation

- Visual quality — 32 200 hectares (31%) of the timber harvesting land base are being managed for visual quality. Maintaining visual quality requires that visible evidence of harvesting be kept within limits. Guidelines are stated in terms of the maximum proportion of an area that may be less than 5 metres tall (the visual green-up). The proportion depends on the specific visual quality objective (VQO)* and the visual sensitivity*. Areas managed for visual quality fall into three categories: 1) retention*/preservation* where visible evidence of timber harvesting must be minimal; 2) partial retention* where harvesting may be noticeable, but not dominant; and 3) modification* where harvesting may be visually dominant, but must blend with the natural landscape. Appendix A, "Description of Data Inputs and Assumptions" contains a detailed description of the specific objectives that apply to these categories.
- Watershed and the Shames Mountain and Onion Lake ski areas — 2708 hectares within the timber harvesting land base fall within community watersheds or ski areas. Harvesting in these areas is limited to ensure that at most 25% of the area is less than 5 metres tall.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable size. Minimum ages for this analysis were set at the youngest age at which stands reach within 5% of their maximum average growth. The minimum harvesting age defines the youngest age a specific type of stand is expected to become harvestable. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives (e.g. for adjacency, old growth and visual quality), and overall timber harvest targets.

Visual Quality Objective (VQO)

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

Visual sensitivity

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

Retention VQO

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

Preservation VQO

Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity.

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).

Modification VQO

Alterations may dominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.

2 Information Preparation

- Kitimat Municipality harvest level — in the Kitimat Municipality (see Figure 2) timber harvesting and forest management rights are held under one licence. Timber harvests will be limited to 30 000 cubic metres per year in this area for a 20-year period.

A more detailed description of the management assumptions is provided in Appendix A, "Description of Data Inputs and Assumptions."

The above discussion outlines three main forest management emphases within Kalum South:

- Integrated resource management where cutblock adjacency and forest type representation objectives apply;

- Watersheds and ski areas; and
- Visual quality management.

All forest areas in Kalum South are managed according to the *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region*. As outlined, some areas are subject to additional management guidelines to emphasize specific resource values such as visual quality or water quality.

Figure 7 displays the composition of the harvesting land base according to the main management emphasis.

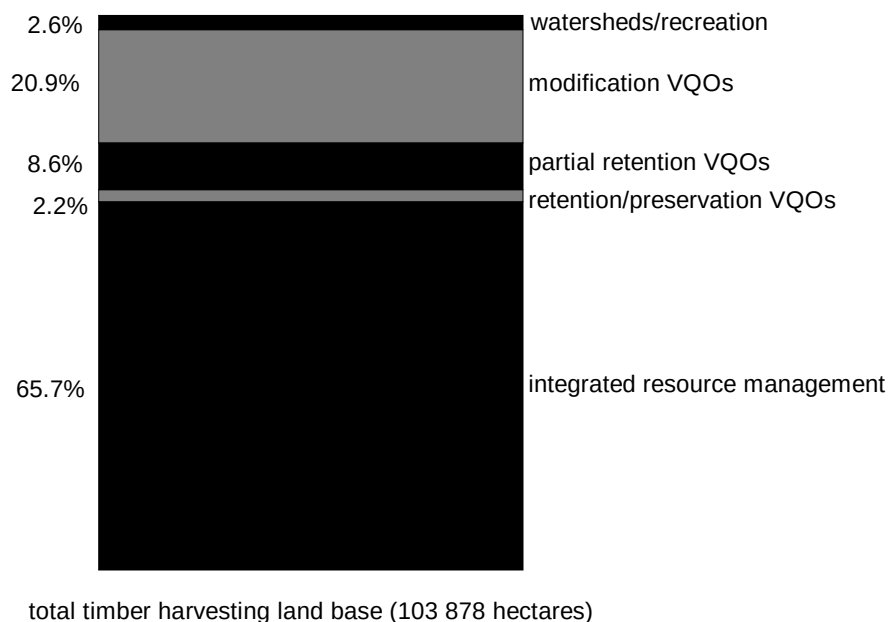


Figure 7. Major forest management emphases — Kalum South timber harvesting land base, 1994.

3 Analysis Methods

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

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. However, the Forest Service model differs from most other models in that it allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of

cutblock adjacency and green-up prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model examines the effects of such guidelines on timber supply.

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

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

4 Results

This section presents results of the timber supply analysis for Kalum South. The analysis uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation." These results will be referred to as the base case because they form the basis for comparison when assessing the effects of uncertainty on timber supply. Because forest management is inherently a very long-term venture, uncertainty surrounds much of the information important in determining timber supply. These factors will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture in

Kalum South, and should not be viewed in isolation of the sensitivity analysis.

4.1 Base case harvest forecast

Figure 8 shows the base case harvest forecast*. The initial level of 464 000 cubic metres per year is 16 000 cubic metres per year (3.3%) below the current harvest level for Kalum South. After the first decade, the harvest falls by 10% to 418 000 cubic metres per year for the decade 11 to 20 years from now. The harvest level that is sustainable over the long term — 400 000 cubic metres per year — is reached in 20 years.

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.

4 Results

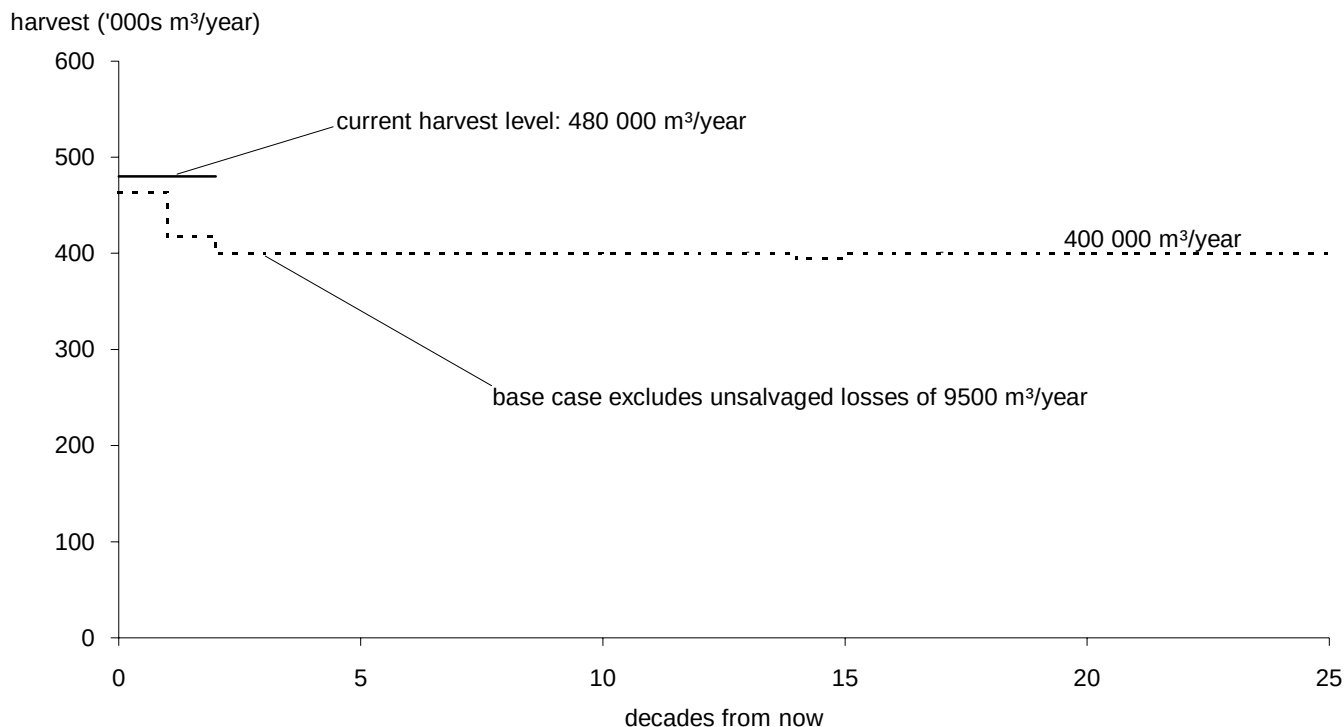


Figure 8. Base case harvest forecast for Kalum South, 1994.

The estimated unsalvaged losses to fire and wind of 9500 cubic metres per year have been subtracted from all harvest forecasts shown in this report.

Several criteria were used to define the base case harvest forecast. The initial level was defined by attempting to maintain the current harvest level for Kalum South (480 000 cubic metres per year) for at least the next 10 years, declining by at most 10% in each of the following decades, and avoiding harvest shortfalls below the long-term level. If the current harvest level could not be maintained without causing serious future harvest shortfalls, as was the

case here, the initial harvest level was lowered until a maximum drop of 10% to the second decade could be attained without causing a future timber supply shortage. A higher initial harvest could therefore be attained by allowing a reduction of more than 10% after the first 10 years. The long-term level was 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.

Growing stock

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

4 Results

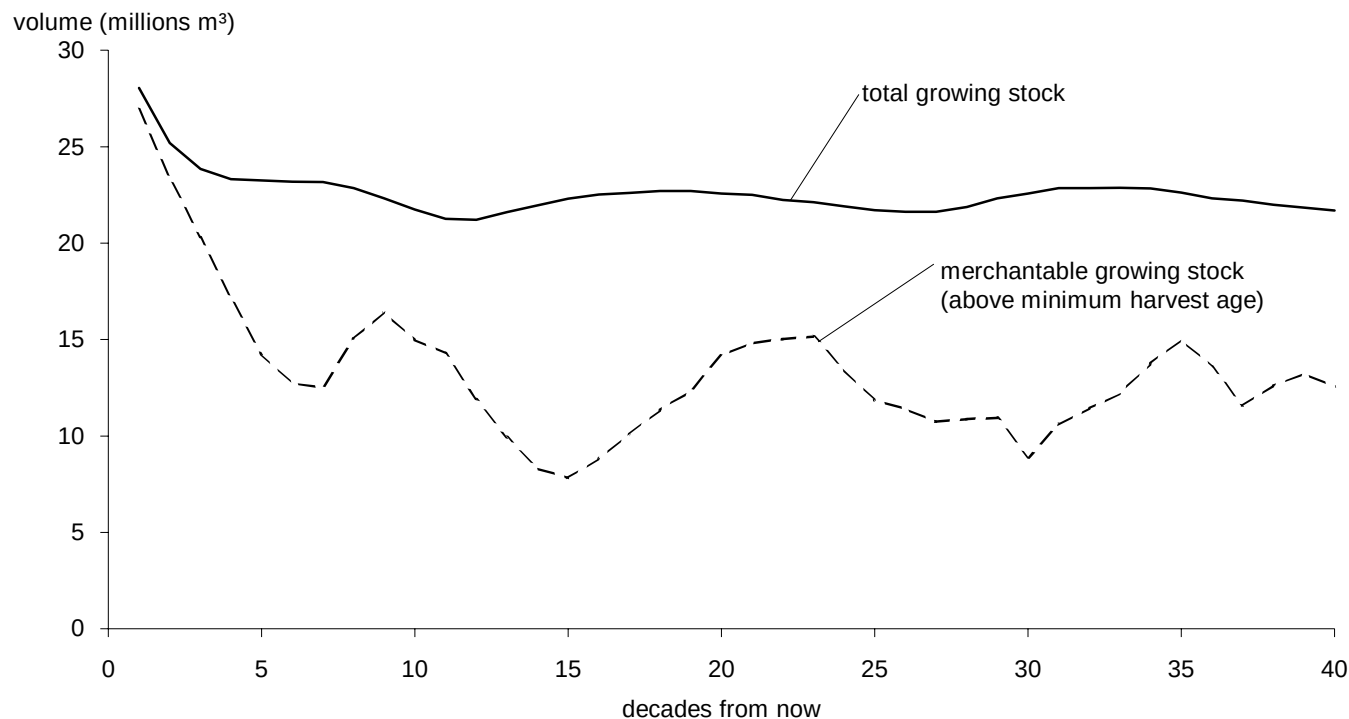


Figure 9. Changes in timber growing stock over time — Kalum South base case, 1994.

The long-term harvest level* is about 5% less than the maximum average growth rate of the Kalum South land base. This is because stands are not harvested exactly at the age that maximizes long-term volume production (that is, the age of maximum average growth) due to forest cover objectives and practical limitations on scheduling harvests.

Timber productivity in managed second growth is expected to be higher than in existing timber. Growth estimates used in this analysis result in a long-term harvest level about 22% higher than if

second-growth stands were expected to grow at the same rate as existing unmanaged stands.

The harvest forecast includes a small shortfall 140-150 years from now. At that time, the available volume of timber — that is, the growing stock older than the minimum harvesting age and not needed to maintain forest cover objectives — is at a minimum. Of the forest cover objectives discussed in Section 2, "Information Preparation," visual quality objectives place the greatest limits on timber availability. The effect of forest cover objectives on timber supply are examined in Sections 5.7 to 5.11.

Long-term harvest level

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

4 Results

4.2 Area, average volume, and average age harvested

Figure 10 shows how annual area harvested would change over the next 250 years if the base case harvest forecast were followed. Figure 11 shows changes in the average timber volume per hectare harvested over the same period. These graphs display a fluctuating pattern. For example, peaks in area harvested appear in years 60-70 and 150-160, with low points in years 80-90 and 220-230. Average volume per hectare harvested is high when area harvested is low, and low when area harvested is high. This relationship is expected since the annual timber harvest is constant at 400 000 cubic metres per year for most of the analysis horizon. The pattern occurs because the first second-growth

stands to become available for harvesting will be primarily good and medium quality growing sites. This is illustrated in Figure 5 which shows that currently, most good sites and a significant portion of medium sites are occupied by young stands. Further, timber yield estimates used in this analysis indicate that compared to poor sites, better quality sites are expected to grow proportionately more timber once harvested and regenerated. Second-growth stands on good sites are estimated to yield from 22-100% more than existing stands at the minimum harvestable age; on medium sites the estimated increase is 12-35%; and on poor sites, second-growth stands are estimated to produce about the same volume or slightly less (10%) than existing stands.

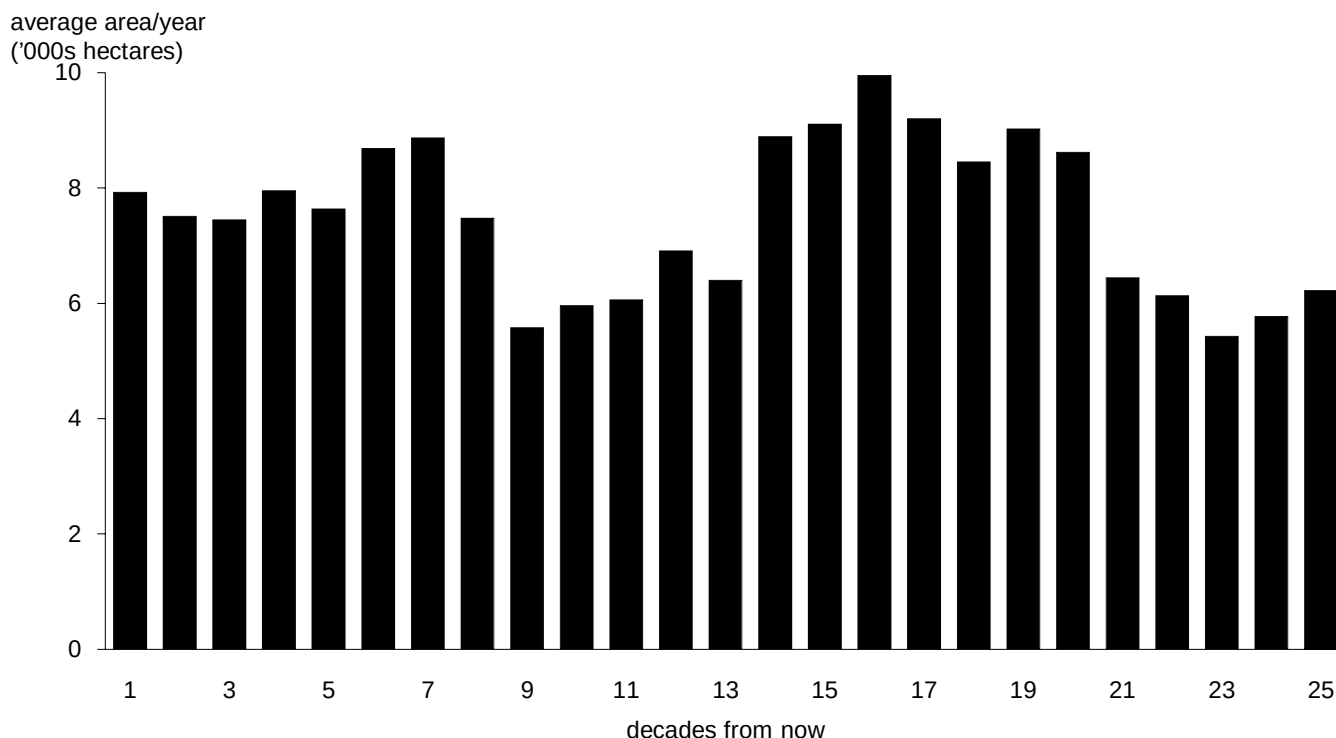


Figure 10. Area harvested over time — Kalum South base case, 1994.

4 Results

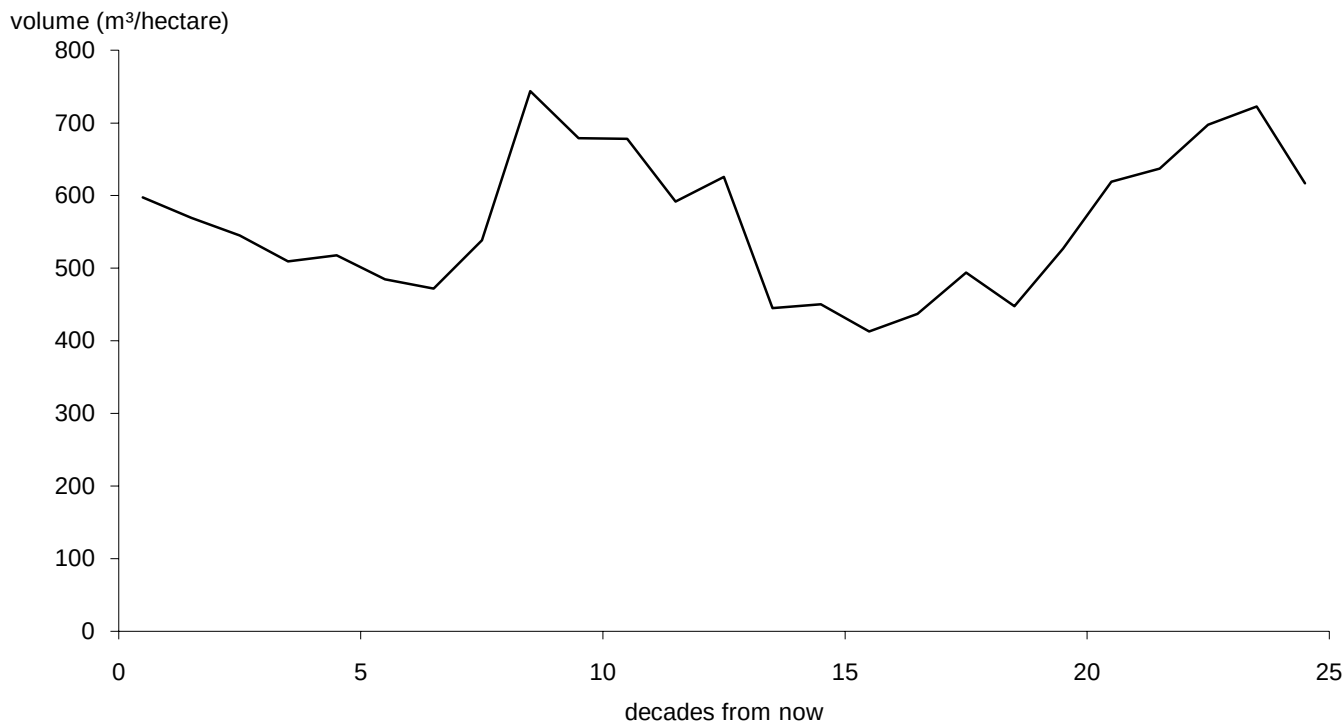


Figure 11. Average volume per hectare harvested over time — Kalum South base case, 1994.

In short, stands on good and medium sites are expected to become available first, and are estimated to yield proportionately higher volumes than poor sites. This means that in 70-90 years when the good and medium site second growth becomes harvestable, the average volume per hectare harvested will be high and the corresponding area that must be harvested to achieve a harvest of 400 000 cubic metres per year will be low. The good and medium sites will be harvested over subsequent years until poor site second growth reaches minimum harvestable age. This first occurs in about 150 years. At that time, more area of relatively low-volume poor sites must be harvested annually than on better sites to reach the same harvest target. The fluctuating patterns of area and volume harvested would be less dramatic if second-growth timber production was estimated

to increase on poor sites to the same degree as on good and medium quality sites.

Figure 12 tracks the change in average stand age harvested for the base case harvest forecast. Over the next 40 years, most harvesting occurs in existing old stands. From years 40-70 harvesting shifts from old growth to second growth, as illustrated by the steep decline in average age harvested. A small peak appears between years 150 and 160 when poor productivity sites dominate the harvest. The lowest average age of 115 years occurs between years 80 and 90 and between years 130 and 150. For the last 80 years of the analysis horizon, the average harvested age is about 130 years. The average minimum harvestable age determined using the ages listed in Table A-16, in Appendix A, "Description of Data Inputs and Assumptions," is about 110 years, so actual harvest ages remain above the minimum at all times.

4 Results

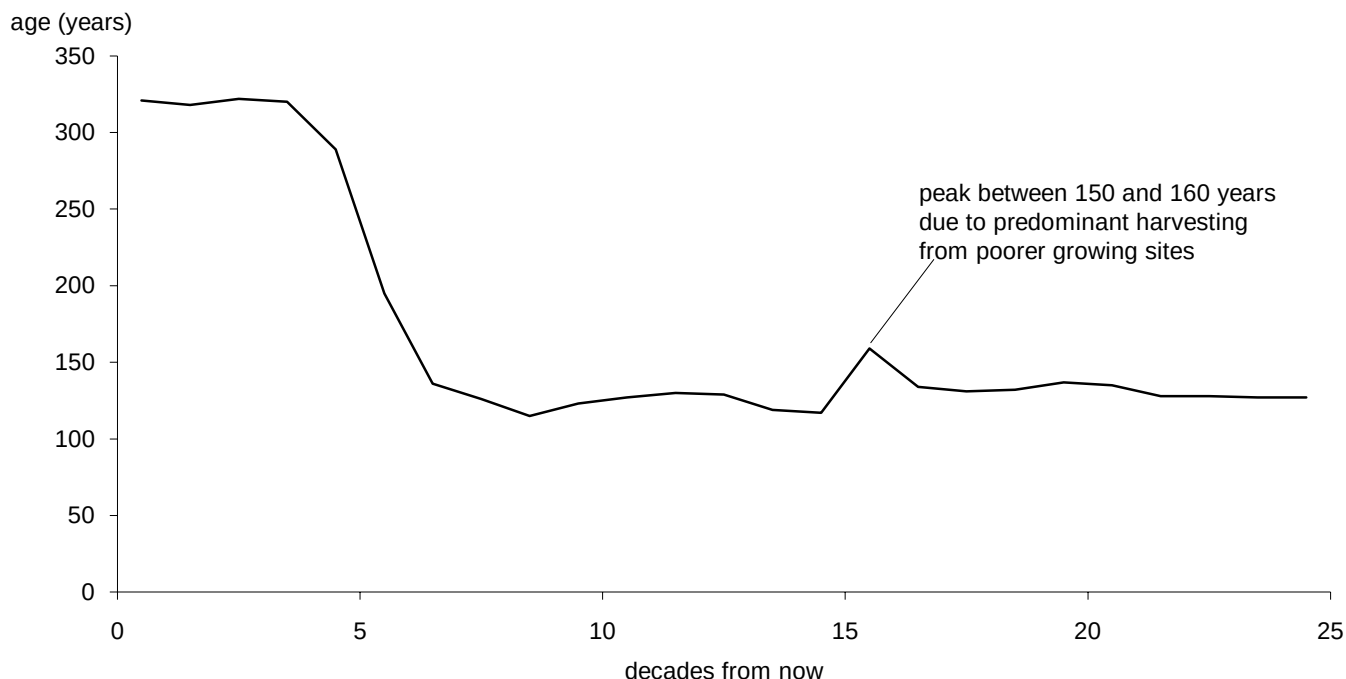


Figure 12. Average harvested age over time — Kalum South base case, 1994.

4.3 Age class composition over time

The charts in Figure 13 show how the age composition of the forest within the timber harvesting land base would change over the next 250 years under the base case harvest forecast. Currently, the timber harvesting land base comprises almost equal areas of forest at or above minimum merchantable age and areas younger than merchantable age. Most of the merchantable forest is older than 300 years. Over time most of the very old forest is harvested, and the bulk of the area remains 140 years old or younger.

These charts include streamside buffers and old growth — a total of 2306 hectares assumed to be 300 years old or more — that are excluded from harvesting under current management but would otherwise be included in the harvesting land base. This area is included to highlight that some old growth will continue to be present in areas available for timber harvesting. The charts do not include environmentally sensitive areas, non-merchantable stands and physically inoperable areas that also contain old-growth forest. Forest cover objectives for visual quality and old-growth forest (older than 150 years) require that additional area remains in old-age forest, which can be seen in the bars representing forest from 160 to 300 years old.

4 Results

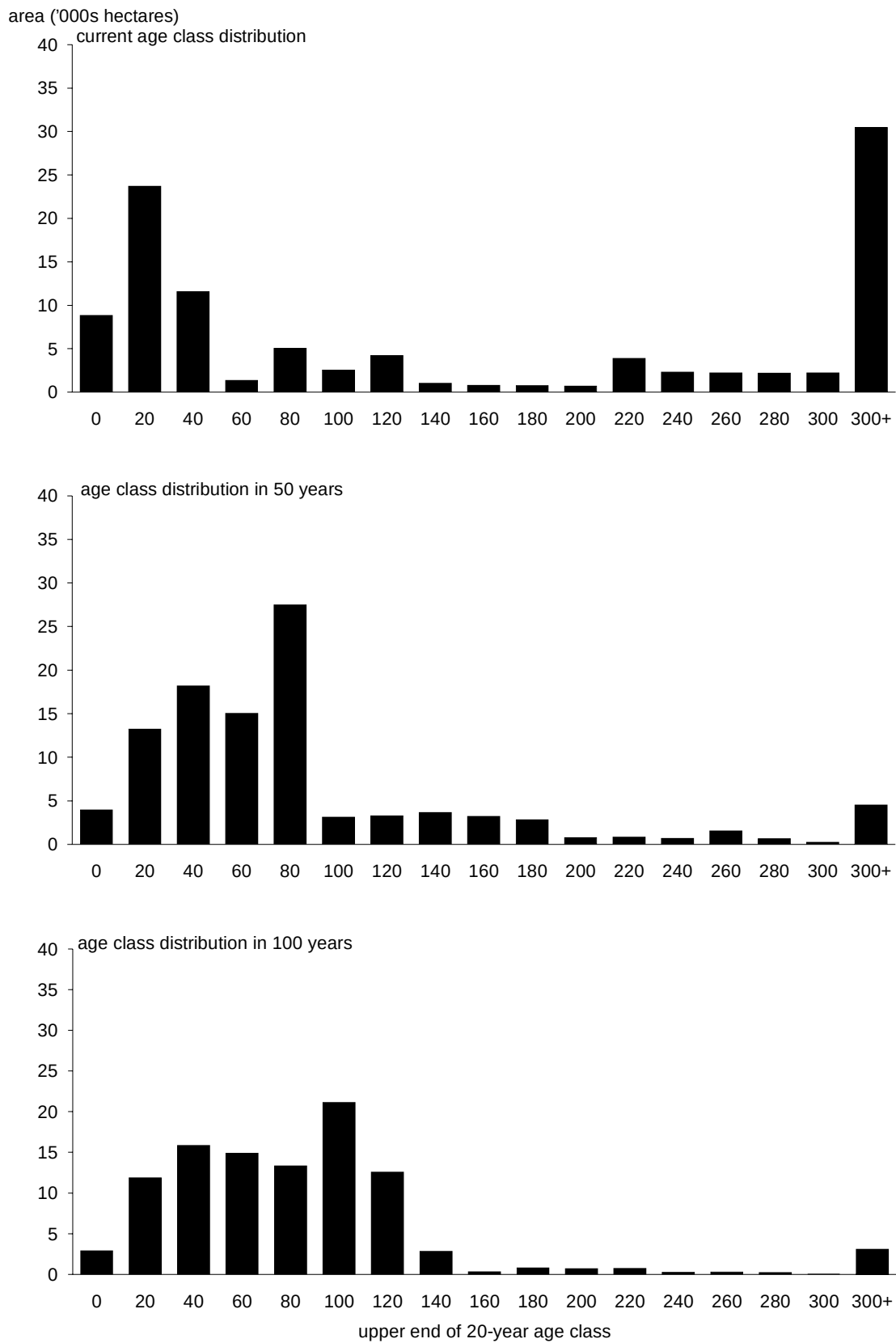


Figure 13. Changes in age composition on timber harvesting land base over time — Kalum South base case, 1994.

4 Results

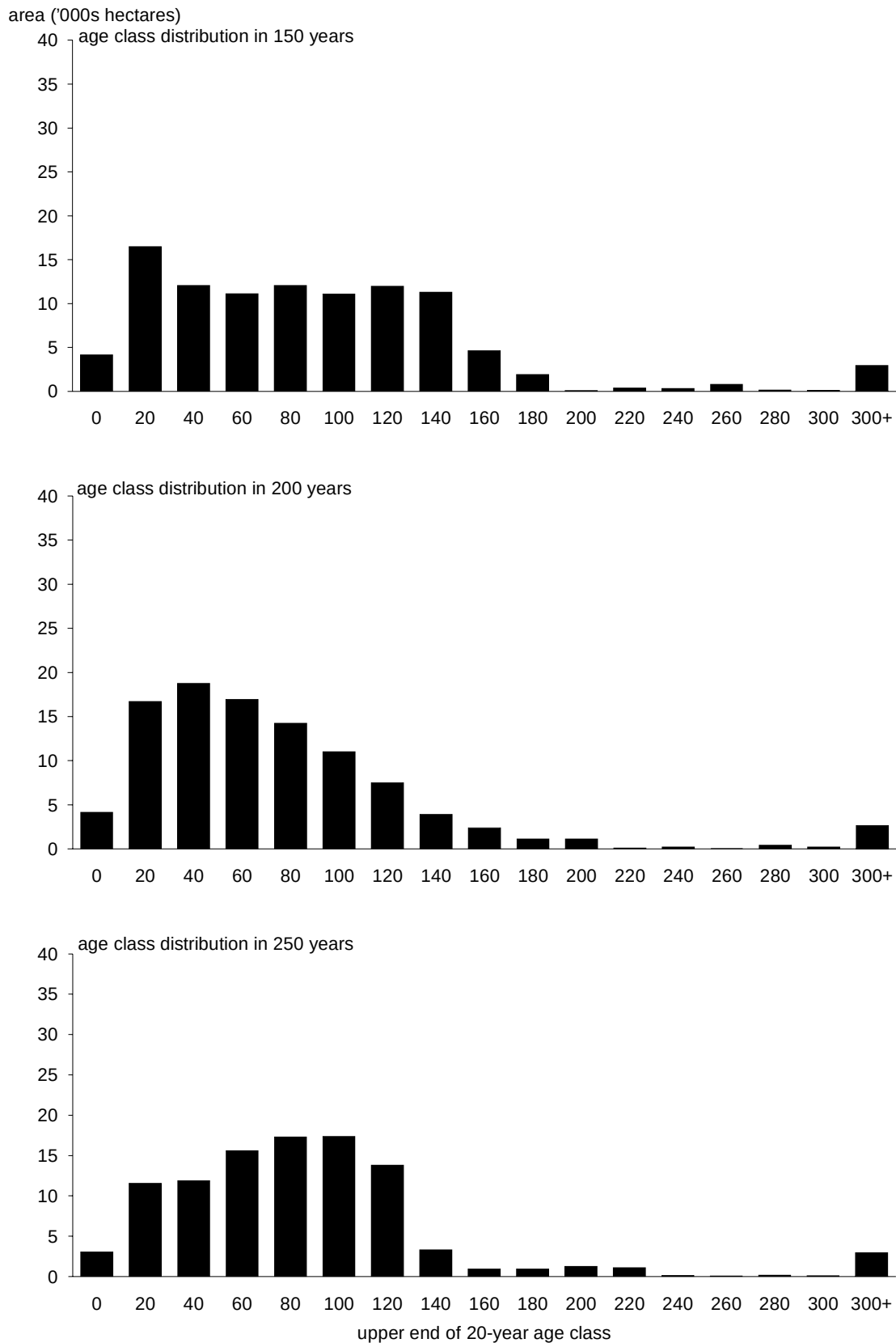


Figure 13. Changes in age composition on timber harvesting land base over time — Kalum South base case, 1994 (concluded).

4 Results

Timber supply is most limiting in the decade from 140 to 150 years from now. This might not be expected since a significant area at that time is older than the average minimum harvesting age of 110 years. However, most of the timber available for harvest in 140 years time comes from poorer

quality growing sites. Minimum harvestable ages for poorer sites are 125-140 years, and timber volumes on these sites are not expected to be as high as on better sites. Together these factors mean that timber availability is at a minimum about 150 years from now.

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 forest management and uncertainty 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 discussed. The results that are based on current forest management assumptions (shown in Figures 8-13) are referred to as the base case.

5.1 Alternative initial harvest levels and harvest flows over time

The base case harvest forecast shown in Figure 8 was defined using criteria such as maximum rate of decline per decade, avoidance of large harvest shortfalls, and maintenance of a fairly constant growing stock level over the long term. While the last of these criteria is linked to maintaining the productivity of forest land, and is therefore a legislated requirement, the other criteria are not requirements, rather they are attempts to avoid both excessive changes from decade-to-decade, and significant timber shortages in the future which might limit future options. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short-term and long-term harvests.

Figure 14 compares two harvest flow alternatives to the base case. If the initial level is set at the current harvest level of 480 000 cubic metres per year, and maintained for 20 years, a fairly significant shortfall appears between years 130 and 150. If the initial harvest is set at 480 000 cubic metres per year, and then reduced immediately in 10 years to the long-term level (a reduction of 80 000 cubic metres per year or 16.7%), there is a small shortfall 140-150 years from now, as in the base case.

5 Timber Supply Sensitivity Analyses

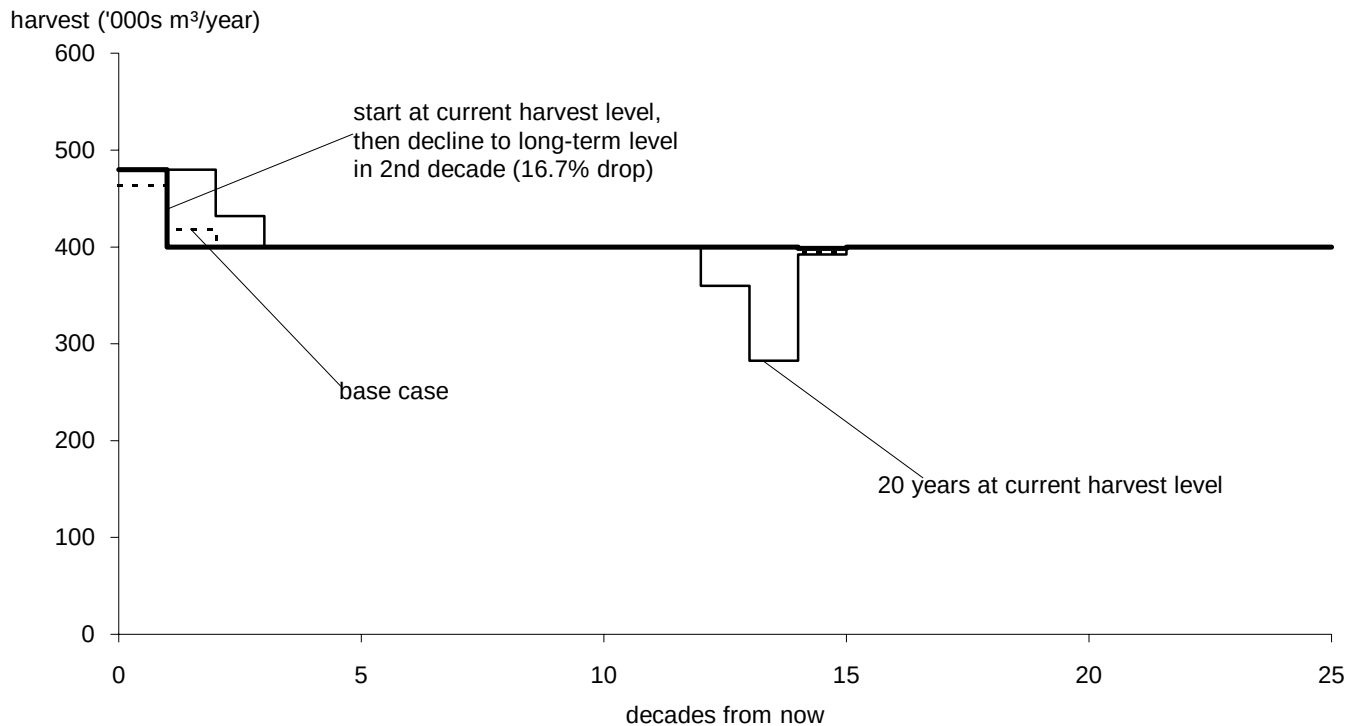


Figure 14. Alternative harvest flow patterns using base case data — Kalum South, 1994.

The above harvest flow alternatives all assume use of existing timber and future timber growth at a maximum rate, since all alternatives show at least minor shortfalls. It would also be possible to reduce the harvest immediately to the long-term level. This would mean that, based on current knowledge and management, surplus merchantable timber would exist beyond both the forest cover objectives of current management, and timber harvest targets.

5.2 Uncertainty in existing timber volumes

Estimates of timber volumes in existing stands are subject to uncertainty because they are based on extrapolation of statistics from some stands to all stands in an area, and on inventory classifications which contain uncertainty. The volumes are more accurate when averaged over large areas, than they are for estimating volumes in a specific stand.

5 Timber Supply Sensitivity Analyses

Figure 15 demonstrates that timber supply over the next several decades is very sensitive to uncertainty in existing volume estimates. If existing volumes are actually 20% greater than those used

for the base case, the current harvest level of 480 000 cubic metres per year could be maintained for almost 80 years before declining to the same long-term level as in the base case.

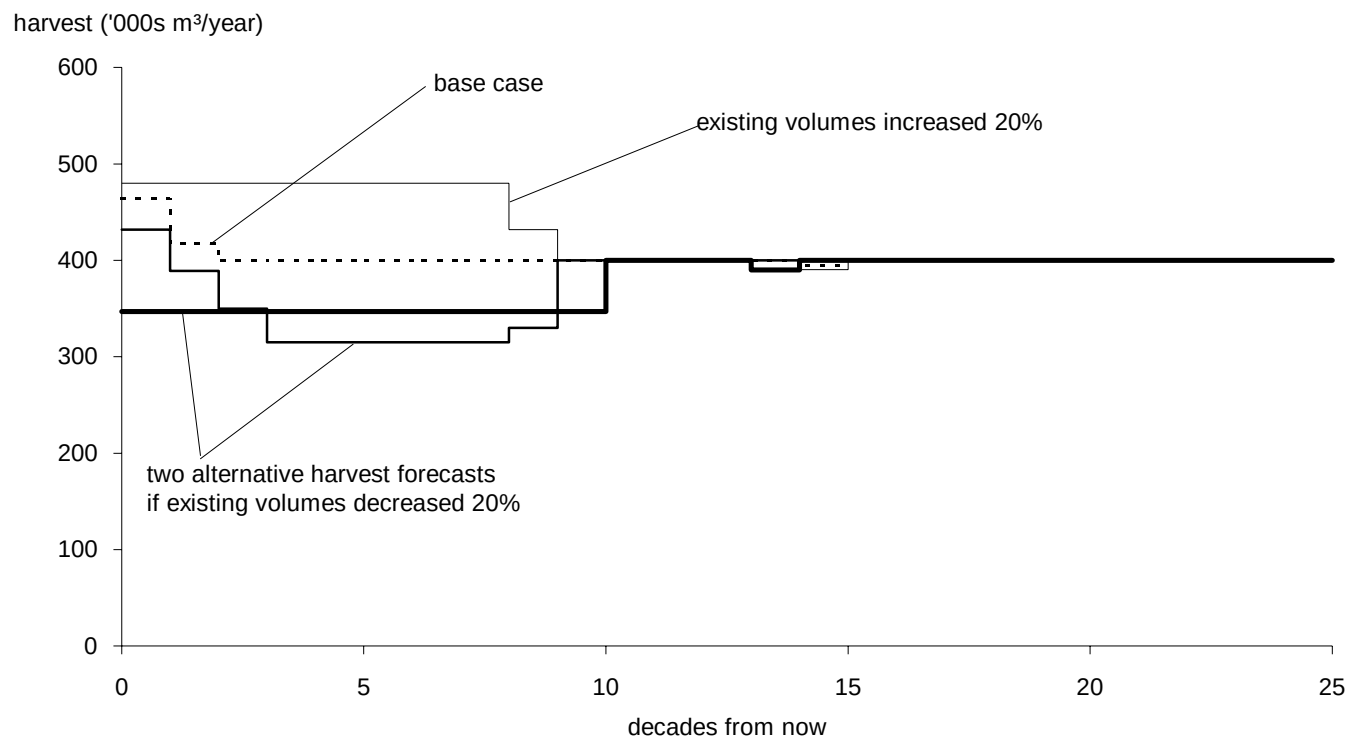


Figure 15. Harvest forecast for 20% uncertainty in existing stand volumes — Kalum South, 1994.

Conversely, if existing volumes are in fact overestimated by 20% for the base case, harvests would need to decline immediately from the current level to avoid severe harvest shortfalls in future years. One alternative would be to decline immediately to 347 000 cubic metres per year for the next 100 years before rising to the base case long-term level. This would be an immediate drop of 133 000 cubic metres per year, or 28%, from the current level, and would be 53 000 cubic metres per year or 13% below the long-term level. A second alternative would be to start at 10% below the current harvest, or 432 000 cubic metres per year, then decline by 10% per decade to 315 000 cubic metres per year and remain at that level for almost 60 years. The initial harvest level could be higher for this alternative if the allowable rate of decline were greater (for example, 15% rather than 10% per decade). The higher initial harvest in the

second alternative is achieved only by declining to a level below the harvest in the first alternative for many years. These two harvest flow alternatives illustrate the trade-off between short- and long-term benefits and costs that exists when harvests must decline in the near future to a level that is sustainable in the long term.

One method for determining whether actual volumes are likely higher or lower than the estimates is to compare the estimates with field data such as timber cruises. An average volume from 50 recent timber cruises in Kalum South was 476 cubic metres per hectare. The average volume projected to be harvested over the first 20-year period in this analysis is 583 cubic metres per hectare. The average cruise volume is therefore about 18% less than the existing volumes indicated in the base case. Since the timber cruises referred to were not designed as a

5 Timber Supply Sensitivity Analyses

statistical sample of all forest types in Kalum South, this comparison cannot support a conclusion that existing volumes are overestimated by 18%.

However, the evidence does suggest that actual harvested volumes may be lower than estimated in the base case.

This sensitivity analysis shows that timber supply over the next several decades is very sensitive to uncertainty about volumes in existing mature stands. **Kalum Forest District staff believe the existing mature volumes used in the base case overestimate actual yields.** This uncertainty does not affect the harvest level that could be sustained over the long term.

5.3 Uncertainty in minimum harvestable ages

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Minimum harvestable ages define when second growth will be available for harvest, and therefore determine how quickly existing stands

may be harvested. The time at which stands will become merchantable is highly uncertain, partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, the minimum age is estimated to be the age at which the stand reaches an average growth rate within 5% of the maximum (or culmination of mean annual increment (MAI)*). This age was chosen to ensure that the long-term production of the timber harvesting land base is close to its maximum. The minimum harvestable ages are minimums; stands may be harvested at older, but not younger, ages. If necessary to meet management objectives, forest cover guidelines would override the minimum harvestable ages. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Mean annual increment (MAI)

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

5 Timber Supply Sensitivity Analyses

Figure 16 shows how timber supply would change if stands become merchantable 20 years sooner than assumed for the base case. The figure shows two potential outcomes of younger minimum harvestable ages. If it were desired to maintain the long-term level close to the base case, harvests could remain at the current level (480 000 cubic metres per year) for 20 years before declining to a long-term level of 390 000 cubic metres per year, 10 000 cubic metres per year less than the base case. A second alternative would be to sacrifice long-term productivity and maintain higher short-term harvests; the current harvest level could be maintained for 50 years before beginning a decline to a long-term level 25 000 cubic metres per year less than the base case. Younger minimum harvestable ages reduce the long-term harvest level because stands are harvested before they attain their

maximum average growth rate. Higher harvests in the short term mean that existing stands will be harvested more quickly, and that second growth must be harvested at younger ages. Harvesting over the next 50-70 years will set up a cycle of harvesting and growth that will continue into the future; that is, if existing stands are depleted more quickly, and consequently second growth is harvested at younger ages, second-growth harvesting must continue at the younger ages in subsequent years to achieve the long-term harvest target. With younger minimum harvestable ages, the base case long-term level could be achieved only by reducing harvests at some time to well below the long-term level for several decades and then increasing harvests. In short, younger harvest ages allow higher short-term harvests, but at the expense of long-term harvests.

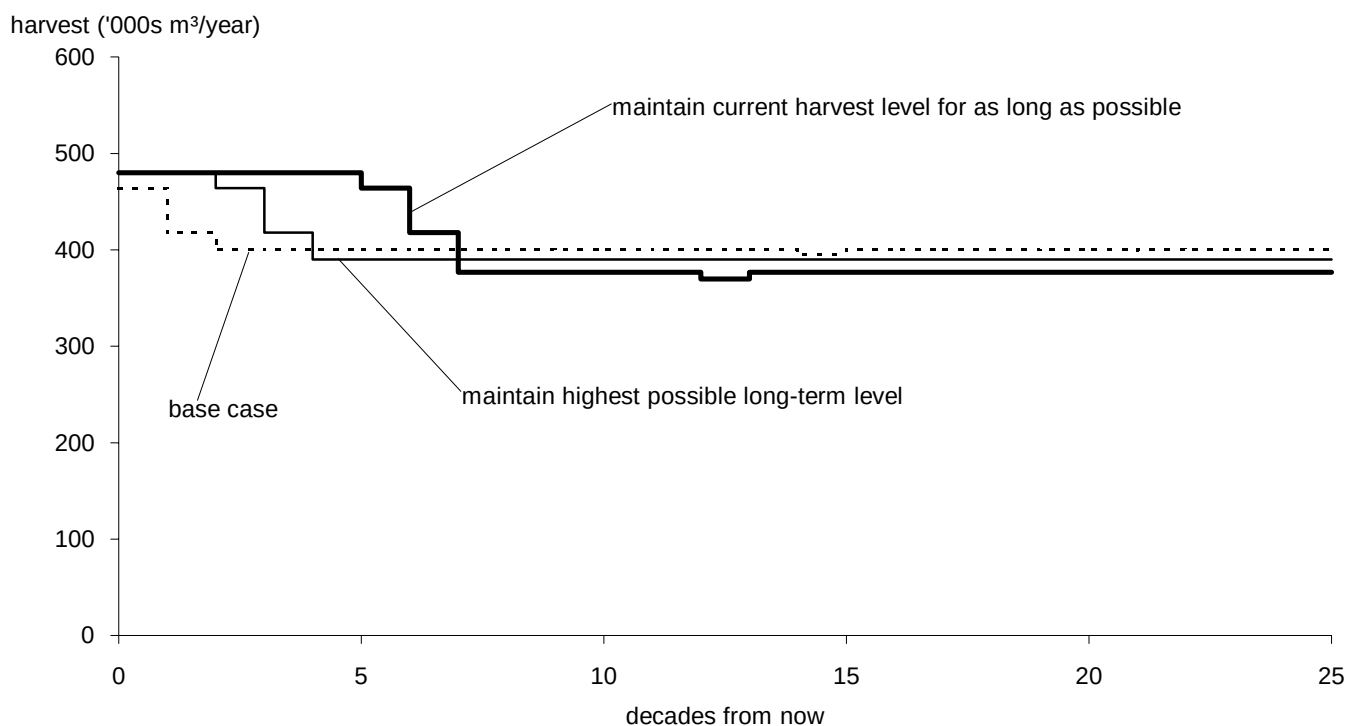


Figure 16. Harvest forecasts if minimum harvestable ages are 20 years younger than base case — Kalum South, 1994.

5 Timber Supply Sensitivity Analyses

Figure 17 illustrates the changes in timber availability if it were assumed that stands actually take 20 years longer to reach merchantability. Two basic harvest flow alternatives are shown. One is to begin at the base case initial level (464 000 cubic metres per year), decline to 350 000 cubic metres per year (50 000 cubic metres per year below the base case long-term level), and then about 100 years from now, rise to a long-term level slightly greater

than in the base case. A second alternative would be to decline immediately to 371 000 cubic metres per year for 100 years, and then increase to the long-term level of 404 000 cubic metres per year. The long-term level is slightly higher than in the base case because stands are harvested nearer to the point of maximum average growth. The change is not as large as when minimum harvestable ages are younger.

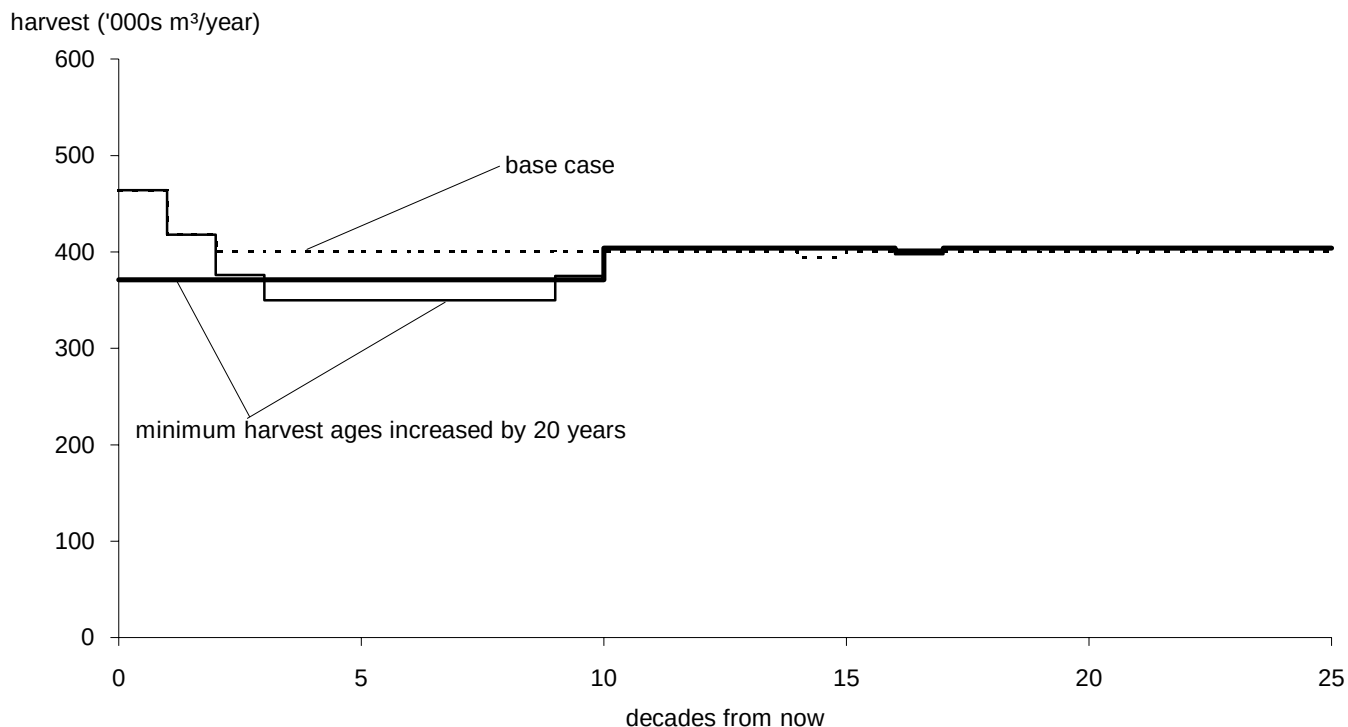


Figure 17. Harvest forecasts if minimum harvestable ages are 20 years older than base case — Kalum South, 1994.

5 Timber Supply Sensitivity Analyses

As well as affecting timber volumes available for harvest, changes to minimum harvestable age could also affect the age composition of the forest. To emphasize this, Figure 18 compares the ages at which stands would be harvested over time with the different minimum harvestable ages. The average harvested ages when minimum harvestable ages are decreased by 20 years correspond to the harvest forecast of 50 years at the current harvest level from Figure 16. Over the last 70 years of the horizon,

average harvested age ranges from 130 to 135 years for the base case, from 145 to 150 years when minimum harvestable ages are 20 years older, and from 100 to 110 years when minimum harvestable ages are decreased. While the same forest cover objectives for adjacency, old growth, and visual quality apply in all forecasts shown, changes to minimum harvestable ages would affect the overall age composition of the forest, and consequently the size and value of the timber.

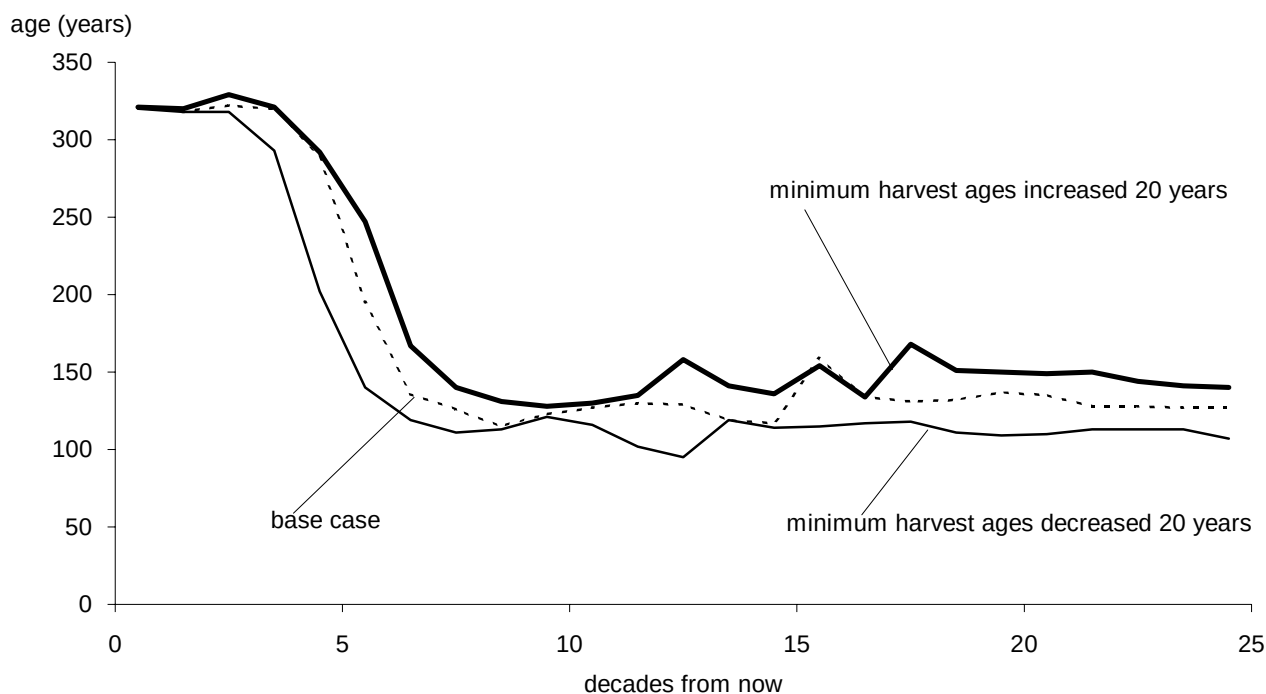


Figure 18. Comparison of average harvested ages when minimum harvestable age is varied — Kalum South, 1994.

These results show that timber supply over the next 100 years is very sensitive to uncertainty in harvest ages for second growth. Long-term supply is less sensitive to this uncertainty, however younger

ages do reduce the long-term level noticeably. Changes to minimum harvestable ages do not remove the necessity of eventually declining to a level sustainable in the long term.

5 Timber Supply Sensitivity Analyses

In this analysis, minimum harvestable ages are not viewed as decisions made to meet forest cover objectives, but rather approximations of the timing of merchantability. This analysis highlights that timber supply is highly sensitive to uncertainty about this timing. Whether minimum harvestable ages used in the base case are appropriate, optimistic, or pessimistic is largely a matter of opinion, at least in the absence of clear evidence that second-growth productivity is significantly higher than estimated in the base case. These issues are discussed here because of all variables important to timber supply, minimum harvestable ages are perhaps the most uncertain, at least in areas like Kalum South where most second growth will not be harvested for many years. Other variables are based on sampling data and experience, or management decisions. Minimum harvestable age, however, will depend on technology and markets well into the future.

5.4 Uncertainty in site productivity

The productivity of a site largely determines how quickly trees will grow, and therefore affects both expectations of timber volumes in regenerated stands, and the age at which those stands will reach merchantable size. The most accurate assessments of site productivity come from stands between 30 and 150 years old. Estimating site productivity in both young and old stands is difficult. Growth in young stands often depends on recent weather, stocking (number of trees per unit area), and

competition from other vegetation as much as on site quality. Old stands have not been subject to management of stocking, and trees used to measure site productivity may have grown under intense competition or been damaged, and therefore not reflect actual site potential. However, as the current age composition chart (Figure 6) shows, Kalum South has limited forest area in the 30-150 year range. This section examines how timber supply is affected by uncertainty in site productivity estimates that determine both regenerated stand volumes and, potentially, minimum harvestable ages. Site productivity could also affect green-up age; however this was not evaluated here, (see Section 5.9, "Uncertainty in green-up ages.")

Kalum Forest District staff feel that data used for the base case most likely underestimate site productivity, mostly due to difficulties in determining productivity of sites currently under old growth. District staff supplied some subjective estimates of site productivity for second growth based on field observations. On average, if these estimates are accurate, regenerated stand volumes would be 50% higher and minimum harvestable ages would be 20 years younger than in the base case. It should be noted that these are subjective estimates predominantly from the Kitimat River area and are not based on extensive field study. The changes to volumes and minimum harvestable ages used here are broad averages; different species and sites would be affected differently by any changes to site productivity.

5 Timber Supply Sensitivity Analyses

Figure 19 displays how timber supply might change if current data underestimates actual site productivity. If regenerated stand volumes are increased by 50% above base case levels, and minimum harvestable ages are decreased by 20 years, it would be possible to maintain the current harvest level (480 000 cubic metres per year) for 50 years, before experiencing a small dip, and then rising to a long-term level of 570 000 cubic metres per year 60 years from now. The first 60 years of this harvest forecast are the same as when only minimum harvestable ages are decreased by 20 years (Section 5.3, "Uncertainty in minimum

harvestable ages," Figure 16). If regenerated stand volume estimates are increased by 50%, but minimum harvestable ages are left at the base case levels, the harvest forecast follows the base case for 70 years before increasing to a long-term level 50% greater than in the base case (600 000 cubic metres per year). This observation demonstrates that the increased timber supply over the next few decades is due largely to decreased harvest age, not increased volume.

Harvesting at younger ages reduces the long-term level, since trees would be harvested before they reach their maximum average growth.

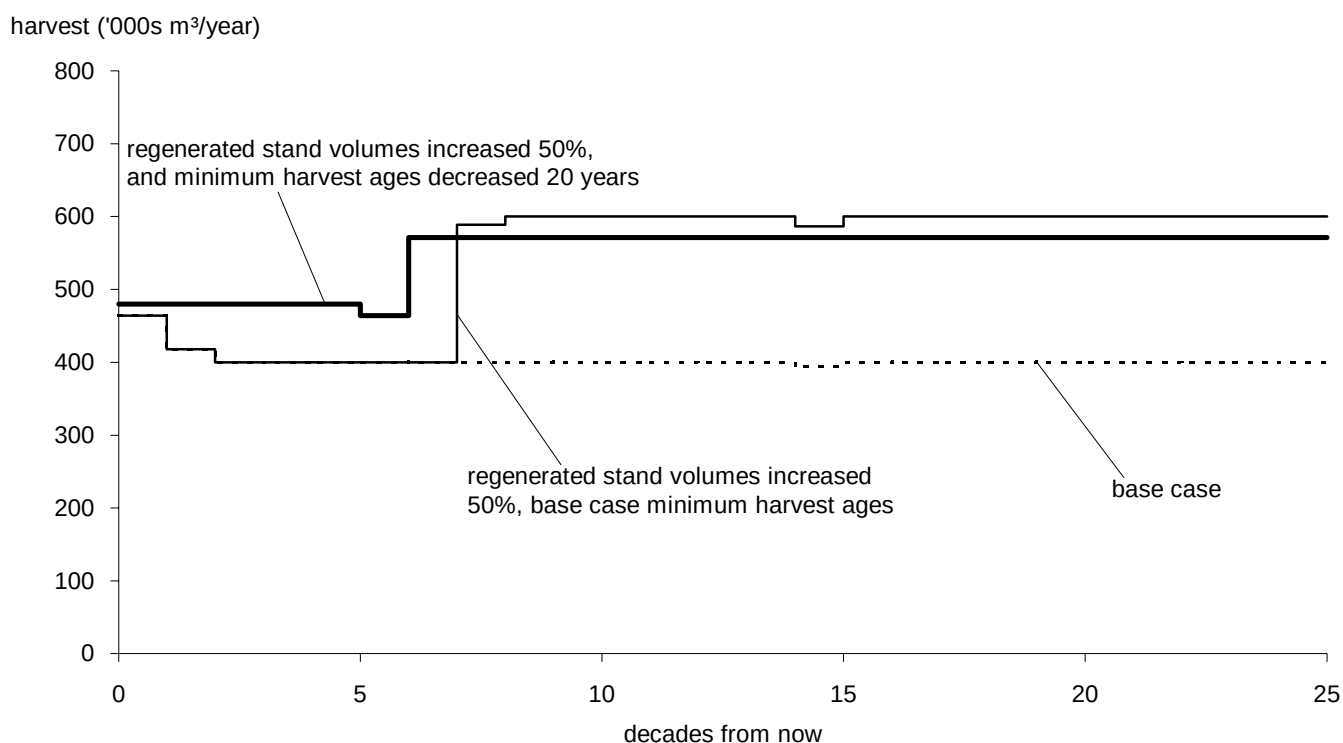


Figure 19. Harvest forecasts if site productivity 50% greater than in base case — Kalum South, 1994.

5 Timber Supply Sensitivity Analyses

While subjective evidence from Kalum Forest District staff suggests that site productivity is underestimated using current inventory data, it is also possible that productivity may be overestimated. For instance, harvesting and road building may result in site degradation; or unforeseen disease, insect, or animal pests may reduce growth. Figure 20 shows how regenerated stand volumes reduced by 50%, together with minimum harvestable ages increased by 20 years, would affect timber supply. While the long-term level is well below the initial harvest, sufficient existing volume exists so that harvests could decline in a controlled fashion (10% per decade) over the

next 80 years to reach a sustainable level of 200 000 cubic metres per year. Therefore, if current estimates of site productivity actually overestimate actual potential, harvests over the next 20 years would not need to decline from the base case levels. A controlled decline could be implemented as long as any decrease from current estimates of site productivity was discovered in the near future. It should be noted that no evidence was provided that site productivity might be 50% less than estimated for the base case. This analysis was performed only to illustrate the implications of uncertainty about site productivity estimates.

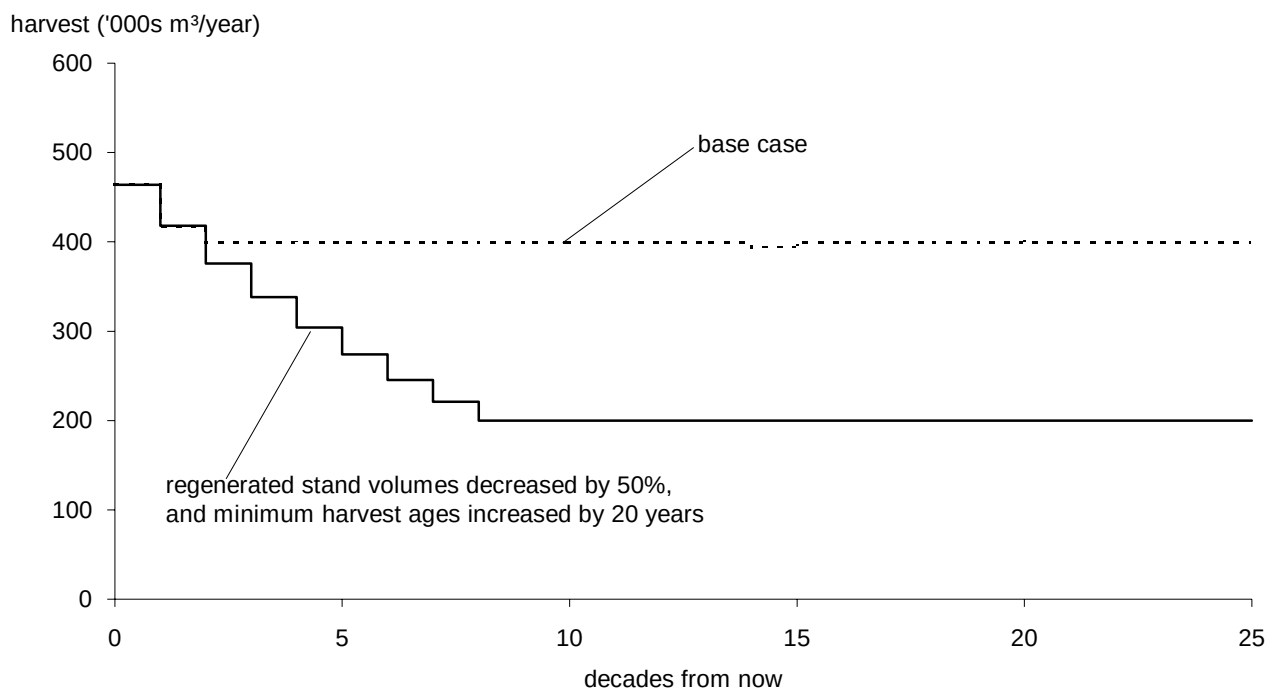


Figure 20. Harvest forecast if site productivity is 50% less than base case — Kalum South, 1994.

In summary, uncertainty about site productivity quite dramatically affects long-term harvest levels. Increased site productivity could allow maintenance of the current harvest level for several decades, but the increased long-term level could not be attained until 60-70 years from now. The increase in available timber in the short term

would be due almost entirely to decreased minimum harvestable age. Decreased site productivity would require continued declines in harvest levels over the next 80 years, but immediate harvest level reductions relative to the base case would not be required to avoid future timber shortages.

5 Timber Supply Sensitivity Analyses

5.5 Uncertainty in regeneration delay

Regeneration delay is the time between harvesting and establishment of a new stand by either planting or natural regeneration. Regeneration delays for the base case are 3 years for planted areas (all good sites and half of medium sites), and 6 years for areas subject to natural regeneration (all poor sites and half of medium sites). This section discusses how timber supply would be affected if stands are actually re-established more quickly or more slowly than assumed for the base case.

Figure 21 demonstrates that if regeneration delays are longer than base case values timber supply would be affected most in the long term. If delays are actually 5 years longer than in the base case, harvests over the next 20 years would not be affected, but the long-term level would drop to about 3.8% (15 000 cubic metres per year) below the base case. If, on the other hand, regeneration delays are actually zero — trees are established as soon as a site is harvested — harvests could begin at the current level and then decline to a long-term level 17 000 cubic metres per year or about 4.2% greater than in the base case.

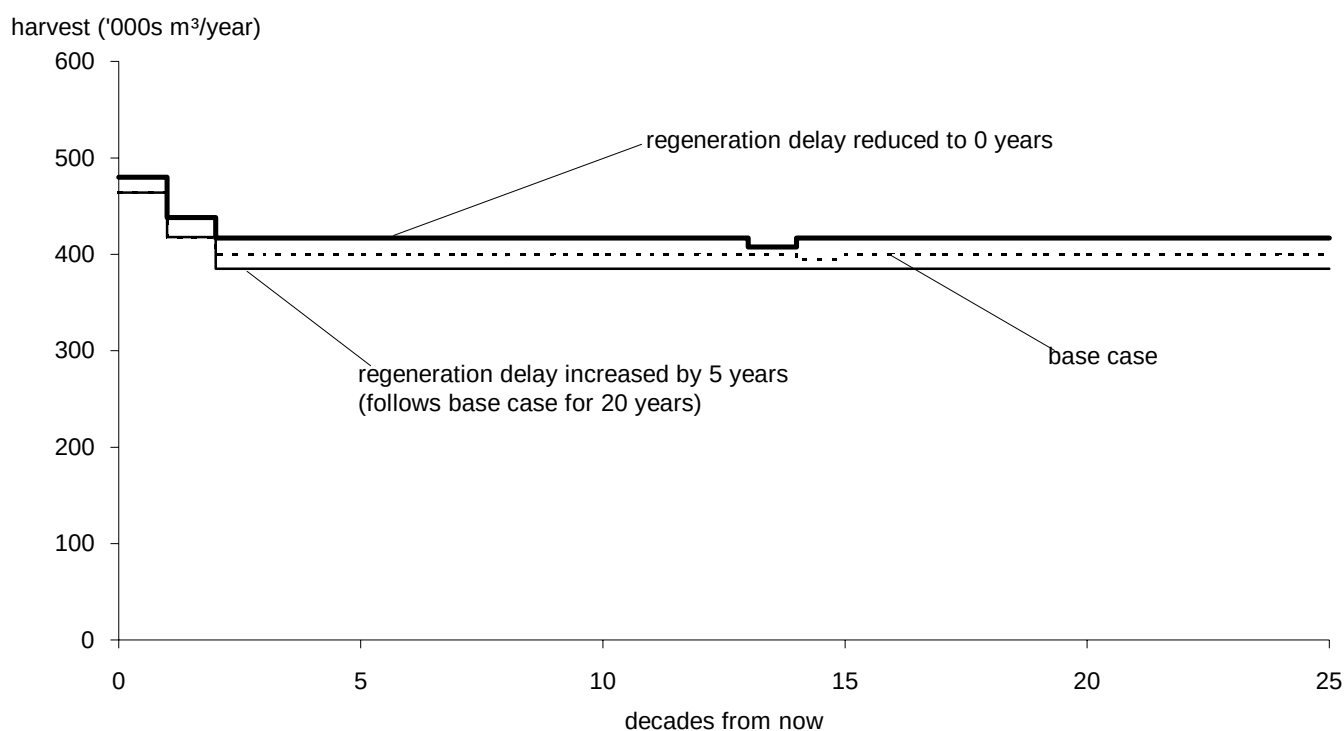


Figure 21. Harvest forecasts if regeneration delays diverge from base case — Kalum South, 1994.

The effect on timber supply is due to both changes in green-up periods, particularly for visual quality objective areas, and changes in the average land base productivity resulting from longer or shorter regeneration delays. For example, a shorter regeneration delay means that a stand would reach

a specific volume in a shorter period than a stand with a longer delay. The average production (volume divided by time between successive harvests) of the stand experiencing no regeneration delay is therefore higher.

5 Timber Supply Sensitivity Analyses

5.6 Uncertainty in land base available for harvesting

Defining the timber harvesting land base involves several assumptions about the types of forest land that are available for harvesting. The forest cover inventory, an operability classification, and forest development plans were used to approximate which stands are merchantable and physically operable. Since approximations were used to define the land base, and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the harvesting land base under current management. A specific example relates to classification of land according to its physical operability. The timber harvesting land base for the base case includes area classified as operable only for non-conventional harvesting systems such as long-line skylines* and helicopter systems (about 6% of the total harvesting land base and 11% of the area greater than minimum harvestable age). Limited harvesting has occurred to date in these areas, so it is uncertain whether they should be included in the land base. Conversely, changing markets and technology may expand the merchantable and physically accessible area.

Other potential sources of uncertainty about the area considered available for timber harvesting include:

- the size of streamside buffers needed to protect fish habitat. Stream buffer widths used for the base case are the minimums suggested in the *British Columbia Coastal Fisheries/Forestry Guidelines*. Increased experience with fish/forestry interactions may indicate different sized buffers are required.
- the area reserved from harvesting to protect old growth.

- outcomes of land use planning processes such as the Protected Area Strategy and the ongoing Kalum South Land and Resource Management Plan. The Timber Supply Review process focuses on current forest management, not on future management and land use decisions made in public planning processes. However, the analysis provides information useful for these processes.

To assess the sensitivity of timber supply to uncertainties in the size of the timber harvesting land base, the area in old-age forest stands on poor and medium productivity sites (areas about which inclusion in the harvesting land base is most uncertain) were increased and decreased by 15%.

Increasing areas in these specific forest types increases the timber harvesting land base by 6%, and increases the currently merchantable timber volume by 13% from base case levels. Decreasing the areas decreases the land base and inventory by the same amounts.

Figure 22 displays the effects on timber supply of the uncertainty about the size of the harvesting land base. An increased land base would allow harvesting at the current level (480 000 cubic metres per year) for 30 years, followed by a decline by year 41 to a long-term level 4% greater than in the base case.

The graph shows two basic harvest flow alternatives for a smaller harvesting land base. One alternative is to drop immediately to 366 000 cubic metres per year for 50 years, and then rise to a long-term level of 384 000 cubic metres per year, 4% less than the base case. A second flow alternative is to begin at the base case initial level, decline by 10% per decade to 350 000 cubic metres per year by year 30, and remain at that level for almost 50 years before rising to the long-term level.

Long-line skylines

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

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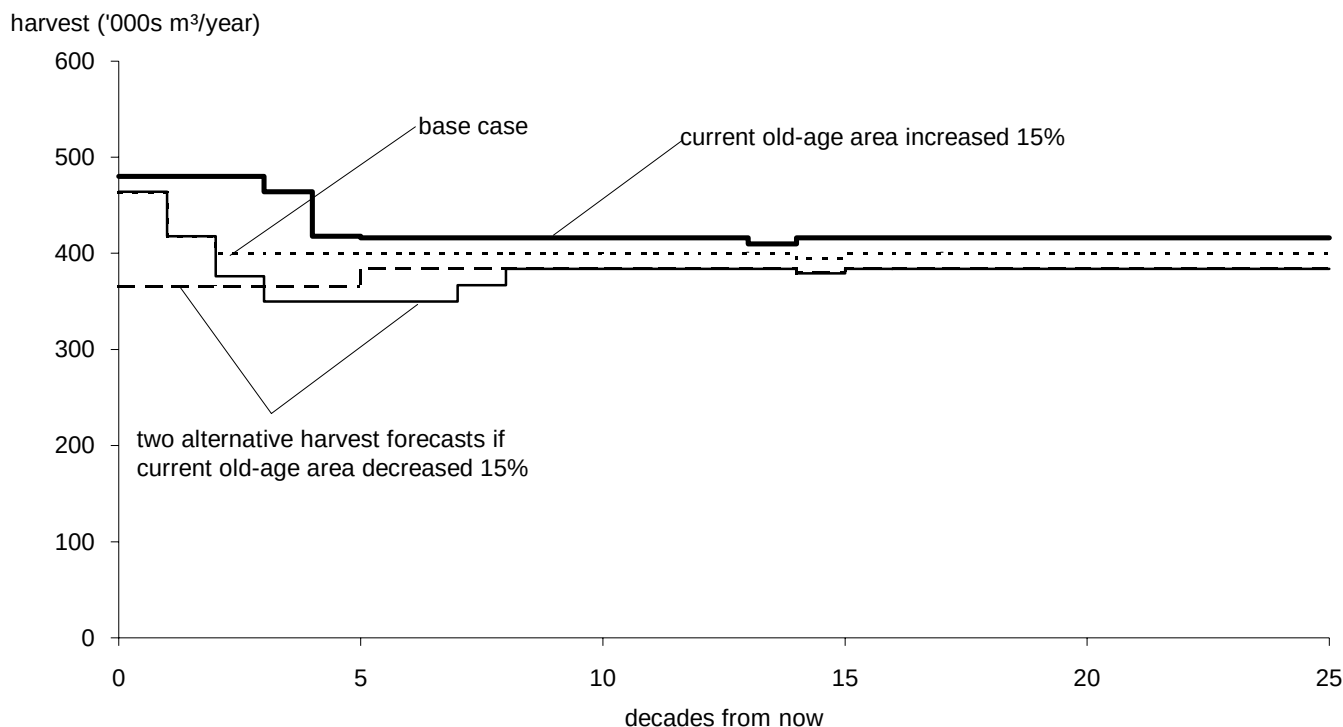


Figure 22. Harvest forecasts reflecting uncertainty in size of the harvesting land base (areas in existing old growth on medium and poor sites increased and decreased 15%) — Kalum South, 1994.

Changing the land base by 6% results in only a 4% change in the long-term land base productivity because the areas added or subtracted are of lower than average productivity.

In summary, timber supply over the next 50 years is very sensitive to uncertainty in the harvesting land base. An increased land base would allow continued harvesting at the current level; a smaller land base would require either a substantial immediate harvest reduction, or several decades of harvests well below the long-term level 30 to 80 years from now. Long-term timber supply is also sensitive to land base uncertainty, but not to the same degree as short-term supply.

5.7 Uncertainty in forest cover objectives for visual quality

Visual quality objectives (VQOs) are stated in terms of the degree to which forestry activities should be visible. The B.C. Forest Service, Recreation Branch has provided a range of visible disturbance limits for each VQO category (stated as a maximum per cent area younger than the green-up age). Different disturbance limits will meet a particular objective for visual quality (for instance, partial retention),

depending on the terrain and forest in the area. For this analysis, determining forest cover objectives for areas with different VQOs involved a series of calculations to incorporate information on visual sensitivity, and differing degrees to which forest outside the harvesting land base can contribute to visual objectives (see Appendix A, "Description of Data Inputs and Assumptions.")

Uncertainty about forest cover objectives may arise from inventory and classification of land into VQO and sensitivity categories, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality. This section investigates how uncertainty in the VQO classification, and in forest cover guidelines for visual quality affect timber supply.

Classification of areas into VQO categories is still in progress in Kalum South. VQO classification involves initial recommendations by Forest Service recreation staff, followed by adjustment and/or approval by management staff. In Kalum South, the final VQO classification will be determined through the Kalum South Land and

5 Timber Supply Sensitivity Analyses

Resource Management Plan, a public process. VQOs have been assigned, and received management approval in most areas visible from Highways 16 and 37. VQOs have not been assessed for the lower Nass portion of the Nisga'a highway. VQOs for the remaining areas visible from the Nisga'a highway, and areas in the Kitimat Municipality visible from the Douglas Channel have not been reviewed by management staff. These areas were assigned an interim VQO of modification for the base case. Therefore, there is uncertainty about how much of the visually important area should be in each class.

To assess the possible effects of uncertainty in VQO classification, area was shifted to the next more, or less, restrictive VQO class (restrictive here means the degree to which harvesting should be noticeable). To examine the effects of more restrictive classification, 50% of the area with a modification VQO (the least restrictive class) in the base case was shifted to partial retention (the next most restrictive class), and 50% of the area in partial retention was shifted to retention/preservation (the most restrictive class). Conversely, the effect of less restrictive classification

was assessed by shifting 50% of the area from retention/preservation to partial retention, and from partial retention to modification. The overall area subject to visual quality management remained constant.

Figure 23 shows how potential harvest levels would be affected by a change in the relative area in each VQO category. Two potential harvest forecasts are shown for the case in which more visually important area is in more restrictive VQO categories. One potential forecast shows the harvest level reduced immediately to about 7% below the base case long term level (374 000 cubic metres per year) and then rising to a long-term level about 2% less than in the base case. An alternative would be to start at the base case initial level, and then decline to 350 000 cubic metres per year 30 years from now, remaining at that level for almost 40 years. There is therefore a trade-off between the short- and long-terms: short-term harvests can be maintained at a higher level only by allowing future harvests to decline substantially, and remain well below the long-term level for many years.

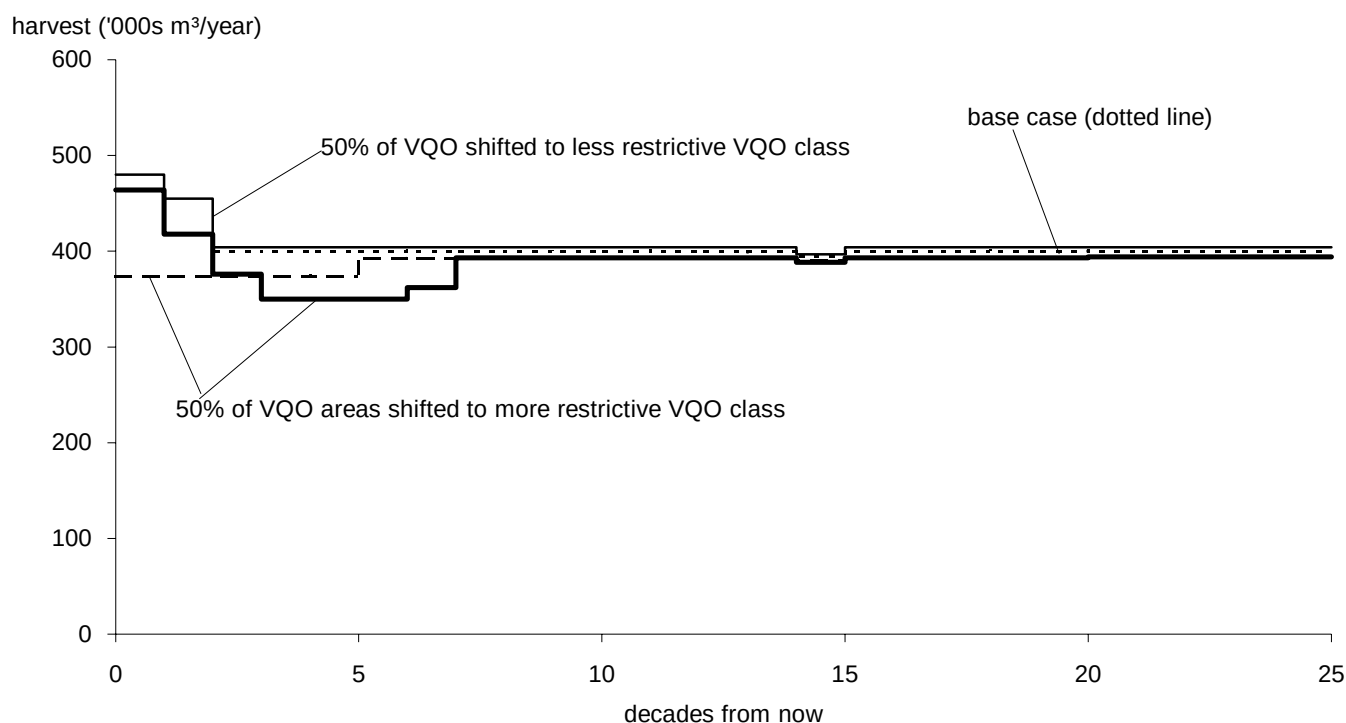


Figure 23. Harvest forecasts if 50% of areas subject to visual quality management shifted to next less/more restrictive VQO category — Kalum South, 1994.

5 Timber Supply Sensitivity Analyses

If relatively more visually important area is in the less restrictive VQO categories, harvests could begin at the current harvest level (480 000 cubic metres per year) and then decline to a long-term level 1% higher than in the base case by 30 years from now.

Timber supply shows more sensitivity to shifts in areas to more restrictive VQO categories than shifts to less restrictive categories. This is because in the base case most of the area managed for visual quality is subject to the unrestrictive modification objective (66%), with the remainder in the more restrictive classes of partial retention (27%) and retention/preservation (7%). Therefore, since a given percentage of area is shifted for this assessment, more area is moved into more restrictive categories than to less restrictive categories.

The other source of uncertainty examined in this section is associated with forest cover objectives for visual quality. These objectives provide guidance on the amount of visible disturbance that will likely meet a particular visual quality objective.

However, there is uncertainty about the amount of forest cover actually needed to meet visual quality objectives. To examine the potential effects of this uncertainty, forest cover objectives for each VQO category were both increased and decreased by 5% (that is, adding or subtracting 5 percentage points to the visual quality forest cover objectives used in the base case).

Figure 24 illustrates that short-term timber supply is sensitive to uncertainty about VQO forest cover objectives. Increasing the allowable amount of area that does not meet green-up requirements in each VQO class by 5% would increase timber availability enough to allow harvests to remain at the current level for 20 years. The less restrictive VQO cover objectives would increase the long-term level by slightly more than 1%. Completely removing the visual quality objectives would increase timber supply only very slightly beyond the increase provided by raising allowable disturbance by 5%. Increasing the allowable disturbance by only 2% would increase available supply enough to maintain harvests at the current level for 10 years.

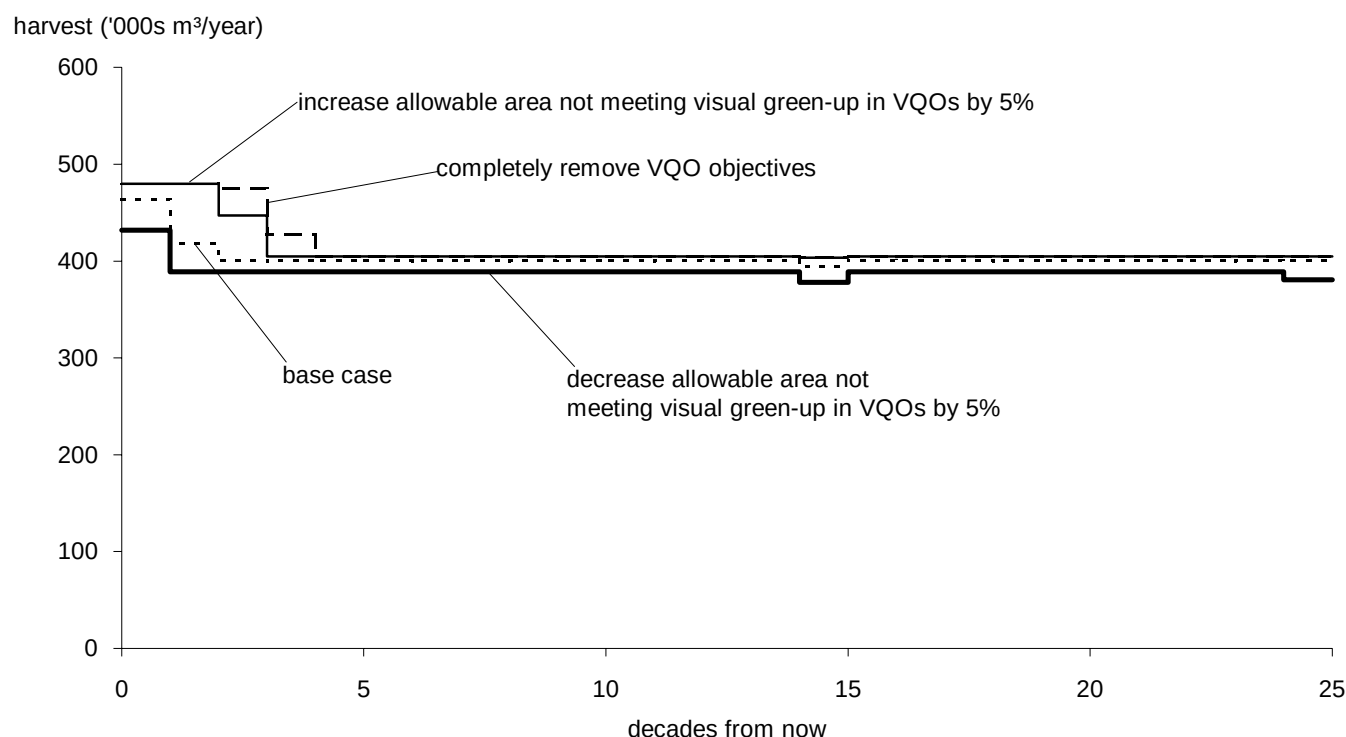


Figure 24. Harvest forecasts if forest cover objectives for visual quality management areas changed by 5% — Kalum South, 1994.

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Decreasing the allowable amount of area that does not meet green-up requirements by 5%, that is employing more restrictive guidelines than in the base case, would require immediate reduction to 10% below the current harvest level (432 000 cubic metres per year), followed by a decline to a long-term level 3% below the base case to avoid large timber shortages in the future.

Almost all of the effect on timber supply resulting from changes to either the relative area in each VQO category, or to changes in forest cover objectives for visual quality relates to the area in the more restrictive classes (partial retention and retention/preservation). The forest cover objective for modification VQOs does not affect timber supply significantly even if changed by 5%. Most of the increase in timber supply effected by less restrictive forest cover objectives, shown in Figure 24, is due to changes in forest cover objectives for areas managed for partial retention and retention/preservation visual quality. This is emphasized further by comparing Figures 23 and 24, which show that shifting area from less restrictive to more restrictive classes has a larger effect than more restrictive forest cover guidelines.

Timber supply over the next 20-30 years is sensitive to uncertainty in forest cover objectives for visual quality. If more area is in more restrictive VQO classes, or more restrictive guidelines were needed to meet visual quality objectives, harvests would either need to be reduced immediately, or decline to a level below the long-term level for many years to avoid serious future harvest shortfalls. Conversely, more area in less restrictive VQO classes, or less restrictive guidelines would increase short-term timber supply sufficiently to maintain harvests at the current level for up to 20 years.

5.8 Uncertainty in the method used to represent adjacency objectives

The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* require that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. To ensure that harvesting does not become overly concentrated in a watershed, the guidelines set a maximum limit on the overall area that has not yet reached the green-up condition. Specifically, the regional harvesting guidelines require that watersheds be harvested over a minimum of 3-passes, whereby up to 40% may be harvested in the first-pass, and 30% may be harvested in the remaining 2-passes. This analysis employs a forest cover requirement to represent this watershed level guideline, and to approximate the adjacency guidelines. Because the forest cover requirement is an approximation, it is not certain how accurately it reflects how adjacency and the pass system guidelines affect timber supply. There is some evidence that 4- or 5-passes may be required to meet adjacency objectives (Nelson and Errico 1993).

The 3-pass harvesting guideline applied in the base case does not restrict timber supply; therefore applying a forest cover requirement to mimic a 2-pass harvesting system does not increase timber availability.

If a 4-pass guideline (a maximum of 25% of the harvesting land base may be younger than green-up age) more accurately reflects harvesting restrictions that are required to meet adjacency objectives, timber supply would decline slightly relative to the base case 10 to 20 years from now (Figure 25). If harvests continue for 10 years at the initial base case level, harvests would have to drop to 406 000 cubic metres per year in the following decade.

5 Timber Supply Sensitivity Analyses

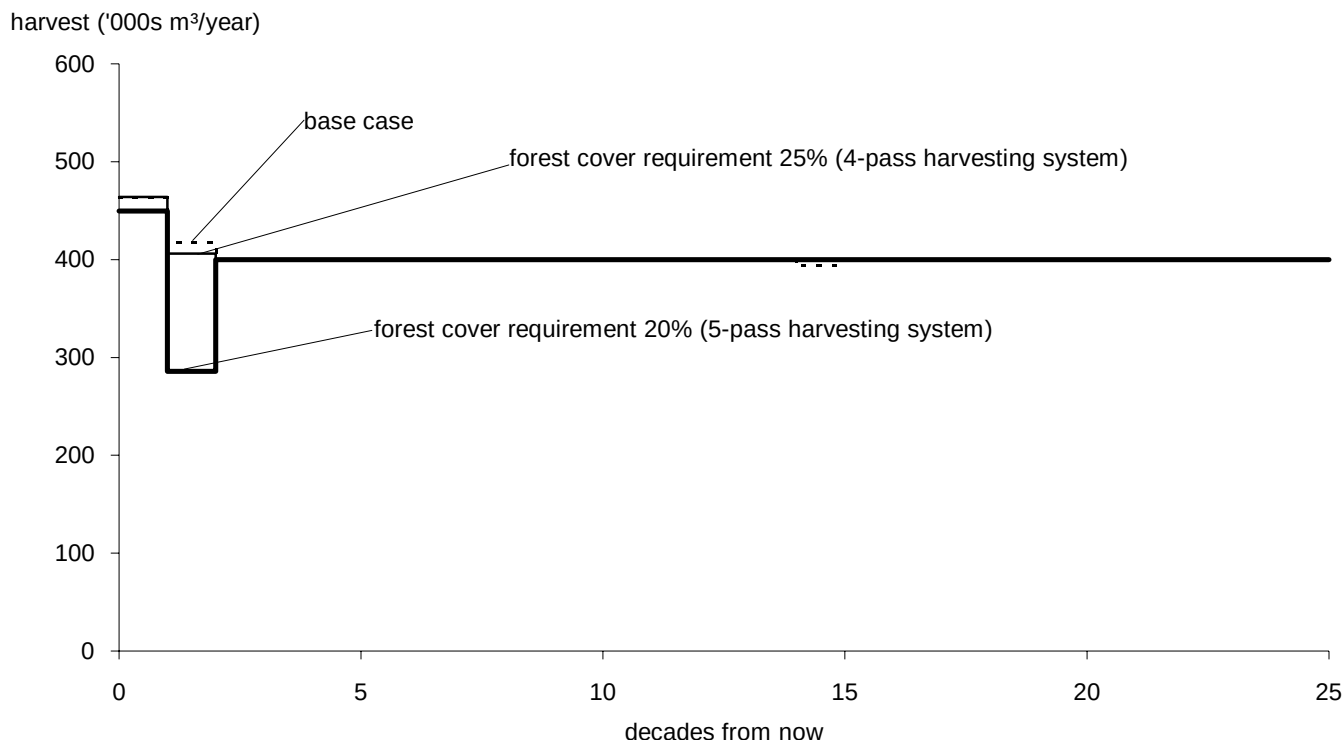


Figure 25. Harvest forecasts if forest cover requirements used to approximate adjacency and pass system guidelines were different from base case — Kalum South, 1994.

Figure 25 also shows the effects of a 5-pass harvesting guideline. While the guideline would allow harvests over the next 10 years at the base case level, it would severely limit timber availability 11 to 20 years from now.

If a 3- or 4-pass forest cover guideline for areas under general integrated resource management meet adjacency objectives, timber supply would not differ significantly from the base case. If more restrictive guidelines were needed, short-term timber supply would be substantially reduced.

5.9 Uncertainty in green-up ages

Forest cover objectives for visual quality and adjacency applied in this analysis involve estimates of when second-growth stands will reach green-up conditions, normally expressed as the desired height of a stand. Green-up age, the time needed to reach the desired condition, is determined using a growth and yield model. The green-up period includes both the green-up age and the regeneration delay, or time taken to establish a stand after harvesting. Uncertainty about green-up age arises because the desired green-up condition

may not accurately reflect actual needs, and because uncertainties about growth and yield may mean that stands will reach the desired condition sooner or later than estimated. However it is worth noting that, according to the Table Interpolation Program for Stand Yields (TIPSY), the growth and yield model used to estimate green-up age, the average site index of stands would have to increase by over 10 metres to lower the green-up age by 5 years, or decrease by over 5 metres to extend the period by 5 years. Therefore, it is unlikely that uncertainty in site productivity alone would cause large changes in green-up age.

Figure 26 shows that potential short-term harvest levels are moderately sensitive to uncertainty about green-up age. If green-up ages in the base case overestimate the time needed to meet green-up conditions by 5 years, it would be possible to harvest at the current level of 480 000 cubic metres per year for 10 years before declining to the base case long-term level by year 30. A long-term level 1% higher than the base case can be achieved starting about 100 years from now. Virtually all of the change relative to

5 Timber Supply Sensitivity Analyses

the base case is associated with shorter green-up ages in the visual quality objective areas. Even if green-up ages for areas subject to adjacency

guidelines and the 3-pass forest cover guideline were 10 years less than in the base case, timber supply would not change noticeably.

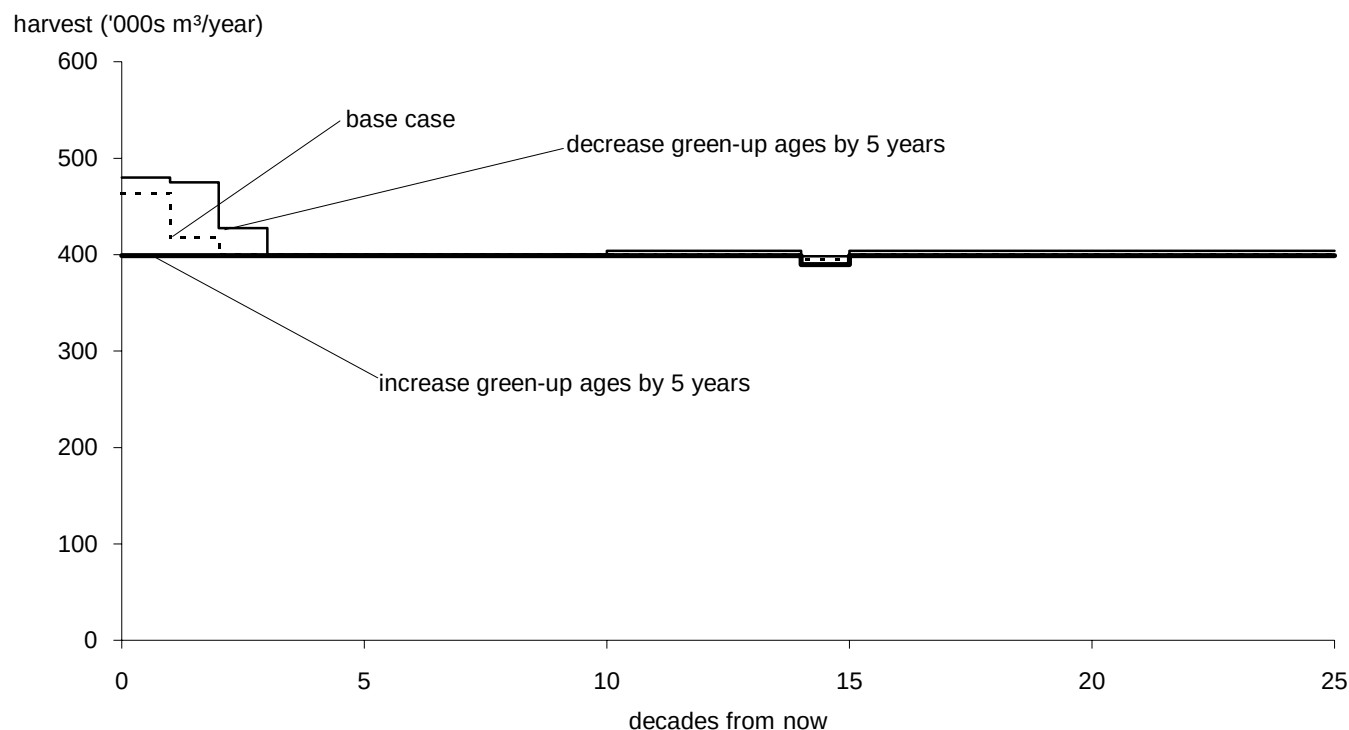


Figure 26. Harvest forecasts if green-up ages were either 5 years longer or shorter than base case — Kalum South, 1994.

If green-up ages are actually 5 years longer than estimated for the base case, harvests would have to decline immediately to a long-term level slightly lower (1000 cubic metres per year) than in the base case. Green-up ages of only 3 years more than the base case would require immediate reduction to the base case long-term level to avoid future harvest shortfalls. Again, most of the effect is due to changes in green-up ages for areas subject to visual quality objectives. Increasing only visual quality area green-up ages by 4 years would require an immediate reduction to the base case long-term

level. If green-up ages for general integrated management areas were 10 years longer than for the base case, harvests over the next 20 years would have to be about 1% less than in the base case.

Overall, fairly small uncertainty in green-up ages could have moderate effects on timber availability over the next 20 years. Most of the impact is due to uncertainty about green-up ages for VQOs. Changes in green-up ages of 3 to 5 years could either allow harvesting at the current level for 10 years, or require immediate reduction to the long-term harvest level.

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5.10 Uncertainty in forest cover objectives for old-age forest

Forest cover objectives for old-age forest used in this analysis follow guidelines requiring that at least 12% of each major forest ecosystem remain in old-growth condition. The purpose of the guideline is to protect biological diversity. Since management for biodiversity is a relatively new forest management objective of which knowledge is currently limited, the 12% figure may either over- or underestimate the old-growth area actually required to protect biodiversity. This section examines the effects on timber supply of this uncertainty.

A portion of the 12% old-growth objective is met by forest in environmentally sensitive areas, non-merchantable forest types, streamside buffers and old-growth reserves that are not in the timber

harvesting land base. In addition to these areas, a forest cover objectives for old growth was applied to represent a requirement that at least 1680 hectares, about 1.6% of the harvesting land base, remain above 150 years of age at all times. Figure 27 shows the implications to timber supply if this objective is both removed and doubled (to 3360 hectares). Removing the old-growth objective would allow the timber harvest to begin at the current level (480 000 cubic metres per year) and then decline over the subsequent 30 years to a long-term level very slightly higher (1000 cubic metres per year) than in the base case. Doubling the objective would require an immediate decline to 423 000 cubic metres per year, about 12% below the current level, and then to a long-term level 4000 cubic metres per year less than in the base case, to avoid harvest shortfalls below the long-term level.

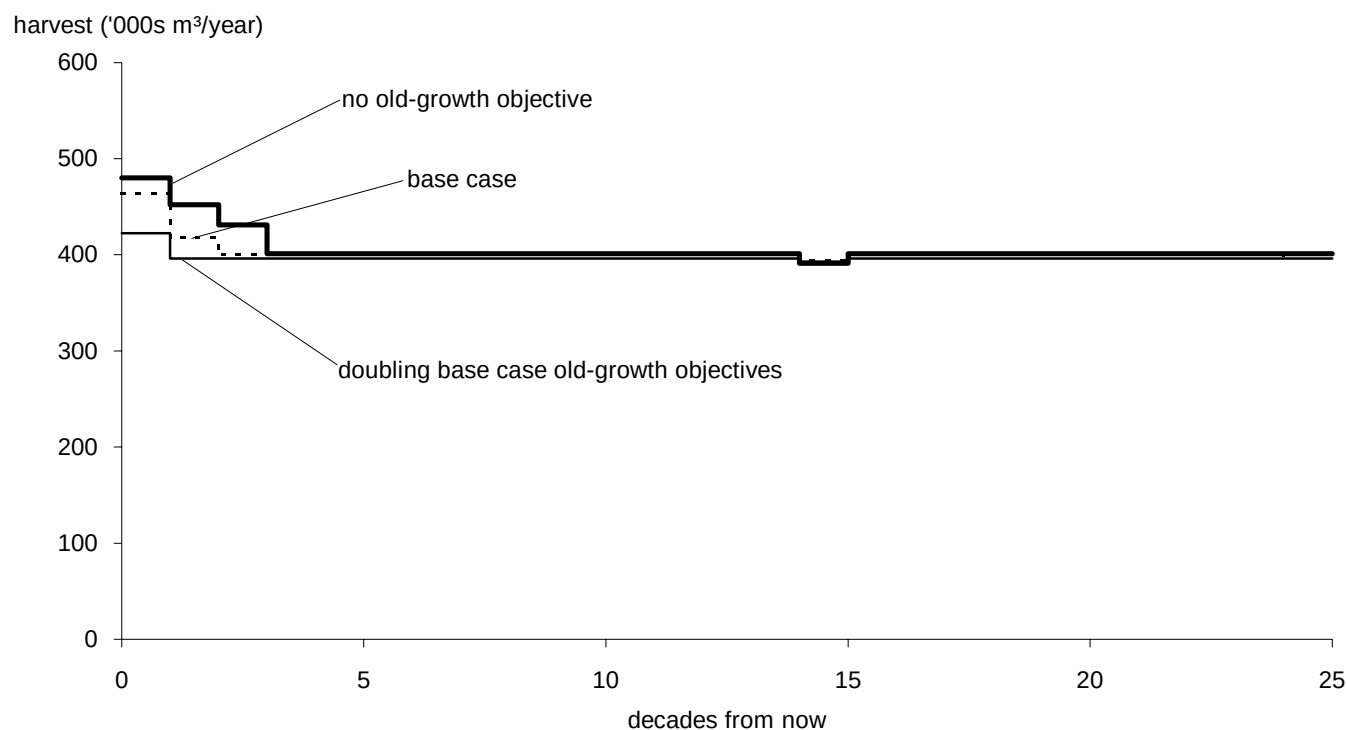


Figure 27. Harvest forecasts if forest cover objectives for old growth were different than base case — Kalum South, 1994.

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Timber supply therefore shows low to moderate sensitivity to uncertainty in the old-growth objective. Harvests over the first 30 years change by 5%-9% compared to the base case. Over the long term, the changes are about 1% when the objective is either removed or doubled.

5.11 Uncertainty in minimum age for old-age forest

Forest cover objectives for old-age forest include an estimate of the age at which stands will develop old-growth attributes. This age was estimated to be 150 years for this analysis. Because of our limited understanding about both biodiversity and old-growth structure and function, there is some uncertainty about the estimate. For example, it may be possible to create old-growth conditions in younger stands through silvicultural treatments such as thinning and pruning. This section examines how timber supply is affected by this uncertainty.

Results shown in Figure 28 demonstrate that uncertainty in old-growth age has very little effect on short-term timber supply, and almost no effect over the long term. If stands actually reach old-growth conditions at 250 years of age rather than 150 years, harvests over the next 20 years

would not be affected, and the long-term level would drop very slightly, by 1000 cubic metres per year to 399 000 cubic metres per year. An old-growth age 50 years less than assumed for the base case would allow harvests to remain at the current level for the next 10 years followed by a decline over the subsequent 20 years to a long-term level 1000 cubic metres per year greater than the base case.

Timber supply is insensitive to increases in old-growth age because most of the old-growth forest cover objective is met by reserving a portion of the timber harvesting land base from harvest. There are two methods of achieving an old-growth forest cover objective. One is to reserve the desired proportion of the land base from harvesting, essentially reducing the size of the harvesting land base. The second is to meet the old-growth objective dynamically, by harvesting some of the old-growth area when younger forest reaches old-growth age. If the first method is used, as is the case here, increases in the old-growth age have little impact on timber supply. Decreases in old-growth age have a slightly larger effect on timber supply by allowing a greater portion of the old-growth objective to be met in dynamic fashion.

5 Timber Supply Sensitivity Analyses



Figure 28. Harvest forecasts if minimum age for defining old growth was different than base case — Kalum South, 1994.

5.12 Uncertainty about commercial thinning performance

The current silviculture plan for Kalum South includes commercial thinning, and Kalum Forest District is presently locating areas for thinning. The base case assumes that overall (i.e. not annually), one-quarter of good-quality growing sites, or about 1700 hectares, will be thinned. However, the amount of thinning that will actually occur will depend on silviculture budgets and markets for the products of thinning. Also, the analysis considers single-entry commercial thinning. If economic conditions and timber growth permit multiple entries, yields from thinnings could increase slightly relative to those estimated for the base case.

Figure 29 shows that commercial thinning affects short-term timber supply slightly. The harvest forecast without commercial thinning is about 16 000 cubic metres per year lower over the first 10 years, and 15 000 cubic metres per year lower over the second 10 years than the base case. If commercial thinning was done on 75% of good sites, timber supply over the first 20 years would increase very slightly above the base case. Commercial thinning does not affect the long-term harvest level significantly.

In the context of the whole Kalum South these effects are not large. However, the results indicate that the short-term harvest levels shown for the base case depend on commercial thinning. If thinning does not continue, short-term timber supply could decrease slightly.

5 Timber Supply Sensitivity Analyses

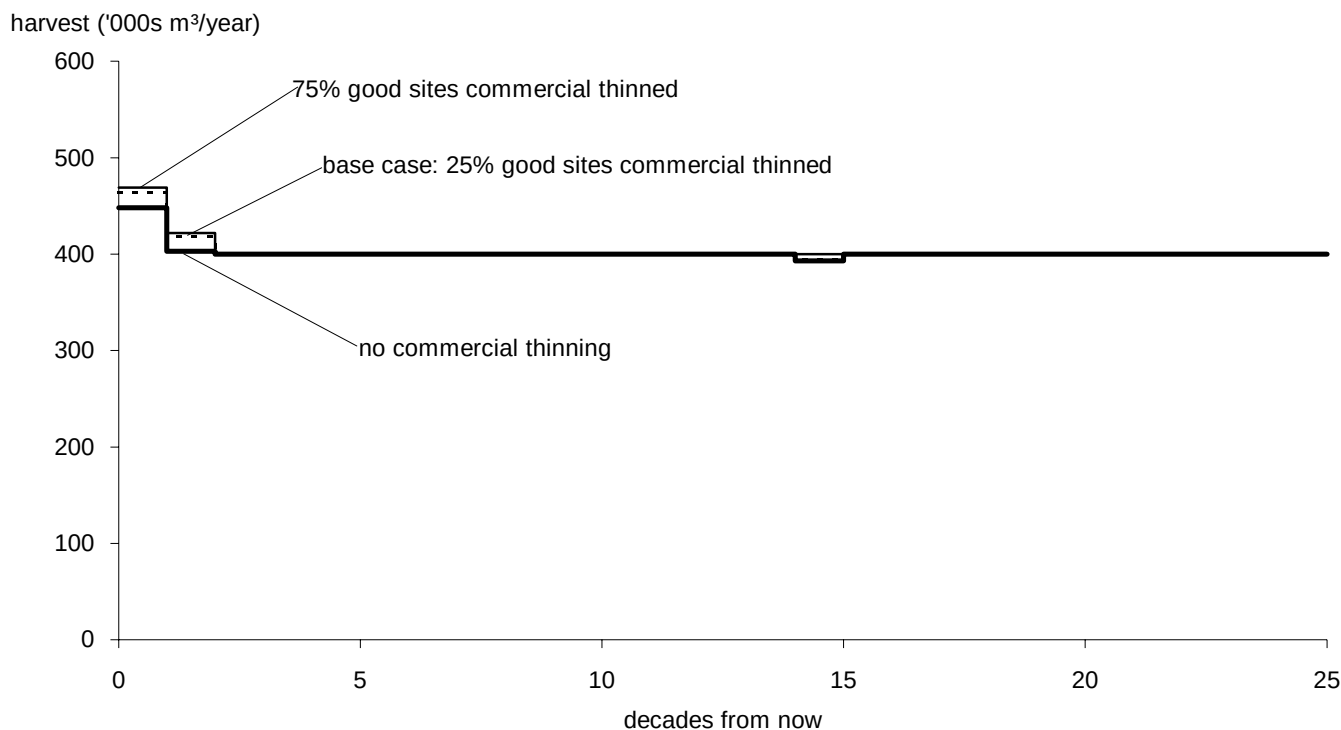


Figure 29. Harvest forecast if amount of commercial thinning changes — Kalum South, 1994.

5.13 Interaction between estimates of existing timber volumes and site productivity

Sections 5.2, "Uncertainty in existing timber volumes" and 5.4, "Uncertainty in site productivity" demonstrate that timber supply over the next several decades is very sensitive to uncertainties in volume estimates for existing old-growth stands, and site productivity estimates for second-growth stands. These results are important because: 1) recent timber cruise information indicates that volume estimates for existing stands used for the base case may overestimate actual volumes; and, 2) field observations by Kalum Forest District staff suggest that the productivity of second growth may be better than indicated by inventory information. However, the degrees to which existing stand volumes may be overestimated and future site productivity may be underestimated are not known for certain. The purpose of this section is to examine in more detail the interaction between

existing stand volumes and future stand site productivity. Specifically, the purpose is to investigate the possibility for increased site productivity to offset lower existing stand volumes.

To examine this issue: (1) existing timber volumes were decreased by 10% and 20%; and (2) to recognize that higher site productivity may mean that stands will reach a merchantable condition at younger ages, minimum harvestable ages were set at three different levels (base case, base case less 10 years, and base case less 20 years) for both levels of existing volumes. This resulted in six harvest forecasts. The analysis was guided by the question: given the decreased existing volumes and the minimum harvestable ages, by how much would second-growth volumes have to increase above base case estimates to allow harvests to follow the base case forecast without causing large future timber supply shortages? Harvests were then increased to the corresponding long-term sustainable harvest as soon as possible, again without causing future timber supply shortages.

5 Timber Supply Sensitivity Analyses

Figures 30 and 31 display the results. Generally, the earlier second growth becomes available for harvesting, the lower the second-growth volume increase would have to be to offset lower current volumes. If existing volumes are in fact significantly lower (20%) than those used in the base case, and the minimum harvestable ages assumed for the base case turn out to be accurate, it would be unlikely that increased volume production from second growth due to higher site productivity could increase timber supply sufficiently to support base case harvests (bold line in Figure 31). Conversely, if existing stand volume estimates used in the base case are within 10% of actual volumes, and second growth becomes available for harvesting significantly earlier than assumed for the base case, the necessary second-growth volume increase would be quite small (Figure 30).

Therefore, as minimum harvestable ages decrease, the increase in second-growth volumes needed to offset lower existing volumes also decreases. It would be likely however, that lower harvest ages would be made possible by higher stand volumes due to increased site productivity. The results highlight that to offset lower volumes from existing stands, second growth would have to become available sooner than assumed for the base case, as well as have higher volume.

The analysis shows that the possibility for improved timber production in second growth to offset decreased timber supply caused by lower existing stand volumes depends on: the degree to which existing volumes are overestimated in the base case; how much earlier second growth becomes available for harvesting than assumed for the base case; and the increase in volume production from second growth.

These results can also be used to approximate the interaction between uncertainty about the size

of the timber harvesting land base, and uncertainties about existing timber volumes and site productivity. Any change in the timber harvesting land base would affect both the existing merchantable volume and the effective productivity of the land base (more land would produce more timber and vice versa). So, for example, if the timber harvesting land base were actually smaller than defined for the base case, the existing timber inventory would be smaller, and overall land base production would be lower. Therefore, to counteract such a decrease, future site productivity would have to be high enough to offset both factors. Conversely, a larger land base than estimated for the base case would in part offset lower volume estimates for existing merchantable stands.

There is some uncertainty about all of these factors and this analysis can provide only an indication of how these uncertainties interact to affect timber supply. A decision on whether or not current volumes and future site productivity can offset one another requires a basis in both existing inventory data and field observations, as well as an assessment of acceptable risk. For example, if harvests are maintained at current levels based on assessments that second-growth production will be significantly higher than currently estimated, and the assessments turn out to be wrong while existing stand volumes have been significantly overestimated, future timber supply shortages will be likely. Conversely, if existing stand volumes are not substantially overestimated, and second-growth stands produce higher timber volumes more quickly than assumed in the base case, substantial benefits might be lost in the short term if harvest levels were reduced. This analysis cannot dictate which decision would be correct; it can only highlight the potential trade-offs implied by existing information.

5 Timber Supply Sensitivity Analyses

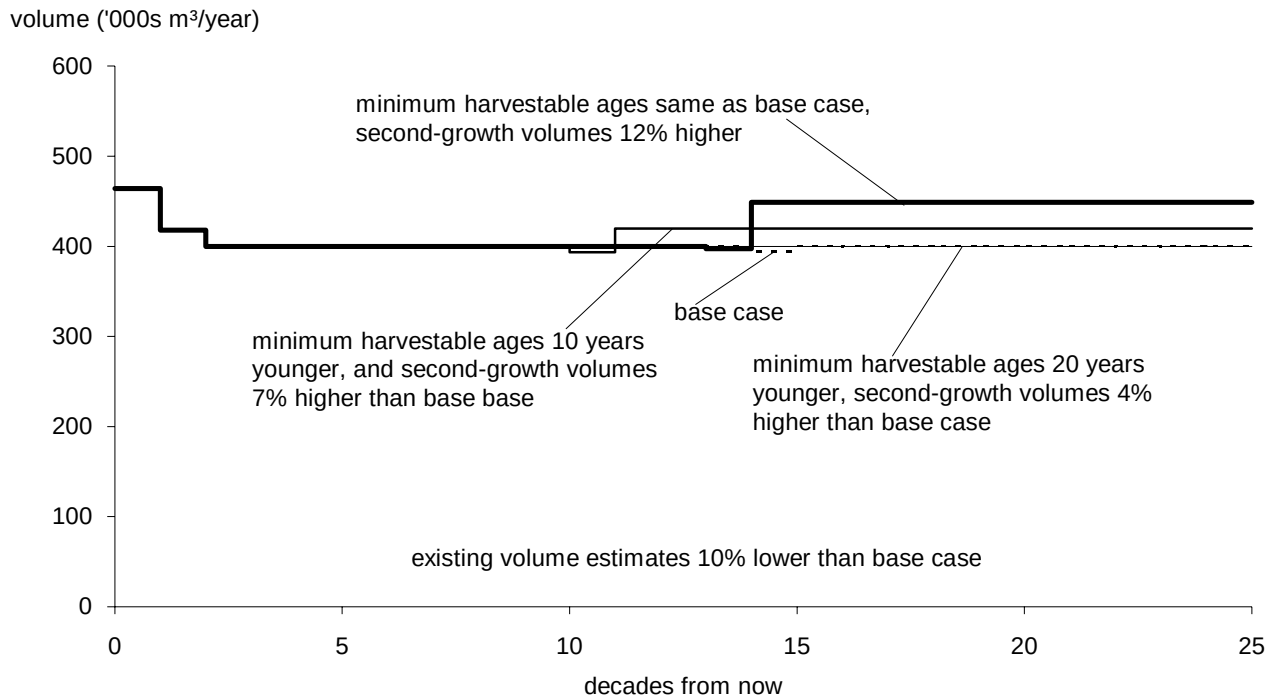


Figure 30. Interaction between lower existing stand volumes and increased site productivity. Existing volume estimates 10% lower than base case — Kalum South, 1994.

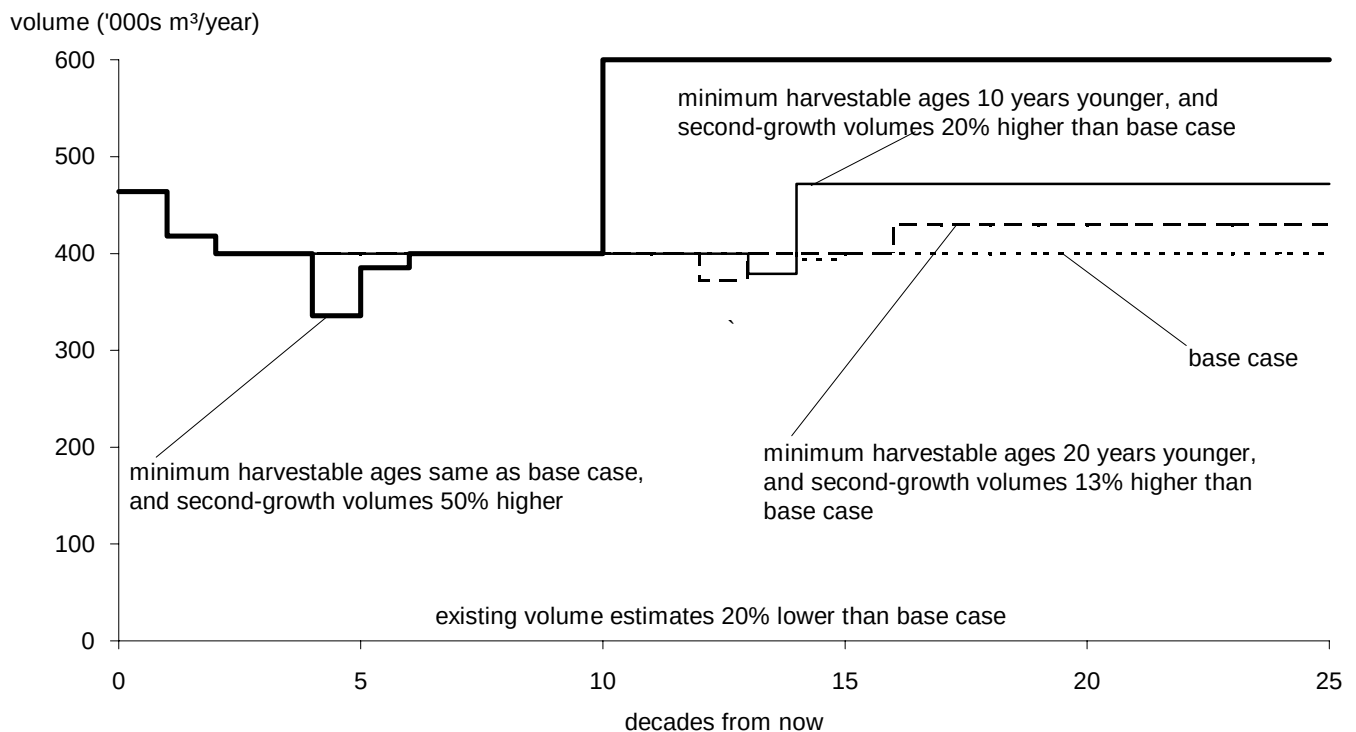


Figure 31. Interaction between lower existing stand volumes and increased site productivity. Existing volume estimates 20% lower than base case — Kalum South, 1994.

6 Summary and Conclusions

The results of this timber supply analysis suggest that a small reduction from the current harvest level in Kalum South (480 000 cubic metres per year) would be necessary in the short term to avoid either substantial future harvest level reductions, or severe future timber shortages. Using current forest inventory and timber growth information, and assuming continuation of current forest management practices, a harvest of 464 000 cubic metres per year — 16 000 cubic metres per year or 3.3% below the current harvest — could be maintained for 10 years, followed by a 10% decline to 418 000 cubic metres per year for the next 10 years, and finally to a long-term level of 400 000 cubic metres per year. The current harvest of 480 000 cubic metres per year could be maintained only by allowing a drop of 80 000 cubic metres per year (16.7%) to the long-term level immediately after the next 10 years. An initial harvest level between the current level and 464 000 cubic metres per year could be achieved by declining between 10% and 16.7% after the next 10 years. Under any of these regimes, most timber harvesting would occur in second-growth stands by about 70 to 80 years from now.

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

Two important uncertainties with potential effects on harvest levels over the next few decades are estimates of timber volumes in existing stands, and second-growth site productivity. Recent timber cruise figures suggest that timber volumes used for existing stands in the base case may overestimate actual volumes. If this is the case, an immediate drop in the harvest would be required to avoid significant future timber shortages.

While existing stands may have lower volumes, field observations suggest that second-growth stands may have higher productivity than is being estimated from the existing inventory. Higher productivity second-growth stands would grow faster, produce higher volumes, and require less time to reach merchantable size than current estimates indicate. If second growth could be

harvested at younger ages than currently assumed, the current harvest rate in existing old-growth forests could potentially be maintained. If this is the case, harvests might be able to rise above the current level 80 to 90 years from now.

An important issue in Kalum South therefore is the possibility that higher productivity from second growth may offset lower existing stand volumes. Sensitivity analysis shows that the degree to which second-growth volume production would have to increase above current estimates to offset a decreased estimate of existing timber volumes depends on how much lower existing stand volumes are than current inventory-based estimates, and the time needed for second growth to reach merchantable conditions.

Timber supply over the next few years is also sensitive to uncertainty in the size of the timber harvesting land base. Currently, a significant portion of Kalum South is classified as operable only for harvesting systems not conventionally used in the area, such as long-line skyline systems. If harvesting activities do not move into these areas, both short- and long-term timber supply would be significantly smaller than indicated in the base case results summarized above. Conversely, future economic factors may expand the land base available for harvesting, for example, if currently non-merchantable species become marketable, or if wood prices rise significantly. Whether or not the timber harvesting land base will expand in the future is unknown. It is clear however, that short-term harvests depend significantly on timber in areas operable only for non-conventional harvesting systems.

The uncertainties associated with existing timber volumes, site productivity, and the land base have the greatest potential impact on timber supply. However several other factors can also affect timber supply in the short or long term.

Uncertainty about minimum harvestable ages has a large effect on timber supply. Lower harvest ages would increase potential harvests, while higher ages would require either immediate harvest reductions, or reductions to well below the productive capacity of the land for several decades beginning about 20 years from now. There would be little long-term effect from harvesting at the range of ages tested.

6 Summary and Conclusions

Second-growth harvest ages are highly uncertain, since they depend on future markets and technology, and are affected by uncertain estimates of second-growth productivity. Until there is clear evidence that second-growth productivity differs significantly from estimates used in this analysis any increase in short-term timber supply stemming from optimistic estimates of productivity and harvestable ages should be approached with caution. Conversely, a belief that minimum harvestable ages will be longer than assumed for this analysis would indicate a conservative, or cautious, viewpoint but would also be based on conjecture.

Forest cover guidelines to protect visual quality have moderate effects on timber supply in the short term, and only small impact over the long term. If visual quality could be maintained while placing fewer limitations on harvesting than assumed in this analysis, the timber supply would increase sufficiently to maintain current harvest levels for up to 20 years. Conversely, if maintaining visual quality required more restrictive guidelines, harvests would have to be reduced somewhat.

Uncertainty about the age at which harvested areas become greened-up has a moderate effect on timber supply. The effects arise almost entirely due to changes in green-up ages for visual quality management areas. Results indicate that if green-up ages are 5 years less than assumed for the base case, the current harvest level for Kalum South could be maintained for another 10 years without causing future timber supply shortages. If the ages are 5 years longer, harvests would have to decline immediately to avoid future shortages.

Timber supply is affected only slightly by uncertainty in forest cover guidelines for old growth, or the estimated age at which stands reach old-growth conditions. Either doubling or entirely removing requirements for a certain area of the harvesting land base to be in old-growth condition at all times would, respectively, slightly reduce or increase potential harvests over the next 20 years. Changes to the old-growth area requirement,

within the range tested for this analysis, would not affect long-term harvests. If stands take up to 250 years to reach old-growth conditions, 100 years longer than assumed for the base case, timber supply would not be affected. Lower old-growth ages would slightly increase short-term timber availability.

Current estimates of stand growth indicate that commercial thinning increases short-term timber supply slightly, and does not affect long-term harvest possibilities. In the base case of this analysis commercial thinning contributes about 3% of the harvest over the next 20 years. If budgets or markets fail to allow thinning to continue, short-term supplies could be reduced slightly.

In conclusion, this analysis indicates that using current inventory and growth and yield information, timber harvests in Kalum South will have to decline to the long-term growth potential of the land base over the next 10 to 20 years. Several uncertainties important to timber supply deserve attention both in discussions about short-term harvest levels, and in inventory and research over the next few years. First, indications from recent inventory work suggesting that existing merchantable timber volumes may be overestimated should be investigated. Second, field observations suggesting that second-growth productivity may exceed estimates based on the existing inventory require corroboration. Third, to maintain the timber supply indicated this analysis, harvesting operations must move into areas operable for non-conventional harvesting systems. Finally, although the above three factors appear most important in defining the Kalum South timber supply, visual quality objectives also have moderate effects. It will be important to examine the visual quality management classification, forest cover guidelines, and desired green-up conditions and periods to ensure they accurately reflect demands and meet objectives. These factors are currently being reviewed in the Kalum South Land and Resource Management Planning process.

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> .
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.
Commercial thinning	A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts (as opposed to juvenile spacing). It is carried out to improve the health and growth rate of the remaining crop trees.
Cutblock adjacency	The desired spatial relationship among cutblocks as specified in integrated management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or where timber harvesting may cause avalanches.
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 stands	Stands composed of sufficient seedlings of an acceptable commercial species that are free from growth-inhibiting brush, weed and excessive tree competition.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Incremental silviculture	Forest management activities, beyond those necessary to establish a free-growing stand, undertaken to promote growth and increase timber values.

8 Glossary

Juvenile spacing	A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased (see Commercial thinning).
Long-line skylines	A system that allows harvesting over long distances, as well as suspension of logs above the ground. Such systems decrease the amount of road needed to access an area, and minimize soil disturbance. The operability classification distinguishes between areas operable by conventional skyline (yarding distance up to 750 metres) and by non-conventional skyline (longer than 750 metres).
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base and includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Modification VQO	Alterations may dominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked	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.

8 Glossary

Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area. In Kalum South, operable areas are further classified as operable either for conventional systems (ground skidding, cable yarding and skyline systems with a maximum yarding distance of 750 metres) or non-conventional systems (skyline systems with a yarding distance of more than 750 metres, and helicopter systems).
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).
Preservation VQO	Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity.
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity.
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.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.
Timber Supply Area (TSA)	An integrated resource management unit established in accordance with <i>Section 6</i> of the <i>Forest Act</i> .
Tree Farm Licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
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

Description of Data Inputs and Assumptions

Introduction

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

A.1 Zone and Analysis Unit Definition

A.1.1 Zone characteristics

Twelve geographic areas, or zones, were defined for this analysis. The zones were defined either by large drainages, by visual quality objective ratings, or by classification as a Forest Service reserve for watershed or recreational use. Zone boundaries were defined using inventory region (REGION) and compartment (COMPART), the recreation (RECREATE) field on the inventory file, and ownership (OWNER, OWNCHAR) codes. The Hecate zone was defined using the timber supply block (TSB) variable (Supply Block D). Following is a list of the twelve zones. Table A-1. provides the criteria used for zone definition.

- (1) Kitimat Municipality;
- (2) Kitimat Valley;
- (3) Lower Skeena River;
- (4) Kalum River/Skeena River West;
- (5) Cedar River/Skeena River East;
- (6) Thunderbird Integrated Resource Management Plan (IRMP);
- (7) Retention visual quality objective areas (VQOs);
- (8) Partial retention VQOs;
- (9) Modification VQOs;
- (10) Hecate;
- (11) Preservation VQOs (combined with zone 7 due to small area — 113 hectares total);
- (12) Community watershed, ski areas, and fish and wildlife reserves.

A wildlife habitat zone was not defined, since a supporting inventory is lacking for the Kalum South.

Delineation of zones facilitated computer modelling of several aspects of current forest management. The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region*, as well as stream buffer and representative forest type considerations, were applied to zones 1-6 and 10 individually based on the forest cover characteristics of the zone. Specific forest cover objectives were applied to the VQO and watershed/recreation zones.

Visual quality objectives on the inventory file are recommended values. Some of these were altered during the management approval process. The recreation polygons for which approved VQOs differ from recommended VQOs are listed in Table A-2. VQOs for Kalum Lake north of Terrace (mapsheets 103I077, 103I087, 103I097) have not been approved, and were assumed to be modification for this analysis. The VQO codes are not considered final until public review is completed, and consensus is reached on what each code should be. This is expected to occur during the ongoing Kalum South Land and Resource Management Plan.

Tables A-3. and A-4. list the forest cover polygons for the Kitimat Municipality and Kitimat Valley that have been assigned VQOs.

A.1 Zone and Analysis Unit Definition

Table A-1. Zone assignment

Zone	Defining variables			
	Mapsheet	Inventory region	Inventory compartment	Other
1. Kitimat Municipality	103H086 103H087 103H096 103H097 103H098 103I007 103I008	-	-	-
2. Kitimat Valley	103I017 103I018 103I027 103I028	-	-	-
3. Lower Skeena River	-	64	022, 023, 024 025, 026, 027 028, 030	-
4. Kalum/Skeena West	-	64	007, 008, 009 010, 011, 012 013, 014, 028, 029, 030	-
5. Cedar/ Skeena East	-	64 65	017, 019, 020 001, 019, 020, 021, 022, 023	-
6. Thunderbird Plan Area	-	64	001, 002, 003 004, 006	-
7. Retention VQO	-	-	-	RECREATE Code: 07V, or as approved ^a
8. Partial Retention VQO	-	-	-	RECREATE Code: 08V, or as approved ^a
9. Modification VQO	-	-	-	RECREATE Code: 09V, or as approved ^a
10. Hecate	-	-	-	TSB D
11. Preservation VQO	-	-	-	RECREATE Code: 06V, or as approved
12. Community water- shed and other F.S. reserve	-	-	-	Ownership code 69C

(a) See Table A-2.

A.1 Zone and Analysis Unit Definition

Table A-2. Recreation polygons for which approved VQO are not the same as initial recommendation

Mapsheet	Recreation polygon number	Recreation code	VQO recommended	VQO management approved
103I023	13107	07V9M3A1ab-A13	Retention	Partial retention
	13109	07V9M3A1ab-A13	Retention	Partial retention
103I035	13007	08V4E1L6lm-C12	Modification	Partial retention
103I039	13001	08V3E3--l--C13	Partial retention	Preservation
	13004	08V4E1--lv-B13	Partial retention	retention
103I045	13013	08V4E2E3lptC13	Partial retention	Modification
	13025	07V8E1L4lm-C11	Retention	preservation
103I047	13002	08V4E6E1lmpB12	Partial retention	Modification
	13003	08V4E2E3ltuB14	Partial retention	Modification
	13011	08V4E3E2lj-C13	Partial retention	Modification
103I048	13023	08V8E5--ptsC15	Partial retention	Retention
103I049	13003	07V4E3--lp-B14	Retention	Partial retention
	13005	08V3E3--l--C13	Partial retention	Preservation
	13006	07V3E1L4lm-C12	Retention	Preservation
103I057	13001	07V8E1--lmpC12	Retention	Partial retention
	13005	07V8E1--lmpB12	Retention	Partial retention
	13007	07V4E3E2tujC14	Retention	Partial retention
	13011	07V4E3E2tujC14	Retention	Partial retention
103I058	13018	07V8E3----C13	Retention	Partial retention
	13003	07V8E3----C13	Retention	Partial retention
	13007	07V5E5----C13	Retention	Partial retention
103I067	13002	08V4E3E2tuvC13	Partial retention	Modification
	13003	08V4E2E3tu-C13	Partial retention	Modification
	13004	08V4E1W3lmjC12	Partial retention	Modification
	13015	08V5E2M2tu-C13	Partial retention	Modification
	13018	07V4E3E2tvjC13	Retention	Modification
103I068	13023	09V7C2H1alpA14	Modification	Partial retention
	13010	07V4E3--tvjC13	Retention	Modification
	13011	08V4E1L4lmpC12	Partial retention	Modification
103I069	13023	07V1E1L4lm-B12	Retention	Preservation
103I070	13002	07V4E1L4lm--B12	Retention	Preservation
	13004	07V3E1L4lm--B12	Retention	Preservation
103I078	13016	08V7E3L6lm-C12	Partial retention	Modification
103I079	13013	08V4E3E2lj-C13	Partial retention	Modification
	13022	08V4E3L8jlzB14	Partial retention	Modification
	13032	08V4E3---lp-B13	Partial retention	Modification
	13033	08V4E1L4lm-B12	Partial retention	Modification
103I089	13004	09V5E3A1arA14	Modification	Retention
	13015	08V4E3--lp-B13	Partial retention	Modification

A.1 Zone and Analysis Unit Definition

Table A-3. Visual quality objective classification for Kitimat municipality (zone 1)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103H086	Modification	34	5	103H086	Modification	145	100
		52	100			146	100
		59	80			147	100
		60	50			148	100
		61	30			149	100
		76	5			150	100
		85	100			151	100
		87	100			152	100
		91	95			153	100
		102	40			155	100
		104	100			156	100
		105	70			157	100
		106	100			165	100
		107	100			166	100
		108	100			173	100
		109	100			174	100
		110	100			175	100
		111	100			176	100
		112	100			177	100
		114	100			178	100
		115	100			180	100
		116	100			181	100
		117	100			182	100
		118	100			183	100
		120	40			184	100
		121	50			185	100
		122	80			191	100
		134	100			192	100
		135	100			193	100
		136	100			194	100
		137	100			195	100
		138	100			196	100
		139	100			197	100
		140	100			198	100
		141	100			199	100
		142	100			200	100
		144	90			202	100

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-3. Visual quality objective classification for Kitimat municipality (zone 1)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103H097	Modification	10	50	103H097	Modification	139	20
		12	60			141	50
		26	20			142	100
		28	30			143	100
		33	100			144	100
		34	100			145	100
		52	35			146	100
		53	50			147	100
		54	100			150	100
		56	80			151	100
		58	100			152	100
		59	80			153	100
		62	80			154	100
		66	100			158	5
		67	100			162	30
		68	35			163	100
		70	100			164	100
		71	100			165	100
		73	100			172	65
		78	100			174	5
		80	100			177	90
		81	5			178	100
		91	20			179	10
		93	10			180	95
		101	40			181	80
		103	100			182	90
		104	100			184	100
		105	100			185	100
		106	100			186	100
		107	100			187	100
		108	100			188	100
		111	100			189	100
		114	85			190	100
		115	70			191	100
		117	15			192	100
		118	35			193	100
		119	65			194	100
		124	10			195	100
		130	5			197	100
		133	100			199	100
		134	75			200	100
		135	20			201	100
		136	5			207	90

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-3. Visual quality objective classification for Kitimat municipality (zone 1)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103H097	Modification	208	100	103H097	Modification	224	100
		209	100			226	100
		210	100			227	100
		211	100			228	100
		212	100			230	100
		213	100			231	100
		214	100			232	100
		215	100			233	100
		216	100			234	100
		217	100			235	100
		218	100			236	100
		219	100			237	100
		220	100			238	100
		221	100			239	100
		222	100			240	100
103H087	Modification	223	100	103H087	Modification	241	50
		1	100			8	100
		2	100			9	100
		3	50			11	100
		4	100			12	100
		5	100			13	100
		6	100			14	100
103H096	Modification	7	100	103H096	Modification	15	100
		85	100			157	25
		89	50			160	5
		94	80			161	90
		101	60			163	100
		105	20			169	95
		113	5			170	100
		153	60			171	10

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-3. Visual quality objective classification for Kitimat municipality (zone 1)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103I007	Partial retention	19	100	103I007	Partial retention	386	100
		29	100			387	100
		30	100			388	100
		31	90			389	100
		32	20			390	100
		48	100			392	100
		50	100			396	100
		51	100			401	100
		66	100			402	100
		67	100			403	100
		68	95			404	100
		96	100			405	100
		97	100			406	100
		98	100			407	100
		125	100			408	100
		126	100			409	100
		127	95			410	100
		159	95			412	100
		202	50			413	100
		382	100			414	100
103I008	Partial retention	384	100	103I008	Partial retention	415	100
		385	100			416	100
		102	100			127	60
		123	100			146	100
		124	70			172	100
		125	20			173	70
		126	50			174	100

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-3. Visual quality objective classification for Kitimat municipality (zone 1) (concluded)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103I007	Modification	252	10	103I007	Modification	256	100
		255	65				
103I008	Modification	5	100	103I008	Modification	77	100
		6	100			79	100
		7	100			80	100
		8	100			81	100
		9	100			82	90
		13	100			86	100
		14	100			87	100
		16	100			89	100
		17	30			90	100
		18	50			91	100
		21	90			92	100
		23	100			93	100
		24	100			94	100
		25	100			95	100
		26	100			96	100
		27	100			97	100
		28	100			98	80
		29	50			100	5
		34	100			101	100
		37	95			104	100
		42	50			105	100
		44	70			106	70
		45	95			107	100
		53	100			108	95
		55	5			109	100
		60	95			110	100
		61	20			112	100
		63	20			114	85
		72	70			115	85
		73	100			116	100
		74	100			131	50
		75	100			133	20
		76	100			138	40
		76	100			219	40

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-4. Visual quality objective classification for Kitimat Valley (zone 2)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103I017	Modification	837	75	103I017	Modification	2268	100
		2260	100			2274	55
		2262	70			2275	10
		2264	100			2335	50
		2265	20			2377	65
103I018	Partial retention	73	85	103I018	Modification	1553	100
		77	40			1554	100
		79	65			1555	100
103I018	Modification	42	60			1556	100
		52	100			1557	100
		63	85			1558	100
		64	100			1560	100
		65	100			1561	100
		69	35			1562	100
		71	100			1563	100
		72	100			1564	100
		90	55			1565	100
		95	100			1566	100
		96	100			1567	100
		97	100			1568	100
		105	100			1569	100
		106	100			1570	100
		123	100			1571	100
		1535	100			1572	100
		1543	100			1573	100
		1545	100			1576	100
		1546	100			1577	100
		1547	100			1580	100
		1548	100			1581	100
		1549	100			1582	100
		1550	100				
		1551	100				
		1552	100				

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-4. Visual quality objective classification for Kitimat Valley (zone 2)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103I018	Modification	1583	100	103I018	Modification	1712	100
		1584	100			1713	100
		1585	100			1714	100
		1587	100			1715	100
		1588	100			1717	100
		1589	80			1719	50
		1590	50			1721	100
		1591	50			1722	100
		1593	100			1726	100
		1594	100			1728	100
		1595	100			1729	100
		1596	100			1730	100
		1597	100			1731	100
		1598	100			1732	100
		1599	100			1733	100
		1601	100			1741	100
		1602	100			1742	100
		1603	100			1743	100
		1605	100			1744	100
		1606	100			1746	100
		1607	100			1749	100
		1613	100			1788	100
		1614	100			1791	100
		1615	100			1796	55
		1616	100			2010	100
		1617	100			2011	100
		1618	100			2012	100
		1619	100			2013	100
		1620	100			2014	100
		1621	100			2015	100
		1622	100			2016	100
		1628	20			2017	100
		1694	15			2018	100
		1703	100			2019	100
		1704	85			2020	100
		1706	100			2022	100
		1707	100				

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Table A-4. Visual quality objective classification for Kitimat Valley (zone 2) (concluded)

Map #	VQO	Polygon	Per cent area	Map #	VQO	Polygon	Per cent area
103I028	Modification	63	75	103I028	Modification	75	100
		68	100			77	100
		69	100			78	100
		70	100			128	100
		72	100			129	100
		73	100			133	100
		74	100			133	100
		134	100			176	100
		136	100			177	100
		137	100			178	100
		138	100			179	100
		140	100			180	100
		141	100			182	100
		142	100			183	100
		143	100			184	100
		144	100			185	100
		145	100			186	100
		146	100			187	100
		147	100			188	100
		148	100			191	100
		149	100			192	100
		150	100			193	100
		151	100			194	100
		151	100			247	100
		152	100			249	100
		153	100			795	35
		154	100			810	75
		156	100			812	20
		158	100			816	10
		159	100			819	80
		164	100			820	55
		168	100			829	10
		169	100			1509	10
		170	100			1581	10
		171	100			1591	15
		172	100			1621	75
		173	100			1622	100
		174	100			1624	100
		175	100			1628	15

Note: Per cent area denotes the percentage of the polygon to be assigned the corresponding VQO.
 Partial retention VQO areas are assigned to zone 8.
 Modification VQO areas are assigned to zone 9.

A.1 Zone and Analysis Unit Definition

Zone 12 consists of Forest Service reserves (Ownership 69C) summarized in Table A-5.

Table A-5. Zone 12, community watersheds and recreation reserves

	Total area (hectares)	Timber harvesting land base (hectares)
Community watersheds	2137	1392
Shames and Onion	5371	1131
Lake ski areas		
Fish and wildlife	257	184
Total	7765	2707

Given the small area in these reserves, and uncertainties about how they will be managed, Kalum Forest District staff felt it was satisfactory to combine the areas, and apply an overall average forest cover objective (4-pass with a 5 metre green-up criterion).

Table A-6. Timber harvesting land base by zone (including timber licence reversions)

Zone	Area (hectares)
(1) Kitimat Municipality	4 026
(2) Kitimat Valley	10 314
(3) Lower Skeena	3 034
(4) Kalum River/Skeena West	12 589
(5) Cedar River/Skeena East	17 529
(6) Thunderbird IMP	13 173
(7) Retention/preservation VQO	2 268
(8) Partial retention VQO	8 932
(9) Modification VQO	21 696
(10) Hecate	7 611
(12) Watershed/recreation	2 707
Total	103 878

A.1 Zone and Analysis Unit Definition

A.1.2 Analysis unit characteristics

To simplify timber supply modelling given the high number of unique forested stands in the Kalum South (about 6500), as well as to reflect the precision of inventory sampling, individual stands are grouped into analysis units. Analysis units are defined by forest cover (inventory type group), site quality (site index range), and silvicultural prescription. Each analysis unit is assigned its own timber volume projection (yield table).

Table A-7. documents the variables used to define each analysis unit. Type groups are B.C. Forest Service Inventory Branch categories that denote the dominant tree species as well as other species present.

Site index was assigned using FREDTAB, a computer program supported by the Ministry of Forests Research Branch. The site index ranges used to define analysis units were based on criteria used in locating stands for silvicultural activities. The same site index ranges were used for analysis unit assignment for hemlock, balsam, cedar, spruce and lodgepole pine to facilitate estimation of timber yields where a mix of species is anticipated, and where species conversion is anticipated.

Analysis units are not specific to a zone; that is, different zones may contain the same analysis units. For example, zones 1 through 4 are all coastal zones (in FIZ A) and therefore all contain analysis unit 1 (good site hemlock/balsam/cedar/spruce). Timber yield tables were developed for each of the 21 analysis units shown.

A.1 Zone and Analysis Unit Definition

Table A-7. Analysis unit characteristics

	Analysis unit	Age range (years)	Forest inventory zone (FIZ)	Inventory type groups	Site index range (metres @ 50 years breast height age)
0/1	Hemlock/Balsam/Cedar/Spruce, good site - coast	All	A	09-20	≥26
0/2	Hemlock/Balsam/Cedar/Spruce, medium site - coast	0-140	A	09-20	15-26
0/52	Hemlock/Balsam/Cedar/Spruce, medium site - coast	141+	A	09-20	15-26
0/3	Hemlock/Balsam/Cedar/Spruce, poor site - coast	0-140	A	09-20	<15
0/53	Hemlock/Balsam/Cedar/Spruce, poor site - coast	141+	A	09-20	<15
0/4	Lodgepole pine, all sites - coast (including Kitimat Valley)	All	A	28-34	≥26
0/5	Cottonwood, all sites - coast (including Kitimat Valley)	All	A	35-36	
1/1	Hemlock/Balsam/Cedar, good site - interior	All	J	09-20	≥26
1/2	Hemlock/Balsam/Cedar, medium site - interior	0-140	J	09-20	15-26
1/62	Hemlock/Balsam/Cedar, medium site - interior	141+	J	09-20	15-26
1/3	Hemlock/Balsam/Cedar, poor site - interior	0-140	J	09-20	<15
1/63	Hemlock/Balsam/Cedar, poor site - interior	141+	J	09-20	<15
1/4	Lodgepole pine, good site - interior	All	J	21-34	≥26
1/5	Cottonwood, all sites - interior	All	J	35-36	15-26
2/1	Hemlock/Balsam, good site - Kitimat Valley	All	Zone 2	09-20	≥26
2/2	Hemlock/Balsam, medium site - Kitimat Valley	All	Zone 2	09-20	15-26
2/3	Hemlock/Balsam, poor site - Kitimat Valley	0-140	Zone 2	09-20	<15
2/73	Hemlock/Balsam, poor site - Kitimat Valley	141+	Zone 2	09-20	<15
2/30	Short rotation spruce (< 30 yrs, > 4 metre height)		Zone 2	21-26	All

A.1 Zone and Analysis Unit Definition

Western redcedar (inventory type groups 09-11) was included in the hemlock/balsam analysis units. Cedar-leading sites comprise about 0.9% of the harvesting land base, compared to 80% for hemlock-leading, and 8% for balsam-leading forest types. Spruce is not anticipated to be a dominant species in regenerated stands because of the spruce leader weevil. Stands currently labelled as spruce-leading, and younger than 30 years are assumed to be in the process of converting to hemlock- or balsam-leading stands. An exception is approximately 880 hectares of young spruce in the Kitimat Valley that is assumed to be old enough, and sufficiently dominated by spruce to manage on a short rotation (about 40 years), and then convert to hemlock. Spruce older than 30 years makes up a small portion of the land base (1282 hectares), and for simplicity was combined with hemlock, balsam, and cedar analysis units.

Lodgepole pine also constitutes a relatively small part of Kalum South (5779 hectares in the timber harvesting land base). Most of this area is in medium sites (site index 15-26 metres). Therefore, only two pine analysis units were defined, one for the coast, and one for the interior, which combine all sites. Since there are only about 100 hectares of pine in the Kitimat Valley, these areas were combined with the coastal analysis unit. Similarly, two analysis units were defined for the cottonwood, one for the coast, and the other for the interior. A minor area of larch (type group 34) — 13 hectares in harvesting land base — was included with lodgepole pine units.

It is acknowledged that error may be associated with assigning site index to both young (less than 30 years) and old (over 150 years) stands. Current data and site estimation methods are most accurate for stands between 30- and 150-years old. In part to address this issue, some analysis units were split: a unit was defined for areas from 0 to 140 years, the other for areas over 140 years of age. This was done only for analysis units with significant area in both age ranges: hemlock/balsam/cedar/spruce medium and poor sites in both the coast and the interior, and poor sites in the Kitimat Valley. For older stands, site index was not reassigned to the site index for currently young stands. The volume estimation system used for the analysis (Variable Density Yield Prediction) provides satisfactory results for volumes currently in older stands. Reassigning site index for older stands to values estimated from young stands is not statistically valid. It is more important to have reasonable estimates of the productivity of currently young stands, that is, those expected to become available as existing mature timber is harvested. This is because timber supply over the next few decades in most situations is quite sensitive to timing of availability of second growth, which is linked to the site productivity. It is recognized that uncertainty in site index creates uncertainty about long-term sustainable production. However, timber supply over the next few decades depends more on existing timber volumes, and timing of availability of current second growth, issues that the analysis unit splitting was designed in part to address.

Analysis unit numbers listed in Table A-7. are not all sequential; for example, there are no units numbered 6, 7, 8, 9, and 10. The numbers are merely labels for identifying the various units, and were assigned to make it easier to differentiate among units. A "0" prefix is used for coastal units "1" for interior units, and "2" for Kitimat Valley units.

A.1 Zone and Analysis Unit Definition

Table A-8. Timber harvesting land base by analysis unit

Analysis unit	Area (hectares)	Per cent of total
0/1	2 179	2.1
0/2	12 054	11.6
0/52	5 525	5.3
0/3	5 641	5.4
0/53	12 610	12.1
0/4	2 254	2.2
0/5	2 379	2.3
Subtotal coast	42 642	41.0
1/1	1 985	1.9
1/2	14 471	13.9
1/62	5 421	5.2
1/3	5 040	4.9
1/63	17 877	17.2
1/4	3 394	3.3
1/5	825	0.8
Subtotal interior	49 013	47.1
2/1	2 482	2.4
2/2	4 962	4.8
2/3	2 906	2.8
2/73	994	1.0
2/30	879	0.8
Subtotal Kitimat Valley	12 223	11.8

A.2 Definition of the Timber Harvesting Land Base

This section provides the information used to define the land base considered available for timber harvesting in the analysis. The harvesting land base is derived by excluding the areas identified in the following sections from the total area in the inventory file.

A.2.1 Land not managed by the B.C. Forest Service/un-typed, and non-forest land

Ownership codes on the inventory file are used to determine which areas are not under Forest service jurisdiction. Ownership codes as defined by Inventory Branch denote both ownership and administrative designation. Areas such as Crown grants and Indian Reserves are not administered by the provincial government. Most land in the Kalum South is administered by the provincial government, but not all is managed by the Ministry of Forests. For example, the Ministry of Environment, Lands, and Parks administers parks. Further, some forest land administered by the Ministry of Forests is not managed as part of a timber supply area. For example, woodlot licences, once allocated, are managed as separate units. The AAC for a woodlot initially comes from an AAC determined for a TSA, but upon allocation that allowable harvest is administered as part of the woodlot, not the TSA.

Tree Farm Licence (TFL) areas are managed — and have their allowable annual cuts determined — separately from TSAs. However, sometimes small areas of TFLs may be included in the TSA inventory. This land does not contribute to the TSA harvesting land base.

Table A-9. outlines the total area in each ownership category for Kalum South.

Table A-9. Ownership codes for Kalum South

Description	Ownership code	Area	
		Hectares	Per cent of total
Crown grant	40	25 535	4.6
Federal reserve	50	773	0.1
Indian reserve	52	5 093	0.9
Ecological reserve	60	3	0.0
Use, recreation, and enjoyment of public (UREP)	61 N ^a	5 386	1.0
	61 C ^b	1 777	0.3
Forest management unit	62 C	495 438	90.1
Provincial park class A	63	629	0.1
Park reserve, recreation area	67	594	0.1
Government reserve	69 N	2 548	0.5
	69 C	9 752	1.8
Timber licence in TSA	70	3 302	0.6
Tree farm licence	76	70	0.0
Woodlot licence	77	748	0.1
Miscellaneous lease	99	544	0.1
Total		549 762	100.0

(a) Not available for integrated resource management.

(b) Available for integrated resource management.

All areas with ownership codes (OWNER, OWNCHAR) other than 62C or 69C are excluded from the timber harvesting land base for this analysis.

A.2 Definition of the Timber Harvesting Land Base

In addition, all areas that are untyped (TYPID_PR=8) or classified as non-forest (TYPID_PR=6) are excluded from the harvesting land base.

A.2.2 Inoperable areas

Areas defined as physically inoperable were not considered as part of the harvesting land base. Characteristics used in defining operability include slope, topography (for example, the presence of gullies, exposed rock), difficulty of road access, soil instability, elevation and timber characteristics. Operability maps for Kalum South were drafted in late 1991.

Criteria for applying the operability reduction were:

- records with operability label (OPERABLE variable) of I or N were removed from timber land base for most mapsheets.
- all forest land on mapsheets 103I017 103I018, 103I027, 103I028, and 103I086 is operable; operability classification on the inventory file is ignored for these maps.
- all forest in inventory region 64, compartment 011, mapsheets 103I066, 103I067, 103I076, 103I077, 103I087; and in region 64, compartment 014, mapsheet 103I087 is operable; operability classification on the inventory file is ignored for these areas.

Methods used in determining operability lines are documented in *A Report on Mapping of Operability Lines within the South Kalum* (November 25, 1991). Figure A-1 on the following page shows the general location of the physically and economically operable areas in Kalum South.

A.2.3 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of the environmental sensitivity of forest areas. Most areas rated as highly sensitive are considered completely unavailable for timber harvesting, except that areas with highly sensitive soils are partially available. Moderately sensitive areas are considered partially available according to the following table.

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

ESA code	ESA description	Per cent area unavailable
Es1	High soil sensitivity	90
Es2	Moderate soil sensitivity	10
Ew1	High wildlife importance	100
Ew2	Moderate wildlife importance	50
Er1	High recreation value	100
Er2	Moderate recreation value	50
Ep1	High regeneration problem	100
Ep2	Moderate regeneration problem	50
Ea1	High avalanche problems	100

Land base exclusions for recreation ESAs were not applied on mapsheets 103I057 and 103I058 because the classifications were outdated.

A.2 Definition of the Timber Harvesting Land Base

Figure A-1. Physically and economically operable areas within Kalum South, 1994.

A.2 Definition of the Timber Harvesting Land Base

Table A-11. Areas by ESA for Kalum South after previous land base deductions

Zone	ESA 1						ESA 2			Total		Total
	Ea	Er	Ep	Es	Ew	Eh	Er	Es	Ew	ESA 1	ESA 2	
1) Kitimat Municipality	1	1	49	57	0	0	0	43	0	109	43	152
2) Kitimat Valley	0	0	9	0	0	0	0	0	0	9	0	9
3) Lower Skeena	50	192	20	141	62	0	0	145	0	465	145	611
4) Kalum/Skeena West	21	50	83	883	60	35	4	886	0	1132	886	2022
5) Cedar/Skeena East	64	227	287	863	17	0	31	2020	0	1458	2050	3509
6) Thunderbird	15	82	71	376	0	0	0	363	0	543	363	906
10) Hecate	0	0	0	275	0	0	0	284	2200	275	2483	2758
12) Watershed etc.	3	0	0	35	76	663	0	96	0	777	96	873
7) Retention/pres. VQO	29	88	68	202	1	136	0	339		523	339	862
8) Partial retention VQO	42	60	90	346	6	54	0	758	0	597	758	1355
9) Modification VQO	37	295	253	1244	19	27	0	1431	0	1874	1431	3305
Non-VQO Total	153	553	519	2629	215	699	34	3837	2200	4768	6067	10839
VQO Total	108	442	410	1791	26	217	0	2528	0	2994	2528	5522
Total	261	994	930	4420	241	916	34	6365	2200	7762	8595	16360

Note: Columns may not sum exactly due to rounding.

The areas listed are those remaining after deducting areas not administered by the B.C. Forest Service, non-forest areas, non-commercial, brush and inoperable areas.

Some inventory records are labelled with more than one ESA code, for example, both recreation (R) and soils (S). For such overlapping codes, only the first code is listed, unless soils is first (e.g. if code is SR, the area is listed under R).

A.2 Definition of the Timber Harvesting Land Base

A.2.4 Non-merchantable forest types

Several types of forest are not currently used because they contain non-commercial tree species or low timber volumes, or have low productive potential for timber. Deciduous forest areas, except where cottonwood is dominant, are not currently harvested. Coniferous and cottonwood stands that have not reached minimum height or site occupancy (stocking or crown closure) limits by a specified age may be considered unavailable for timber harvesting. Areas classified as low site are also removed from the timber harvesting land base.

Table A-12. Per cent of non-merchantable forest cover considered unavailable for timber harvesting

Species (I TYPGRP)	Criteria				Per cent area excluded
	Low site (site index @ 50 years breast height age)	Age (AGE_PROJ)	Height ^a (NHT_PROJ)	Crown closure (CRNCLOS)	
All		>100 yrs	<22.5 m		100
All		>60 yrs		0 -25%	100
All ^b	FIZ A (coast): Cottonwood < 8 m Balsam < 6.5 m Cedar < 8.5 m Hemlock < 7 m Lodgepole pine < 8.5 m Spruce < 3 m FIZ J (interior): Cottonwood < 7 m Balsam < 6.5 m Cedar < 9 m Hemlock < 7.5 m Lodgepole pine < 9.5 m Spruce < 5 m				100
37-42 (deciduous)					100

(a) Current practice is to harvest in stands of height greater than 23 metres. Stands with a 22.5 metres height would be rounded up to 23 metres for operational height estimates.

(b) Special site (SSITE) was used to modify site quality estimates for inventory records with special site labels. Any areas with a SSITE of good, medium or poor were NOT removed from the harvesting land base. Site index cut-offs were determined using the FREDDIE program supported by Ministry of Forests, Research Branch. The interactive version of VDYP (version 4.5) was used to generate volumes based on the first two leading species (or the first three if the first two did not constitute at least 50% of the volume). The low site cut-off was set at the site index for which the maximum mean annual increment was 1 cubic metre per hectare per year.

A.2 Definition of the Timber Harvesting Land Base

Table A-13. Areas in non-merchantable forest types for Kalum South after previous deductions

Zone	Deciduous	Age > 100 Height < 22.5 m	Age > 60 Cr Cl < 25%	Low site	Total
1) Kitimat Municipality	34	380	63	115	592
2) Kitimat Valley	1305	63	169	65	1602
3) Lower Skeena	354	54	249	120	776
4) Kalum/Skeena West	535	448	117	73	1173
5) Cedar/Skeena East	260	978	51	1	1291
6) Thunderbird	372	749	160	126	1407
10) Hecate	1193	218	30	0	1441
12) Watershed etc.	123	4	15	1	144
7) Retention VQO	399	169	4	36	609
8) Partial retention VQO	340	662	56	38	1096
9) Modification VQO	923	1534	67	74	2598
Non-VQO total	4177	2894	854	502	8426
VQO total	1662	2365	127	148	4302
Total	5839	5259	981	650	12 728

Note: Columns may not sum exactly due to rounding.

The areas listed are those remaining after land base deductions for areas not administered by the B.C. Forest Service, non-forest areas, non-commercial brush, and inoperable areas.

Inventory records may fall into more than one of the non-merchantable categories listed in this table. However, areas are listed under only one category according to the following sequence: deciduous, height, crown closure, low site. This procedure avoids double-counting.

A.2 Definition of the Timber Harvesting Land Base

A.2.5 Existing unclassified roads, trails, and landings

To account for productive land lost to date during timber harvesting and road building, and not reclassified as non-forest land, 8.8% of areas in Kalum South with a timber harvesting history (HIST_REF=1), and age less than or equal to 30 years were considered not to contribute to further timber production.

The 8.8% figure is a weighted average from studies done for Tree Farm Licences 1 and 41, and forest licences in Kalum South.

A.2.6 Estimated area of future roads

To account for the loss of productive forest land during future timber harvesting and development in Kalum South, 8% of the timber harvesting land base is not considered to contribute to further timber production after it is harvested for the first time. Future site loss is estimated to be less than recently experienced because many sites may be accessed by previously constructed roads, trails, and landings.

Future roads are modelled by removing the specified percentage (8%) from all areas not subject to the existing roads reduction. The future roads reduction therefore applies to areas either without a history reference code (HIST_REF=0), or with a history reference (HIST_REF=1) and greater than 30 years old. Harvesting began in the area about 30 years ago, and therefore, any history reference in older stands would relate to something other than harvesting (e.g. fire, insect infestation) that would not involve access development.

A.2.7 Streamside management zones, fisheries sensitive zones, the Skeena/Nass Islands, and the Thunderbird integrated resource management plan

To protect streams, non-timber values in streamside areas, and to reflect the objectives of the Thunderbird Integrated Resource Management Plan (IRMP), some area is considered unavailable for harvesting. To develop area-specific land base reductions, Kalum Forest District staff measured stream lengths from maps, and employed the assumptions discussed below. Stream lengths and old-growth areas were measured only within physically operable areas ("below the operability line"), and outside of environmentally sensitive areas. Some forest subject to the non-merchantable forest type reduction may have been measured for buffers or old-growth protection, but this area was felt to be minimal.

Streamside management zones (SMZs), fisheries sensitive zones (FSZs)

Streamside buffer areas were defined as 10-metres wide along streams 10 metres or less in width, and 30-metres wide for stream reaches 30 metres or more in width, as recommended in the *British Columbia Coastal Fisheries/Forestry Guidelines*. Buffer widths for streams between 10- and 30-metres wide were defined after reviewing 1:20 000 scale maps. Stream reaches more than 20-metres wide generally were assigned a buffer width of 30 metres.

Skeena/Nass Islands: Skeena and Nass River islands of 20 hectares or greater were considered available for timber harvesting. Streamside management zones of 30 metres in width were assigned to the islands. Fisheries sensitive zones on the islands (i.e. along small channels that run through the islands) were given a 10-metre buffer. Stability mapping from *Hydrological and Geomorphic Considerations for Silvicultural Investments on the Lower Skeena River Floodplain* (FRDA Report No. 122) assisted in determining which areas of the Skeena islands are operable.

A.2 Definition of the Timber Harvesting Land Base

Thunderbird IRMP: Buffer widths within the IRMP area were defined according to the plan. Streamside buffers protect some old-growth forest. Additional area required to meet old-growth objectives identified in the IRMP is listed separately in Table A-14.

Table A-14. lists the area by mapsheet to be removed from consideration for timber harvesting for the above reasons. Stream classes in the table are based on the *British Columbia Coastal Fisheries/Forestry Guidelines*. Class A stream reaches (old classes 1 and 2) contain commercial or sports fish populations during some or all of the year. Class B reaches (old class 3) have resident sports fish populations. Class C (old class 4) usually have no resident fish, but any damage to stream integrity may affect stream reaches downslope.

One-sided buffers (in the "Side" column) apply along wide rivers, where only one side of the river lies on a mapsheet, around lakes or where one side is excluded from the timber harvesting land base due to inoperability, environmental sensitivity, or non-merchantability.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103H086	9	30	1	0.3	A	All species, all ages All
103H096	8.2	41	2	0.1	A	
	8.4	28	1	0.3		
Map total	16.6					
103H097	25.2	42	2	0.3	A	All
	0.9	3	1	0.3	A	
	2.6	13	2	0.1	A	
Map total	28.7					
103I008	0.2	2	1	0.1	A	All
103I017	70.2	117	2	0.3	A	All
	13.8	46	1	0.3	A	
Map total	84					
103I018	43.8	73	2	0.3	A	All
	5.4	18	1	0.3	A	
	28.6	143	2	0.1	A	
	10.6	53	2	0.1	B	
Map total	88.4					
103I024	30	100	1	0.3	Skeena Islands	Immature ^a cottonwood
	3.6	18	2	0.1	Skeena Islands	
Map total	33.6					
103I027	16.2	81	2	0.1	A	All
103I028	36	60	2	0.3	A	All
	2.1	7	1	0.3	A	
	13.8	69	2	0.1	A	
Map total	51.9					
103I034	32.4	54	2	0.3	A	Immature cottonwood
	49.2	164	1	0.3	A	
	3.6	18	2	0.1	A	
Map total	85.2					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103I035	6	20	1	0.3	A	All
	3	15	2	0.1	A	
Map total	9					
103I037	228	114	2	1	Thunderbird IRMP	Mature ^a , all species
	7	7	1	1	Thunderbird IRMP	
	0.6	3	2	0.1	Thunderbird IRMP	
	206			O.G.	Thunderbird IRMP	
Map total	441.6					
103I038	14.4	18	2	0.4	Thunderbird IRMP	Mature, all species
	3	10	1	0.3	Thunderbird IRMP	
	4	2	2	1	Thunderbird IRMP	
	50			O.G.	Thunderbird IRMP	
Map total	71.4					
103I039	3.2	16	2	0.1	A	All
103I040	0.7	7	1	0.1	B	All
103I045	35.4	59	2	0.3	A	All
	26.4	88	1	0.3	A	
	3.4	17	2	0.1	A	
	1.2	12	1	0.1	A	
Map total	66.4					
103I046	18.6	31	2	0.3	A	Immature cottonwood
	10.4	52	2	0.1	A	
	2.4	24	1	0.1	A	
	82.5	275	1	0.3	Skeena Islands	
	2.4	12	2	0.1	Skeena Islands	
Map total	116.3					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103I047	3.6	6	2	0.3	A	All
	5.2	26	2	0.1	A	
	46	23	2	1	Thunderbird IRMP	
	16	16	1	1	Thunderbird IRMP	
	82.4	103	2	0.4	Thunderbird IRMP	
	39	130	1	0.3	Thunderbird IRMP	
	50.8	127	2	0.2	Thunderbird IRMP	
	8.6	43	2	0.1	Thunderbird IRMP	
	270			O.G.	Thunderbird IRMP	(mature ^a only)
	123.9	413	1	0.3	Skeena Islands	
	4.4	22	2	0.1	Skeena Islands	
Map total	649.9					
103I048	6.6	22	1	0.3	Skeena Islands	All
	26.6	133	2	0.1	A	All
	5.5	55	1	0.1	A	All
	16	8	2	1	Thunderbird IRMP	All
	45			O.G.	Thunderbird IRMP	Mature, all species
Map total	99.7					
103I049	2.4	12	2	0.1	A	All
	1	10	1	0.1	A	All
Map total	3.4					
103I055	0.6	3	2	0.1	A	All
	2.3	23	1	0.1	A	All
Map total	2.9					
103056	1	5	2	0.1	A	All
	4.9	49	1	0.1	A	All
Map total	5.9					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103I057	2.4	8	1	0.3	A	Immature ^a , all species
	6	30	2	0.1	A	Immature, all species
	10.9	109	1	0.1	A	Immature, all species
	46.2	154	1	0.3	Skeena Islands	Immature, all species
Map total	65.5					
103I058	15.3	51	1	0.3	A	All
103I059	2.4	24	1	0.1	A	All
103I060	2.1	21	1	0.1	A	All
	8.4	28	1	0.3	Kleanza Lake	All
Map total	10.5					
103I067	27.6	92	1	0.3	A	
	38	190	2	0.1	A	Immature, all species
	0.8	8	1	0.1	A	Immature, all species
	6.8	34	2	0.1	B	Immature, all species
	0.7	7	1	0.1	B	Immature, all species
Map total	73.9					
103I068	4.6	23	2	0.1	A	All
	0.5	5	1	0.1	A	All
Map total	5.1					
103I069	24.9	83	1	0.3	A	Immature, all species
	4.6	23	2	0.1	A	Immature, all species
	0.2	2	1	0.1	A	Immature, all species
	0.2	1	2	0.1	B	Immature, all species
	0.6	6	1	0.1	B	Immature, all species
Map total	30.5					
103I070	0.1	1	1	0.1	A	All
	0.2	2	1	0.1	B	All
Map total	0.3					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103I077	7.5	25	1	0.3	A	Immature ^a , all species
	2.6	13	2	0.1	A	Immature, all species
	9.6	48	2	0.1	B	Immature, all species
Map total	19.7					
103I079	7.8	13	2	0.3	A	All
	43.2	144	1	0.3	A	All
	3.8	19	2	0.1	A	All
Map total	54.8					
103I080	1.6	8	2	0.1	B	All
	0.3	3	1	0.1	B	All
Map total	1.9					
103I086	10.8	36	1	0.3	A	All
103I087	2.8	14	2	0.1	A	All
103I088	0.6	6	1	0.1	A	All
103I089	11.4	38	1	0.3	A	Immature, all species
103I097	1.4	7	2	0.1	A	All
	2.8	14	2	0.1	B	All
Map total	4.2					
103P003	9	30	1	0.3	A	Mature cottonwood
	14.4	48	1	0.3	Nass Islands	Mature cottonwood
Map total	23.4					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

A.2 Definition of the Timber Harvesting Land Base

Table A-14. Areas removed from timber harvesting land base for streamside buffers and old-growth forest (concluded)

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Forest type to remove
103P007	0.6	6	1	0.1	A	Mature ^a , all species
103P013	6	20	1	0.3	A	All
103P014	8.7	29	1	0.3	A	Mature cottonwood
	40.2	134	1	0.3	Nass Islands	Mature cottonwood
Map total	48.9					
103P017	0.8	8	1	0.1	A	All
103P025	7.5	25	1	0.3	A	All
	9.6	48	2	0.1	A	All
Map total	17.1					
103P035	14.1	47	1	0.3	A	All
	1.4	7	2	0.1	A	All
Map total	15.5					
Total hectares	2306.2					

(a) Maturity defined by the inventory identity variable, TYPID_PR: coniferous species, except lodgepole pine, mature at 120 years old, deciduous species and lodgepole pine mature at 80 years old.

Streamside buffers in timber licences (Ownership 70N). Removed before adding TL areas to timber harvesting land base.

Mapsheet	Area removed from harvesting land base (hectares)	Length of reach (100's m)	Side	Buffer width (100's m)	Class	Ownership
103I027	0.6	3	2	0.1	A	70N
103I037	72.0	36	2	1	A	70N
103I069	1.8	6	1	0.3	A	70N
103I079	8.7	29	1	0.3	A	70N
Total hectares	83.1					

A.2 Definition of the Timber Harvesting Land Base

A.2.8 Timber license reversions

Timber licences (TLs) are a form of timber tenure that gives the holder exclusive right to harvest merchantable timber from defined areas of Crown land. After the area is harvested and reaches a free-growing condition the land reverts to Forest Service jurisdiction. The timber cut from TLs is not part of the allowable annual cut of a TSA. There are 3302 hectares of Timber Licences (TLs) in Kalum South. Of this, 2401 hectares contribute to the timber harvesting land base as defined for this analysis. These areas are anticipated to be harvested within the next 7 years, and therefore will revert to the Forest Service in a stocked and free-growing condition, during the first decade of the analysis horizon.

Table A-15. Timber licence reversions for Kalum South

Zone	Analysis unit	Area in timber harvesting land base (hectares)
Kitimat Municipality	0/3 (H/B/C poor - coast)	7.8
Kitimat Valley	2/1 (H/B/C good)	14.5
	2/2 (H/B/C medium)	212.9
	2/3 (H/B/C poor)	33.0
Kalum/Skeena West	1/2 (H/B/C medium -interior)	28.2
	1/3 (H/B/C poor- interior)	64.9
Thunderbird	0/1 (H/B/C good - coast)	26.0
	0/2 (H/B/C medium - coast)	763.2
	0/3 (H/B/C poor - coast)	561.2
	0/5 (Cottonwood - coast)	10.0
Partial retention visual quality	0/1 (H/B/C good - coast)	0.6
	0/2 (H/B/C medium -coast)	113.4
	0/3 (H/B/C poor - coast)	50.5
Modification visual quality	0/1 (H/B/C good - coast)	7.5
	0/2 (H/B/C medium - coast)	139.7
	0/3 (H/B/C poor - poor)	245.5
	0/5 (Cottonwood -coast)	13.0
	1/2 (H/B/C medium - interior)	17.0
	1/3 (H/B/C poor - interior)	92.2
Total		2401.0

A.3 Forest Management Assumptions

A.3.1 Utilization levels

The utilization level defines the maximum allowable stump height and minimum merchantable diameter by species and is used to calculate merchantable volume. A 10 cm diameter top and a 30 cm stump height is assumed for all species.

The utilization level currently practiced for all species except cottonwood (Ac) in Kalum South is a 17.5 cm diameter at breast height. Utilization for cottonwood is 22.5 cm diameter at breast height.

A.3.2 Minimum harvestable age for each analysis unit

Minimum harvestable ages define the earliest age at which an area may be harvested, not the age at which harvesting must occur. Minimum ages were defined as the age at which 95% of the maximum average growth rate (culmination mean annual increment) is reached. The ages listed in the following table were determined from regenerated stand timber volume tables shown later in this appendix. The exception is analysis unit 2/30, short rotation spruce, which is expected to be harvested at 40 years of age and converted to hemlock.

Table A-16. Minimum harvestable age for each analysis unit

Analysis unit	Minimum harvestable age (years)
Coastal:	
0/1 H/B/C - good	70
0/2 H/B/C - medium (0-140 years)	90
0/52 H/B/C - medium (141+ years)	110
0/3 H/B/C - poor (0-140 years)	140
0/53 H/B/C - poor (141+ years)	140
0/4 PI - all sites	70
0/5 Ac - all sites	60
Interior:	
1/1 H/B/C - good	70
1/2 H/B/C - medium (0-140 years)	95
1/2 H/B/C - medium (141+ years)	110
1/3 H/B/C - poor (0-140 years)	130
1/3 H/B/C - poor (141+ years)	140
1/4 PI - all sites	70
1/5 Ac -all sites	55
Kitimat Valley:	
21 H/B/C - good	70
22 H/B/C - medium	90
2/3 H/B/C - poor (0-140 years)	125
2/73 H/B/C - poor (141+ years)	135
2/30 Short rotation spruce	40

A.3 Forest Management Assumptions

A.3.3 Harvest profile

Harvest profile is any specific characteristics desired in timber harvest, and normally refers to the tree species composition of the harvest. In some areas, mills require certain species mixes. The purpose of harvest profile restrictions is to examine if the desired species mix can be attained with existing timber supply.

A harvest profile target was not applied for the Kalum South. The area is mostly hemlock/balsam, and there are no specific mill requirements for spruce, lodgepole pine, or cottonwood.

Kitimat Municipality

The Kitimat Municipality area was assessed separately in the last analysis of the Kalum South. Those results showed the area to have a sustainable harvest of 30 000 cubic metres per year. Currently, rights to harvest this volume of timber are held under one forest licence, and it is anticipated that this will constitute the entire harvest from the area over the next 20 years. Therefore, harvests from the Kitimat Municipality were capped to approximate a total harvest of 30 000 cubic metres per year. About 47% of the currently merchantable inventory in the Kitimat Municipality lies within areas with visual quality objectives (VQOs). Therefore, it was assumed that over the next 2 decades about 53%, or about 16 000 cubic metres per year, of the total harvest from the municipality will come from the non-VQO portion. Since areas with VQOs are aggregated into zones according to the specific objective not geographic location, a harvest target could not be assigned to the VQO portion of the Kitimat Municipality. This target did not affect the base case harvest. As discussed in the report, the target did affect harvests slightly if integrated management area adjacency objectives were changed from 40%/33% (3-pass) to 25% (4-pass).

A.3.4 Forest cover requirements

This analysis did not involve an explicit spatial evaluation of timber supply. However, the computer model used (FSSIM Version 4.2) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition (usually defined by the height of young trees), or the minimum required area of old-age forest. Pass systems for timber harvesting can be linked to stand-level adjacency concerns; that is, experience may show that a certain number of harvest passes may be necessary to meet adjacency guidelines. Therefore, forest cover guidelines can approximate the effect of adjacency guidelines as well as broader forest level goals. For this analysis forest cover requirements were assigned based on the *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region*, and forest cover guidelines for visual quality management (VQO guidelines) provided by the Ministry of Forests, Recreation Branch.

Forest cover guideline for 3-pass harvesting cycle

The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* stipulate that an area cannot be logged until trees in any adjacent logged areas have reached a height of at least 3 metres. The harvesting guidelines also require a harvest cycle of at least 3-passes, whereby up to 40% of the operable area in a landscape unit may be cut during a first-pass, and up to 30% may be cut during both the second- and third-passes.

A.3 Forest Management Assumptions

Visual quality management areas

VQO guidelines as reflected in *Procedures for Factoring Recreation Input into Timber Supply Analysis* were used to derive forest cover requirements for the VQO zones.

Table A-17. Forest cover guidelines (maximum per cent below green-up period) by VQO class

	Visual absorption capacity (VAC)		
	High	Medium	Low
Preservation	1	0.5	0
Retention	5	3	1
Partial retention	15	10	6
Modification	25	20.5	16

VACs are listed in the fourth (4th) field of the RECREATE code on the Kalum TSA inventory file:

0-3: High VAC
 4/7: Low VAC
 5/8: Medium VAC
 6/9: High VAC

Forest cover guidelines weighted by the timber harvesting land area and VAC were calculated for each VQO class. For example, for the Partial Retention VQO zone:

$$\text{Weighted \% Disturbance} = (\% \text{ High VAC area}) \times (15\%) + (\% \text{ Medium VAC area}) \times (10\%) + (\% \text{ Low VAC area}) \times (6\%)$$

Table A-18. shows the weighted forest cover guidelines.

Table A-18. Weighted forest cover guidelines by VQO class

VQO class	Weighted forest cover guideline
Retention and preservation	2.56%
Partial retention	9.24%
Modification	19.88%

Note: Because of the small area in the preservation VQO class (113 hectares total), it was combined with retention VQOs.

A.3 Forest Management Assumptions

Weighted forest cover guidelines were next adjusted to account for the forest area outside the timber harvesting land base in each VQO class. That is, forest unavailable for harvesting due to physical inoperability, environmental sensitivity or non-merchantability contributes to the visual quality of an area. For this adjustment, a "green-to-net" ratio was calculated for the VQO class by dividing the total forested area by the timber harvesting land base.

Table A-19. lists the green-to-net ratios for each VQO class.

Table A-19. Green-to-net ratio by VQO class

VQO class	Green-to-net ratio
Retention and preservation	3.94
Partial retention	1.84
Modification	1.62

The final step in determining the forest cover guideline for the VQO class is combining the weighted forest cover guideline with the green-to-net ratio. This step requires an estimate of how forest within the timber harvesting land base is distributed across the landscape. That is, the harvesting land base could be a fairly solid area separated from inoperable areas by a distinct line. Conversely, area both available and unavailable for harvesting could be fairly evenly dispersed. The intermediate condition is that harvestable forest is distributed in clusters within the landscape. Whether the available forest is solid, clustered, or dispersed determines how to employ the green-to-net ratio. In dispersed landscapes the full ratio is used (available and unavailable areas are in cutblock-sized pieces which are essentially adjacent); that is, the weighted forest cover guideline is multiplied by the green-to-net ratio. In solid areas, the green-to-net ratio is not used (available and unavailable areas are separated). In clustered areas, the average of the dispersed and solid factors is used. More detail is available in the procedures document referred to above.

Table A-20. lists the estimated percentage of area by VQO class in each distribution category.

Table A-20. Distribution category by VQO class

VQO class	Dispersed	Clustered	Solid
Retention/preservation	43	57	0
Partial retention	16	51	33
Modification	9	53	38

The final forest cover guidelines are listed in Table A-21.

Table A-21. Forest cover guidelines by VQO class

VQO class	Forest cover guideline (maximum per cent area below green-up age)
Retention/preservation	7.94% (rounded to 8%)
Partial retention	12.48% (rounded to 12.5%)
Modification	24.23% (rounded to 24%)

A.3 Forest Management Assumptions

Table A-22. summarizes the forest cover requirements for South Kalum. The requirements are applied in the form: a maximum of 40% of the area in a zone may be younger than the specified green-up age. The 40% guideline applies to the first-pass; it is changed to 33% after the first 20 years. The effect of decreasing the maximum allowable disturbed area is assessed in sensitivity studies done as part of this analysis.

The Table Interpolation Program for Stand Yields (TIPSY) supplied by the B.C. Forest Service, Research Branch was used to estimate when trees in Kalum South will reach a height of 3 metres for the 3-pass system, and 5 metres for the VQO zones. Since each area will support a range of growth rates, average green-up ages (based on average zonal site index from FREDDIE) were used for each zone to simplify the analysis. Growth rates are higher in coastal zones (Kitimat Municipality and Valley, Lower Skeena River, Thunderbird IRMP) than interior zones. These green-up ages do not include regeneration delay.

Table A-22. Forest cover requirements for adjacency and visual quality

Zone	Green-up age (years)	Maximum per cent area younger than green-up age
1) Kitimat Municipality	15	40
2) Kitimat Valley	11	40
3) Lower Skeena River	13	40
4) Kalum/Skeena West	13	40
5) Cedar/Skeena East	15	40
6) Thunderbird IRMP	14	40
7) Retention/preservation VQO	22	8
8) Partial retention VQO	21	12.5
9) Modification VQO	22	24
10) Hecate	13	40
12) Community watershed and other reserves	19	25

Representative forest types

The *Interim Regional Timber Harvesting Guidelines for the Interior Portion of the Prince Rupert Forest Region* specify that at least 12% of each major forest type to be maintained in old growth. For this analysis, forest type representation was modelled using forest cover requirements. When determining the area needed for forest type representation, Kalum Forest District staff in consultation with the B.C. Ministry of Environment, Lands and Parks considered the contributions of environmentally sensitive areas, streamside buffers, and non-merchantable forest types. Representation of 12% of each forest type within the physically operable area, that is below the operability lines, was desired. The following table lists the areas required for each zone of Kalum South.

A.3 Forest Management Assumptions

Table A-23. Forest cover requirements for representation of old-growth forest

	Zone	Area in timber harvesting land base to remain ≥ 150 years (hectares)	Total area in timber harvesting land base (hectares)	Per cent area ≥ 150 years
(1)	Kitimat Municipality	84	4 019	2
(2)	Kitimat Valley	493	10 054	5
(3)	Lower Skeena	83	3 035	3
(4)	Kalum River/Skeena West	263	12 495	2
(5)	Cedar River/Skeena East	581	17 528	3
(6)	Thunderbird IMP	177	11 813	1.5
(10)	Hecate	0	7 611	0

The area required for representation in the Kitimat Valley is relatively high because this area comprises few classified environmentally sensitive areas and non-merchantable forest types that could serve as representative types. The total areas do not include timber licence reversions.

Old-growth requirements were not determined for visual quality management zones.

Table A-24. compares the current condition of the timber harvesting land base to the objectives listed in Tables A-22. and A-23.

Table A-24. Initial conditions for forest cover objectives

Zone	Adjacency/green-up		Old growth	
	Maximum limit (per cent)	Current state (per cent)	Minimum limit (per cent)	Current state (per cent)
1	40	7.0	2	75.6
2	40	10.7	5	3.4
3	40	24.0	3	49.2
4	40	12.4	2	46.7
5	40	28.3	3	52.3
6	40	18.9	1.5	38.8
7	8	2.4	-	-
8	12.5	22.3	-	-
9	24	32.8	-	-
10	40	10.9	-	-
12	25	28.2	-	-

From this table it can be seen that the green-up objective in the partial retention (zone 8) and modification (zone 9), visual quality areas, and in the watershed/recreation (zone 12) are currently not being met. Likewise, the old-growth objective for Kitimat Valley (zone 2) is currently not being met. While the forest cover objectives are not being met on average for these areas, this does not mean the objectives are not met in all landscapes within the areas.

When Kalum Forest District began managing for visual quality, it was realized that existing alterations in some landscapes exceeded the new management objective. For these landscapes, the visual quality objectives will be met once the regenerated stands reach visual green-up conditions.

A.3 Forest Management Assumptions

A.3.5 Unsalvaged losses

Unsalvaged losses are timber volumes destroyed or damaged by a natural cause. Wind and wildfire are the two main sources of timber loss in Kalum South. Timber volume losses to endemic insects and disease (i.e. that normally occupy a stand) are accounted for through growth and yield or inventory sampling and are incorporated in yield tables. The purpose of the unsalvaged loss estimate is to account for losses to epidemic infestations and other factors not accounted for in yield estimates.

The following table summarizes estimates of the average annual unsalvaged volume loss to wind and fires, over the long term on the timber harvesting land base.

Table A-25. *Unsalvaged losses*

Cause of loss	Gross losses in cubic metres/year	Salvaged volume in cubic metres/year	Annual unsalvaged loss in cubic metres/year
Insects	-	-	-
Disease	-	-	-
Fire	2 500	0	2 500
Wind damage	14 000	7 000	7 000
Other	-	-	-
Total			9 500

Other potential sources of losses include:

Porcupine — currently attacking immature western hemlock stands, but extent of damage cannot be estimated at this time.

Spruce leader weevil — current information is insufficient to determine volume losses to weevil. Generally, spruce that has grown to 10 metres or more is less susceptible than younger and shorter stands. Balsam and hemlock will normally fill in where spruce trees are lost to the weevil, thereby offsetting volume loss. However, regeneration delay may be increased by about 5 years in infested stands.

A.3 Forest Management Assumptions

A.3.6 Basic silviculture and regeneration assumptions

Basic silviculture includes any activities required to establish free-growing stands of commercially valued species. Basic silviculture is assumed to occur over the long term in Kalum South.

Regeneration assumptions:

- All good sites (SI > 26 metres) planted.
- Fifty per cent medium sites (SI 15-26 metres) planted; 50% natural regeneration and fill-planted if necessary.
- All poor sites regenerated naturally and fill-planted if necessary.
- Regeneration delay: 3 years if planted; 6 years if natural regeneration.
- Average density for natural regeneration is 4000 stems per hectare (range 3000-7000 stems per hectare).
- Areas that are currently labelled as spruce-leading with less than 30% composition in other species are assumed to convert immediately to a hemlock/balsam analysis unit of the same site class with a regeneration delay corresponding to the analysis unit.
- Areas currently labelled as spruce-leading, but with 30% or more in other species are assumed to convert immediately to the hemlock/balsam analysis unit of corresponding site class with the same age as listed on the inventory file.
- Areas in the Kitimat Valley, currently classified as spruce-leading that are 4 metres or more in height, are managed on a short rotation (40 years), and converted to hemlock after harvest.
- All other analysis units are assumed to regenerate to the same type as their current condition.

A.3.7 Not satisfactorily restocked (NSR) areas

Inventory files were updated recently, and were assumed to reflect accurately the amount of NSR. Backlog NSR is being restocked rapidly, and was assumed to follow the same re-stocking schedule as current NSR (i.e. standard regeneration delay). In addition to areas listed as NSR on the inventory file, some stands classified as spruce-leading were also assumed to be NSR. As discussed in the previous section, spruce-leading stands less than 30 years old in which hemlock, balsam, cedar, or pine comprise less than 30% are assumed to be NSR. Conversely, spruce-leading stands in which other species make up more than 30% of the stand are assumed to be satisfactorily restocked to hemlock/balsam.

A.3 Forest Management Assumptions

Table A-26. Not satisfactorily restocked (NSR) areas

Zone	Analysis unit	Site	Area (hectares)	Zone	Analysis unit	Site	Area (hectares)
1 Kitimat Municipality	0/3 H/B (C)	P	279.1	8 Partial retention VQO	0/1 H/B (C)	G	8.9
					0/2 H/B (C)	M	17.4
					0/3 H/B (C)	P	190.2
2 Kitimat Valley	2/1 H/B	G	138.4		1/1 H/B (I)	G	125.6
	2/2 H/B	M	96.2		1/2 H/B (I)	M	90.1
	2/3 H/B	P	709.5		1/3 H/B (I)	P	100.5
3 Lower Skeena River	0/1 H/B (C)	G	47.2	9 Modification VQO	0/1 H/B (C)	G	58.6
	0/2 H/B (C)	M	201.2		0/2 H/B (C)	M	49.4
	0/3 H/B (C)	P	274.9		0/3 H/B (C)	P	920.4
					1/1 H/B (I)	G	21.5
4 Kalum/Skeena West	0/1 H/B (C)	G	20.6		1/2 H/B (I)	M	181.1
	0/2 H/B (C)	M	148.0		1/3 H/B (I)	P	478.5
	0/3 H/B (C)	P	26.0		2/1 H/B (KV)	G	78.0
	1/1 H/B (I)	G	199.8		2/2 H/B (KV)	M	12.2
	1/2 H/B (I)	M	88.7		2/3 H/B (KV)	P	213.7
	1/3 H/B (I)	P	374.9				
				10 Hecate	0/1 H/B (C)	G	132.1
5 Cedar/Skeena East	1/1 H/B (I)	G	59.7		0/3 H/B (C)	P	147.9
	1/2 H/B (I)	M	388.5		1/2 H/B (I)	M	188.1
	1/3 H/B (I)	P	1450.0		1/3 H/B (I)	P	272.6
6 Thunderbird IRMP	0/1 H/B (C)	G	67.5	12 Watershed/recreation	0/1 H/B (C)	G	6.9
	0/2 H/B (C)	M	135.0		0/2 H/B (C)	M	34.6
	0/3 H/B (C)	P	627.6		0/3 H/B (C)	P	60.6
					1/2 H/B (I)	M	2.6
7 Retention VQO	0/2 H/B (C)	M	6.4		1/3 H/B (I)	P	45.5
	1/1 H/B (I)	G	3.3				
	1/3 H/B (I)	P	13.1				

Note: (C) denotes coastal analysis units; (I) denotes interior units; (KV) denotes Kitimat Valley units.

The areas shown in Table A-26. have already been reduced by 8.8% to reflect the reduction in operable area due to roads, trails, and landings (see Section A.2.5, "Existing unclassified roads, trails, and landings".)

Current NSR is harvested land not restocked with commercially valued species to an adequate standard, but within a specified time after the disturbance (e.g. logging, fire). The time varies by species, and ranges from 3 to 6 years. For this analysis, current NSR is expected to be restocked within the normal regeneration delay of 3 to 6 years.

A.3 Forest Management Assumptions

A.3.8 Rehabilitation of problem forest types or NC/brush areas

No rehabilitation of non-commercial brush (NCC) or currently non-merchantable forest types is planned in Kalum South. The district is rehabilitating some areas to increase soil stability and visual quality, but not to increase the productive area.

A.3.9 Incremental silvicultural treatments

Incremental silviculture comprises any activities beyond those required to establish a free-growing stand. The focus of incremental silviculture, such as juvenile spacing, thinning, fertilization and pruning, is to improve either the volume yield or quality of forest stands. In Kalum South, current incremental silviculture practice depends on site quality.

Stands with a site index at 50 years breast height age of 26 metres or greater, (referred to as good site in this analysis):

- juvenile spacing to 800 stems/hectare, and pruning. Spacing is incorporated into regenerated stand volume estimates. Pruning is not expected to increase volume growth, but rather to increase the value of logs.
- commercial thinning in 75% of areas with site index greater than 26 metres at approximately 45 years of age. Thinning is estimated to take one-third of basal area, with a minimum diameter at breast height of 17.5 cm. Final harvest will occur at about 80 years of age. Commercial thinning yield estimates were developed using the Tree and Stand Simulator (TASS) supported by the Ministry of Forests, Research Branch (see Table A-30. of this appendix).

Stands with site index of greater than or equal to 15 metres and less than 26 metres:

- all stands juvenile spaced to 800 stems per hectare.

Stands with site index less than 15 metres:

- 30% juvenile spaced to 800 stems per hectare.

A.4 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 4.5, developed by the B.C. Forest Service Inventory Branch, was used to estimate timber yields for existing stands.

Deciduous components of forest stands other than cottonwood were removed from existing stand volume estimates for this analysis.

A.4 Volume Estimates for Existing Stands

Table A-27. Timber volume table for existing stands: coastal (FIZ A) analysis units

Age	Analysis unit 0/1 Hemlock/ Balsam: good	Analysis unit 0/2 Hemlock/ Balsam: medium (0-140 years)	Analysis unit 0/52 Hemlock/ Balsam: medium (141+ years)	Analysis unit 0/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 0/53 Hemlock/ Balsam: poor (141+ years)	Analysis unit 0/4 PI	Analysis unit 0/5 Ac
10	0.06	0	0	0	0	0	0.06
20	12.09	1.13	0.62	0.04	0.06	0.15	1.72
30	142.70	41.02	4.72	0.31	0.3	4.98	18.7
40	275.31	137.18	50.33	2.09	2.13	41.31	50.03
50	387.49	225.26	124.37	38.04	28.94	87.16	81.47
60	482.76	302.39	189.83	86.52	71.79	131.11	107.42
70	563.51	369.23	247.73	131.74	115.08	171.92	128.06
80	632.48	427.84	298.68	172.27	154.57	209.74	144.47
90	687.88	476.56	341.36	207.58	188.77	244.69	157.62
100	734.04	518.38	378.17	238.70	218.8	277.33	168.35
110	772.71	554.51	410.09	266.32	245.27	308.04	177.25
120	804.39	585.11	437.04	290.61	268.18	337.02	184.68
130	839.41	618.06	466.03	315.31	291.81	364.89	191.32
140	871.26	648.23	492.81	338.01	313.74	383.52	197.08
150	899.51	675.42	517.03	358.67	333.76	397.35	202.07
160	924.37	699.80	538.90	377.36	352.05	406.73	203.07
170	946.47	721.80	558.66	394.40	368.75	412.44	203.95
180	966.80	742.18	577.22	410.19	384.45	414.72	204.78
190	985.29	760.87	594.39	424.72	399.04	413.57	205.56
200	1002.22	778.20	610.30	438.37	412.63	416.31	206.29
210	1017.73	794.20	625.03	451.10	425.29	419.31	206.98
220	1032.00	809.02	638.78	462.99	437.14	422.34	207.62
230	1045.10	822.75	651.54	474.08	448.21	425.28	208.25
240	1057.11	835.46	663.40	484.48	458.56	428.06	208.83
250	1068.15	847.23	674.41	494.18	468.22	430.64	209.39
260	1076.07	856.20	682.18	502.44	475.8	432.94	209.85
270	1083.20	864.41	689.29	510.15	482.83	435.04	210.28
280	1089.63	871.92	695.77	517.33	489.35	436.9	210.7
290	1095.44	878.78	701.70	524.04	495.4	438.52	211.1
300	1100.65	885.06	707.10	530.30	501	439.91	211.5
310	1105.29	890.77	712.01	536.16	506.2	441.04	211.87
320	1109.45	895.96	716.48	541.61	511.01	441.91	212.23
330	1113.16	900.68	720.50	546.69	515.46	442.48	212.59
340	1116.40	904.97	724.15	551.42	519.57	442.81	212.94
350	1119.25	908.82	727.41	555.84	523.37	442.68	213.27

continued

A.4 Volume Estimates for Existing Stands

Table A-27. Timber volume table for existing stands: interior (FIZ J) analysis units

Age	Analysis unit 1/1 Hemlock/ Balsam: good (see note)	Analysis unit 1/2 Hemlock/ Balsam: medium (0-140 years)	Analysis unit 1/62 Hemlock/ Balsam: medium (141+ years)	Analysis unit 1/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 1/63 Hemlock/ Balsam: poor (141+ years)	Analysis unit 1/4 PI	Analysis unit 1/5 Ac
10	0	0	0	0	0	0	0.14
20	0.45	0.07	0.11	0	0.02	0	1.43
30	8.14	1.66	1.43	0.03	0.12	1.73	24.69
40	59.43	49.96	31.37	0.50	1.01	25.49	60.1
50	137.49	117.86	102.93	15.08	19.40	60.95	93.33
60	203.98	183.10	167.35	48.22	57.56	95.86	119.27
70	263.23	241.71	224.52	83.78	100.41	128.55	139.21
80	312.09	292.74	274.93	116.74	141.10	159.03	154.87
90	353.46	336.40	318.27	146.01	177.18	187.35	167.24
100	389.35	374.78	356.39	172.41	209.48	213.92	177.24
110	420.69	408.78	390.14	196.36	238.52	239.05	185.42
120	448.12	438.92	420.10	218.12	264.7	262.84	192.13
130	476.53	470.67	451.43	240.51	291.27	285.58	198.19
140	501.48	498.49	478.92	260.09	314.83	300.67	203.18
150	524.07	523.64	503.93	277.87	336.41	312.28	207.29
160	544.22	546.08	526.35	293.88	356.06	320.52	208.41
170	562.22	565.59	546.42	308.25	373.86	325.69	209.31
180	578.44	583.11	564.34	321.01	389.84	327.96	210.06
190	592.96	598.90	580.14	332.23	404.03	327.34	210.63
200	607.20	613.89	595.98	344.01	418.64	330.06	211.32
210	620.55	627.85	610.77	355.38	432.67	333.01	211.99
220	632.89	640.88	624.23	366.33	446.12	336.00	212.65
230	643.80	653.03	636.41	376.86	458.94	338.94	213.29
240	654.00	664.39	647.44	386.83	471.04	341.75	213.92
250	663.46	675.01	657.67	396.09	482.37	344.40	214.52
260	671.73	683.41	665.81	403.81	492.26	346.71	214.84
270	679.45	691.23	673.34	411.13	501.51	348.82	215.12
280	686.66	698.50	680.34	417.71	510.11	350.71	215.38
290	693.39	705.29	686.86	423.80	518.15	352.40	215.62
300	699.67	711.62	692.93	429.49	525.66	353.86	215.85
310	705.56	717.55	698.57	434.90	532.72	355.12	216.06
320	711.08	723.09	703.84	439.94	539.31	356.14	216.27
330	716.25	728.26	708.75	444.68	545.48	356.85	216.47
340	721.11	733.11	713.33	449.19	551.27	357.27	216.65
350	725.67	737.63	717.60	453.46	556.75	357.41	216.83

continued

Note: The apparent anomaly of good site volumes less than medium site volumes is due to the higher deciduous component of sites, and to an site index defaulting discrepancy discussed in Section A.5, "Volume Estimates for Regenerated Stands".

A.4 Volume Estimates for Existing Stands

Table A-27. Timber volume table for existing stands: Kitimat Valley (concluded)

Age	Analysis unit 2/1 Hemlock/ Balsam: good	Analysis unit 2/2 Hemlock/ Balsam: medium	Analysis unit 2/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 2/73 Hemlock/ Balsam: poor (141+ years)	Analysis unit 2/30 Short-rotation Spruce
10	0.23	0	0	0	0
20	7.8	1.57	0.19	0.03	38.58
30	157.9	56.83	0.88	0.19	119.86
40	297.19	171.28	6.35	0.81	210.16
50	414.95	270.24	64.44	39.59	295.70
60	515.03	356.03	120.06	90.19	372.58
70	599.85	430.09	169.82	136.24	441.68
80	672.57	494.62	213.99	178.38	501.88
90	731.26	548.04	251.55	214.69	553.83
100	780.46	593.63	284.33	246.74	598.84
110	821.94	632.74	313.13	275.04	637.93
120	856.31	665.84	337.68	299.64	671.80
130	894.36	701.42	363.92	324.72	704.89
140	929.13	734.13	388.32	347.96	734.89
150	960.18	763.64	410.56	369.14	762.00
160	987.89	790.22	430.79	388.54	786.11
170	1012.69	814.22	449.21	406.28	808.09
180	1035.38	836.35	466.74	422.84	828.32
190	1055.96	856.59	483.08	438.16	847.00
200	1074.75	875.18	498.39	452.35	864.34
210	1091.85	892.23	512.73	465.54	880.47
220	1107.45	907.97	526.16	477.89	895.54
230	1121.66	922.44	538.76	489.43	909.70
240	1134.61	935.77	550.60	500.09	923.03
250	1146.42	948.04	561.72	510.09	935.62
260	1155.60	957.82	569.79	518.50	947.21
270	1163.85	966.74	577.30	526.29	958.21
280	1171.23	974.86	584.28	533.48	968.70
290	1177.83	982.23	590.78	540.19	978.76
300	1183.74	988.95	596.84	546.38	988.34
310	1188.96	994.98	602.48	552.19	997.58
320	1193.58	1000.43	607.74	557.50	1006.38
330	1197.62	1005.35	612.61	562.50	1014.87
340	1201.13	1009.76	617.17	567.07	1023.07
350	1204.16	1013.70	621.40	571.29	1030.97

A.5 Volume Estimates for Regenerated Stands

TIPSY (Table Interpolation Program for Stand Yields), supported by B.C. Forest Service, Research Branch, was used to generate managed stand yield tables for this analysis. Table A-28. shows the species composition of each regenerated analysis unit. In TIPSY, balsam is assumed to grow the same as hemlock, therefore percentages for hemlock and balsam were added (column 4).

Table A-28. Species mix for regenerated analysis units, percentage composition by species

Analysis unit	Hemlock	Balsam	Hemlock + Balsam	Cedar	Pine	Sitka Spruce	White Spruce	Cottonwood	SI FREDTAB
0/1	68	28	96	4	-	-	-	-	28.5
0/2	61	25	86	7	-	7	-	-	21.4
0/3	64	24	88	4	4	4	-	-	12.8
0/4	14	-	-	-	86	-	-	-	18.4
0/5	4	-	-	-	-	10	-	86	25.4
1/1	59	41	100	-	-	-	-	-	28.0
1/2	58	26	84	6	5	-	5	-	19.4
1/3	64	16	80	6	10	-	4	-	12.9
1/4	16	-	-	-	84	-	-	-	17.8
1/5	6	-	-	-	-	9	-	85	27.0
2/1	68	32	100	-	-	-	-	-	28.4
2/2	63	24	87	4	-	9	-	-	22.3
2/3	57	24	81	13	-	6	-	-	13.9
2/30	7	-	-	-	-	93	-	-	23.6
0/52	64	20	84	11	-	5	-	-	16.8
0/53	72	19	91	9	-	-	-	-	12.2
1/62	67	25	92	4	-	-	4	-	16.6
1/63	73	27	100	-	-	-	-	-	12.1
2/73	58	36	94	6	-	-	-	-	12.7

Note: Analysis unit 30 (short rotation spruce) converts to unit 2/1 after first harvest.

FREDTAB, also supported by the Forest Service, Research Branch, was used to generate the site index for each record on the inventory file. This site index was used to define analysis units, and to generate the managed stand yield tables. At the time of this analysis, a default in FREDTAB for assigning site index to stands less than 30 years old, based on the SITE variable, was assigning the forest inventory zone (FIZ) "A" default to balsam-leading stands, rather than the FIZ J default.

Because of this discrepancy, records for balsam in interior areas (FIZ J) were assigned coastal site indexes, which may have overestimated site productivity for some records. Existing stand yields from VDYP were based on correct assignment of the default site index, so existing volumes were not affected. Overall changes to land base productivity would be small (about 2% based on the area involved and regenerated stands yields based on the lower site indexes). This discrepancy has since been resolved, however analysis was virtually complete when the problem with FREDTAB was discovered, and due to the minor impacts noted above, the analysis does not incorporate the updated site defaults.

A.5 Volume Estimates for Regenerated Stands

Table A-29. lists the volume tables for regenerated stands. Table A-30. provides volume estimates for commercial thinning.

Table A-29. Timber volume table for regenerated stands: coastal (FIZ A) analysis units

Age	Analysis unit 0/1 Hemlock/ Balsam: good	Analysis unit 0/2 Hemlock/ Balsam medium (0-140 years)	Analysis unit 0/52 Hemlock/ Balsam medium (141+ years)	Analysis unit 0/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 0/53 Hemlock/ Balsam: poor (141+ years)	Analysis unit 0/4 PI	Analysis unit 0/5 Ac
10	0	0	0	0	0	0	0
20	2	0	0	0	0	0	0
30	106	6	0	0	0	9	0
40	254	88	8	0	0	64	58
50	418	195	70	4	2	125	106
60	576	296	142	26	14	184	144
70	737	398	211	58	42	239	174
80	878	497	276	106	78	282	197
90	993	585	336	150	117	323	217
100	1106	674	399	196	157	356	233
110	1210	754	459	237	195	384	246
120	1296	829	510	276	231	410	258
130	1365	894	557	311	264	431	269
140	1433	949	605	343	293	449	278
150	1498	1002	650	377	320	466	286
160	1556	1051	690	407	347	480	286
170	1606	1096	729	435	373	493	286
180	1651	1138	763	460	396	503	286
190	1694	1176	795	482	417	513	286
200	1734	1211	823	502	436	521	286
210	1770	1240	848	521	453	529	286
220	1802	1265	871	538	469	533	286
230	1828	1287	893	555	484	536	286
240	1852	1307	912	571	497	539	286
250	1873	1325	931	587	510	542	286
260	1891	1345	949	601	523	545	286
270	1911	1362	966	614	535	548	286
280	1930	1378	981	626	547	550	286
290	1946	1392	995	637	557	552	286
300	1961	1405	1007	648	567	554	286

continued

A.5 Volume Estimates for Regenerated Stands

Table A-29. Timber volume table for regenerated stands: interior (FIZ J) analysis units

Age	Analysis unit 1/1 Hemlock/ Balsam: good	Analysis unit 1/2 Hemlock/ Balsam: medium (0-140 years)	Analysis unit 1/62 Hemlock/ Balsam: medium (141+ years)	Analysis unit 1/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 1/63 Hemlock/ Balsam: poor (141+ years)	Analysis unit 1/4 PI	Analysis unit 1/5 Ac
10	0	0	0	0	0	0	0
20	1	0	0	0	0	0	0
30	100	3	0	0	0	6	12
40	241	51	7	0	0	55	76
50	399	136	66	4	2	114	123
60	551	221	137	25	12	167	160
70	708	300	205	57	40	222	188
80	846	380	269	100	73	264	210
90	958	456	328	142	112	303	228
100	1068	520	389	186	150	337	243
110	1168	583	449	225	189	366	256
120	1256	642	501	262	224	390	267
130	1324	698	547	294	256	413	276
140	1384	748	592	324	286	433	285
150	1446	793	637	354	312	451	292
160	1501	832	678	381	339	467	292
170	1551	866	715	406	365	481	292
180	1595	898	750	427	389	493	292
190	1635	929	781	447	411	504	292
200	1675	957	810	464	432	513	292
210	1712	983	834	481	449	522	292
220	1744	1008	858	495	465	529	292
230	1772	1031	879	511	480	536	292
240	1795	1052	898	525	493	542	292
250	1816	1072	916	538	506	545	292
260	1835	1090	934	551	517	548	292
270	1851	1103	951	562	529	551	292
280	1869	1116	966	573	541	554	292
290	1885	1127	979	583	551	556	292
300	1900	1137	992	592	561	558	292

continued

A.5 Volume Estimates for Regenerated Stands

Table A-29. Timber volume tables for regenerated stands: Kitimat Valley (Zone 2) analysis units (concluded)

Age	Analysis unit 2/1 Hemlock/ Balsam: good	Analysis unit 2/2 Hemlock/ Balsam: medium	Analysis unit 2/3 Hemlock/ Balsam: poor (0-140 years)	Analysis unit 2/73 Hemlock/ Balsam: poor (141+ years)
10	0	0	0	0
20	2	0	0	0
30	106	7	0	0
40	251	109	0	0
50	414	222	10	3
60	570	331	48	21
70	731	443	98	50
80	871	546	151	94
90	985	644	204	135
100	1098	736	254	179
110	1200	823	299	219
120	1287	898	339	256
130	1355	962	381	290
140	1421	1022	420	320
150	1485	1078	455	350
160	1542	1129	485	378
170	1593	1177	514	404
180	1637	1220	540	428
190	1680	1258	563	449
200	1720	1287	588	468
210	1757	1314	610	485
220	1788	1338	631	501
230	1813	1362	651	516
240	1836	1384	669	531
250	1856	1406	688	546
260	1874	1424	704	560
270	1892	1441	719	573
280	1910	1456	733	585
290	1926	1469	745	595
300	1940	1481	757	606

A.5 Volume Estimates for Regenerated Stands

Table A-30. Volume table for commercial thinning (site index @ 50 years - 28.2 m)

Age	Volume (cubic metres)
10	0
20	01
30	117
40	272
45	349
45	249 ^a
50	313
60	451
70	588
80	725
90	857
100	985
110	1104
120	1212
130	1307
140	1394
150	1471

(a) Thinning occurs at 45 years. Removes one-third of basal area, or 100 cubic metres per hectare.

Commercial thinning volumes were generated using the Tree and Stand Simulator (TASS), assuming a site index at 50 years of 28 metres. Thinning is to occur at 45 years, removing one-third of the basal area. The volumes for commercial thinning listed above have already been reduced from TASS volumes by two operational adjustment factors (OAFs): an "OAF1" of 10% to represent incomplete site occupancy; and an "OAF2" of 5% to account for losses to decay and other pests over time. Final harvest (clearcut) is targeted for 80 years.

APPENDIX B

Land Base Changes since the 1991 Kalum TSA Timber Supply Status Report

Introduction

Table B-1. shows the total area, the timber harvesting land base and areas considered unavailable for harvesting for both the interim timber supply analysis of 1991 (Status Report) and this Timber Supply Review (TSR) analysis. The figures in the "Land Base Change" column represent the effect on the land base of changes since 1991. For areas removed from consideration for harvesting, negative numbers mean more land is removed in the TSR analysis than in the previous analysis. For total and harvestable areas, negative numbers mean the land base is smaller than in 1991.

The main reason the total area is smaller now than in the 1991 analysis is that the Gitnadoix Recreation Area, designated in 1987, is not included in the inventory file as it was in the file used in 1991.

The overall area reduction from the productive forest land was about 12 750 hectares greater in the 1991 Status Report than for the TSR analysis. While it is difficult to ascertain the reason for the difference from figures provided, one major factor is that areas operable only for non-conventional harvesting systems were not included in the timber harvesting land base in 1991. The 1991 analysis did not incorporate a reduction for inoperability. Most areas now classified as inoperable were likely classified as either environmentally sensitive or non-merchantable in the 1991 analysis. It is also likely that more forest types were removed from the harvesting land base due to non-merchantability for the 1991 analysis than for the TSR analysis.

The timber harvesting land base for this TSR analysis is almost 7% larger than that assumed for the 1991 analysis (this percentage employs the long-term harvesting land base after removal of future roads).

Table B-1

Table B-1. Summary of land base changes since 1991

Classification	Areas for timber supply review (hectares)	Areas for 1991 status report (hectares) ^a	Land base change (hectares) ^b
Total land base	549 762	594 801	- 45 039
Reductions to total area:			
Not in B.C. Forest Service jurisdiction	46 189	N/A	N/A
Non-forest	304 123	N/A	N/A
Total productive forest	199 450	205 716	- 6 266
Reductions to productive forest area:			
Not satisfactorily restocked (inoperable)	-	657 ^c	+ 657
Non-commercial cover (NCC)	511	729	+ 218
Inoperable	71 932	0	- 71 932
Deciduous types	5 249	12 352	+ 7 103
Non-merchantable	5 186	35 174	+ 29 988
Low sites	622	6 854	+ 6 232
Existing and future roads ^d	8 752	7 625	- 1 127
Environmentally sensitive	8 157	51 842	+ 43 685
Streamside buffers/old growth	2 306	-	- 2 306
Insect kill and windthrow ^e	0	235	+ 235
Total reductions to forested area	102 715	115 468	+ 12 753
Timber harvesting land base (NSR in brackets)	96 735 (7 978)	90 248 (9 644)	+ 7 193
Add:			
NCC rehabilitation	-	117	- 117
Timber licence reversions	2 401	2 483	- 82
Total timber harvesting land base	99 136	92 848	+ 6 288

(a) The areas are from the Kalum Timber Supply Analysis Information Report of 1988, which were employed in the 1991 Timber Supply Status Report. The values are sums of areas for Kalum South and Kitimat Municipality.

(b) The land base change in this column represents either 1) the difference between the area in the TSR analysis compared to the 1991 Status report (a negative value means the area is now smaller); or 2) the effect of the change in an area reduction on the harvesting land base (a negative value means the reduction is now larger than in the 1991 analysis, and therefore reduces the timber harvesting land base).

(c) This value is the NSR reduction (8562 hectares) less the NSR added back into the land base (7905 hectares) for Kalum South in the 1991 analysis. All NSR in Kitimat Municipality was added back into the land base.

(d) Existing and future roads were combined for the 1991 analysis. To make the comparison consistent, these areas are combined for this analysis as well.

(e) Unsalvaged losses are expressed as a loss of volume in this analysis, not of area as in 1991.