

Soo TSA Timber Supply Analysis

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Preface

This analysis is part of the provincial Timber Supply Review being carried out by the British Columbia Forest Service. The review is examining the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) throughout British Columbia. In many areas of the province, timber supply analyses performed in the early 1980s have not been updated to reflect new inventory information and knowledge 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 analysis 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 Soo Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the next 250 years. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the harvest forecasts in this report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The total area of the Soo TSA is about 880 000 hectares of which 106 000 hectares are considered available for timber harvesting under current management practices. The total volume of standing timber in the area is about 30 million cubic metres, of which 24 million cubic metres is of merchantable age. The area is dominated by stands of Douglas-fir, western hemlock and amabilis fir, with smaller proportions of western redcedar.

In January 1992, the AAC for the Soo TSA was reduced from 697 600 cubic metres to the current AAC of 580 000 cubic metres.

Given current management assumptions, this analysis shows that the AAC cannot be maintained without causing a sharp drop in future harvest levels below the long-term yield. The harvest flow selected as the base case indicates a harvest reduced immediately by 13%, to a harvest level of 506 000 cubic metres per year for a decade, followed by a reduction of 12% per decade for 2 decades to reach a level of 394 000 cubic metres, 11% below the long-term level. This harvest is maintained in decades 3 to 7 and then rises to the steady long-term level of 442 000 cubic metres.

In the Soo TSA the original abundance of mature forest which historically allowed harvest rates well above the long-term level no longer exists. The 1992 AAC reduction was the first step in the decline towards the long-term level. To avoid major timber shortfalls below the long-term level in the future, the remaining mature timber must be harvested at a rate which allows the existing young stands to reach harvestable ages and volumes.

The harvest forecast is extremely sensitive to the estimate of minimum harvestable age because of the age class structure. The ages were based on wood-product objectives and are slightly higher than those used in other south coastal TSAs. Decreasing the ages by 10 years produces a forecast that declines immediately by 6% then steps down 6% per decade to reach the long-term level in decade 4.

The short-term forecast is also very sensitive to uncertainty in the two main factors which affect existing volumes of mature timber — existing stand yields and the size of the timber harvesting land base. Squamish Forest District staff are concerned that the yields from the remaining poor stands may be lower than indicated by the yield curves, especially in the Pemberton Supply block where (there is a high incidence of decay). Also, decreases in the accessible land base are a concern where access is blocked by private land.

The long-term harvest forecast is highly sensitive to uncertainty about regenerated stand yields and the size of the timber harvesting land base, but is generally not sensitive to uncertainty about other data and assumptions.

The forest cover requirements for forest resources such as wildlife, water quality and visual quality impact timber supply slightly in both the short and long term, but even if these requirements are removed, the harvest forecast still shows a decline in the future.

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Introduction

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

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

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions whether a stand is available for harvest often 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 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 the collection and preparation of information and data. The B.C. Forest Service forest inventory* plays a major role in this stage. 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 Soo TSA. Following a brief description of the TSA in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Then 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 Soo TSA

The Soo TSA lies in the south-east portion of the Vancouver Forest Region. As indicated in Figure 1, it extends along the Lillooet River to Harrison Lake and along the Cheakamus River to Howe Sound. It is bounded by tree farm licence (TFL) 38 on the west. It surrounds Garibaldi Provincial Park. The TSA covers approximately 880 000 hectares and is administered from the Squamish Forest District office in Squamish.

The main population centres of the TSA are the communities of Lions Bay, Squamish, Whistler, Mt. Currie and Pemberton. The forest industry plays an important part in the economy of the area, and a

significant tourism sector is growing rapidly. The proximity to the large lower mainland population creates an enormous recreation demand.

The current AAC for the Soo TSA of 580 000 cubic metres per year became effective in January 1992, following a reduction of 17% from the previous AAC of 697 600 cubic metres per year. The draft Soo TSA Plan includes the rationale for this reduction. The draft Soo TSA Plan is a five-year strategic forest management plan that contains detailed objectives for values including wood products and wildlife habitat.

2 Information Preparation

Many pieces of information are required for timber supply analysis. Each piece falls into one of three categories: land base inventory, timber growth and yield, or 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, the area and the nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

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

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

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

timber supply analysis in this report is consistent with this philosophy.

This section describes the types of areas currently not considered to contribute 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.

All study areas identified under the Protected Areas Strategy or as spotted owl habitat are assumed to be available for timber harvesting since these have not yet resulted in any land-use decisions by the provincial government. When such decisions are made under these initiatives, further analysis of the effects on the timber supply will be necessary.

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

- non-Crown areas — areas not managed directly by the B.C. Forest Service.
- non-forest areas — areas not capable of growing productive forest (for example, water, rock, swamp and alpine areas).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- inoperable areas — areas defined 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).
- environmentally sensitive areas* — a proportion of the areas considered to be sensitive due to unstable soils, regeneration problems, recreation or wildlife values were deducted from the timber harvesting land base.

Timber harvesting land base

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

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

- non-merchantable forest types* — areas occupied by timber stands of low volume or non-merchantable species, both coniferous and deciduous or with low timber-growing potential. (low site index*)
- specific defined areas — small areas currently not available for timber harvesting for various reasons (access blocked, local plans, proposed ecological reserve).
- streamside buffers — the area that must remain forested alongside fish-bearing streams.
- existing forest roads, skid trails and landings — the area of productive forest land that has been lost to existing forest roads, trails and landings.
- future forest roads, skid trails and landings — the area of productive forest land that is projected to

be lost to future forest roads, trails and landings is initially included in the timber harvesting land base, but is deducted over time.

The timber harvesting land base is expected to increase by approximately 1000 hectares as some alder stands are converted to coniferous species. Table 1 summarizes the areas represented by these categories and indicates the resulting area of the timber harvesting land base. A more detailed description of these categories and the rationale for the removals and additions are provided in Appendix A, "Description of Data Inputs and Assumptions."

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.

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

Table 1. Timber harvesting land base, Soo TSA.

Classification	Area ¹ (hectares)	Per cent of Crown forest area
Crown forest land	300 716	100
Reductions to Crown forest:		
Non-commercial cover	711	0.2
Inoperable	141 908	47.2
Environmentally sensitive areas	15 108	5.0
Low timber growing potential	20 970	7.0
Deciduous (except cottonwood)	3 443	1.1
Specific areas	3 036	1.0
Streamside buffers	3 466	1.1
Existing roads, trails, landings	3 306	1.0
Total reduction	191 950	63.8
Initial timber harvesting land base	108 765	36.2
Additions:		
Alder rehabilitation	1 000	
Total additions ²	1 000	0.3
Current timber harvesting land base	109 765	36.5
Future reductions:		
Future roads, trails, landings	3 394	1.1
Future timber harvesting land base	106 371	35.4

Notes to table:

- 1 The total area on the inventory file used for this analysis is 719 503 hectares. This area does not include several small parks within the Soo TSA boundary, or the area of Garibaldi Provincial Park which is surrounded by the TSA. If the parks were included the total would be approximately 880 000 hectares.
2. Not satisfactorily restocked (NSR*) is included in the table. See Section A.2.13, "Not Satisfactorily restocked (NSR) areas" in the Appendix for details on treatment of NSR.

Not satisfactorily restocked (NSR)

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

The map in Figure 2 shows the Soo TSA with the area considered operable for timber harvesting. The actual timber harvesting land base is less than

illustrated because of reductions to the operable land base identified in Table 1 and described above.

Figure 2. Area considered operable for timber harvesting, Soo TSA.

2 Information Preparation

Figure 3 shows the stand age distribution of the timber harvesting land base by 20 year age classes. The figure illustrates the large amount of young stands (age 1 to 40) and old stands (age 140 and up) with very few between these ages. This age class gap is a result of the historic harvesting levels imposed on what was mainly a mature forest. The gap has significant impacts on timber supply because the existing mature stands must last until the younger stands become available for harvest, if timber shortfalls below the long-term level are to be avoided.

Figure 4 shows the timber harvesting land base by site quality and stand maturity. The majority of sites

in the Soo TSA are poor (57%), and medium (39%). The good sites represent only a small portion (about 4%). The existing mature forest is mainly on the poorer sites.

Figure 5 shows the species distribution and site quality for the timber harvesting land base. Douglas-fir makes up the greatest portion of the timber harvesting land base, 51%, while hemlock/balsam mixtures represent about 39%. Cedar/spruce and cottonwood make up the remainder. The distributions of the species across good, medium and poor sites are similar.

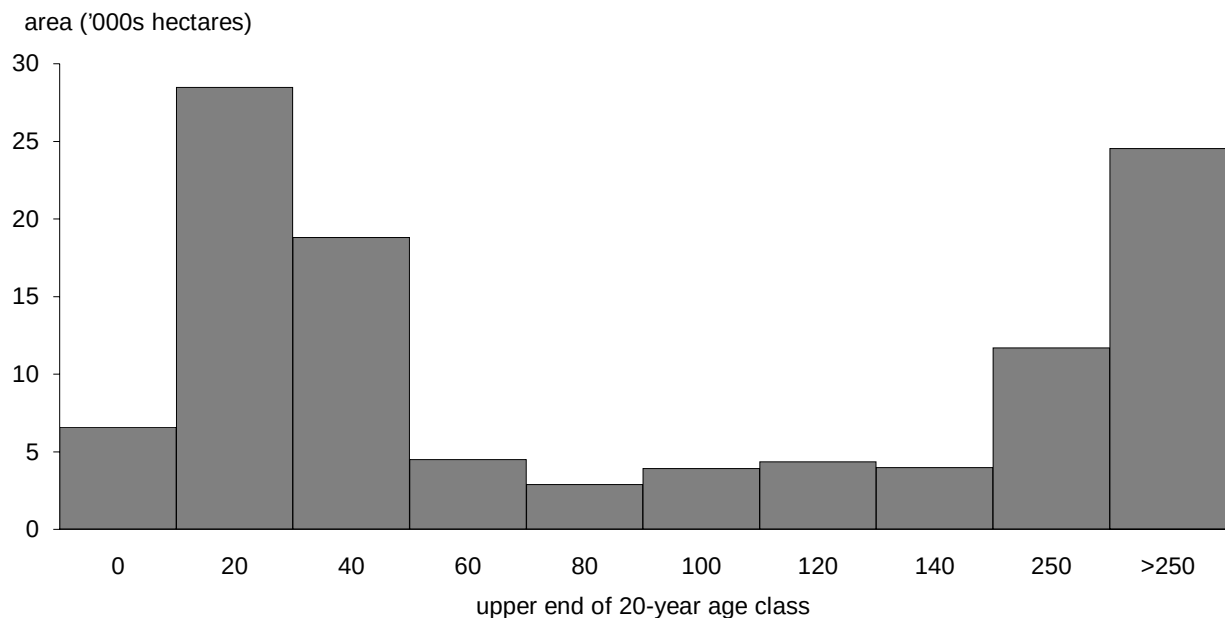


Figure 3. Current stand age distribution — timber harvesting land base, Soo TSA.

2 Information Preparation

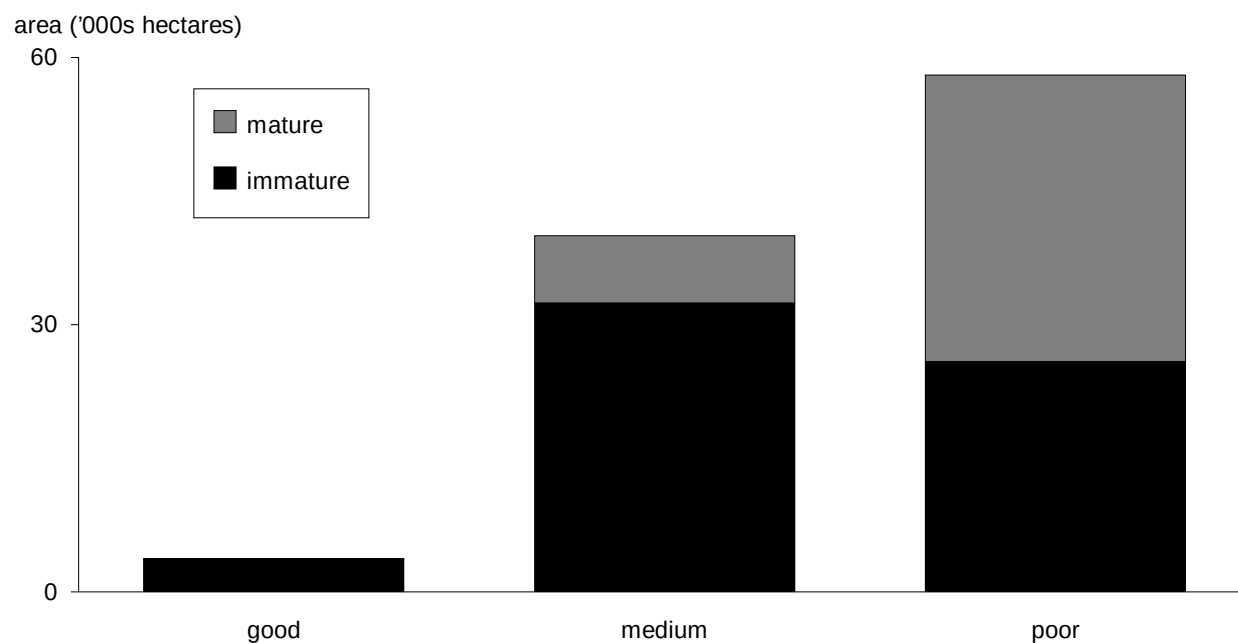


Figure 4. Area of the timber harvesting land base by site quality and stand maturity, Soo TSA.

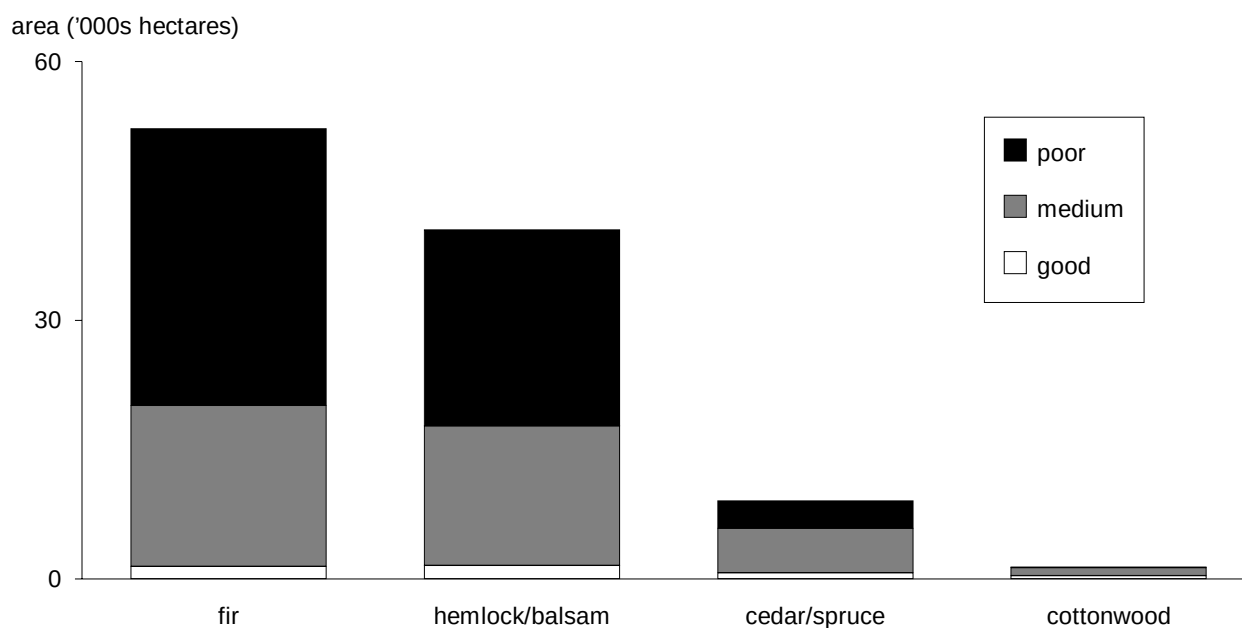


Figure 5. Area of the timber harvesting land base by species and site quality, Soo TSA.

2 Information Preparation

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of individual forest stands over time. The most common measure of the amount of standing timber is volume per area (in British Columbia, cubic metres per hectare). This measure assumes a utilization level or set of dimensions that establishes a minimum size limit for trees and logs that must be harvested and removed from a site. Utilization levels specify a maximum stump height and minimum diameters at the tree base and top.

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

2.3 Management practices

Timber supply is directly connected to forest management activity. The 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 Squamish Forest District and in the Vancouver Forest Region defined these practices as described in the following management assumptions*:

2.3.1 Forest cover requirements

- **Cutblock adjacency*** — timber harvesting is generally not carried out on an area until any adjacent previously harvested areas have reached a particular set of desired conditions (for example, covered with trees approximately 3 metres tall). The time taken to reach these conditions is specified as the green-up period.* In the Soo TSA this requirement generally ensures that no more than 33% of an area being developed for timber harvesting is covered with stands of trees less than 3 metres tall. The sensitivity of the harvest forecast* to both the estimate of the time required for regenerated stands to reach a 3-metre height and the amount of area that may be covered by stands less than 3 metres tall is examined in Sections 5.3 and 5.4.
- **Visual quality of the landscape** — in visually sensitive areas, the green-up requirement is achieved when the trees on a previously harvested area are approximately 5 metres tall.

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.

Cutblock adjacency

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

Green-up period

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.

2 Information Preparation

The proportion of each visually sensitive area that may be covered by recently harvested stands less than 5 metres tall depends on the visual quality objectives for the area. Visual quality objectives* modelled in this analysis include retention*, and partial retention.*

- Wildlife winter range — some areas that provide wildlife winter range have been excluded from the timber harvesting land base. Management of other wildlife winter range is protected by ensuring that no more than 25% of this area is covered with stands less than 4 metres tall, and that at least 65% is covered by stands older than 80 years.
- Community watersheds — in these areas the green-up requirement is achieved when stands on a previously harvested area are approximately 5 metres tall. At any point in time, no more than 17% of the area is allowed to be under cover of stands that have not reached green-up conditions.
- Mushroom habitat — in the small area managed for mushroom habitat the green-up requirement is achieved when trees on a previously harvested area are approximately 5 metres tall. No more than 20% of the area is allowed to be under cover of stands that have not reached green-up conditions. At least 50% of the area must be covered with trees older than 80 years.

The sensitivity of the harvest forecast to changes in the estimates of the cover requirements is examined in Section 5.5, "Sensitivity to changing all forest cover requirements."

2.3.2 Other management practices

- Basic silviculture levels — reforestation activities required to establish free-growing stands of acceptable species. In the Soo TSA, most areas

Partial retention VQO

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

Retention VQO

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

are harvested using a clearcut harvesting system and restocked by planting or natural regeneration.

- Incremental silviculture levels — silviculture activities additional to basic levels identified in the Soo TSA plan to be carried out to improve timber yields. These activities include using genetically improved planting stock, and fertilization.
- Forest health and unsalvaged losses — expected timber losses due to fire, pest (insect, disease and animals) and wind damage. These losses are estimated to be 34 000 cubic metres per year in the Soo TSA, due mainly to fire.
- Utilization levels — control the minimum size of tree that must be removed at harvest. These are specified by a maximum stump height, and minimum diameters at the tree base and top.
- Minimum harvestable age — the time it takes for stands to achieve sufficient tree size to be harvested and utilized. The minimum harvestable age defines the youngest age a specific type of stand is expected to become harvestable. The actual harvest age ranges upwards from the minimum depending on many factors, including the ages of other stands, limits on overall harvest level, and forest cover requirements. For this analysis the minimum harvestable ages are estimated using the wood-product objectives outlined in the draft Soo TSA Plan. The wood-product objectives are based on the range of log grades required in order to provide the greatest financial value from the forest and allow harvesting to be profitable. They are derived from current information on log values and harvesting costs and they vary depending on site quality.

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.

2 Information Preparation

The yield curves are interpreted to determine the age at which the diameter and height will meet the product objective. The mean annual increment* at the minimum harvestable age is within about 5% of the culmination of mean annual increment. This means that trees are harvested at ages very close to those which maximize the total amount of wood harvested over the long term. In general, for unmanaged stands, this results in slightly higher minimum ages than used in other south coastal TSAs. The sensitivity of the harvest forecast to changes in the estimate of minimum harvestable age is examined in Section 5.2, "Sensitivity to uncertainty in minimum harvestable ages." The value impacts are not analysed here.

- High decay stands — the current AAC specifies that 12% of the volume come from stands in the

Pemberton Supply Block identified because of high levels of decay.

- Cottonwood — the AAC includes a cottonwood component of 4157 cubic metres per year.

Figure 6 shows the proportion of the timber harvesting land base subject to the forest management requirements discussed above.

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

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.

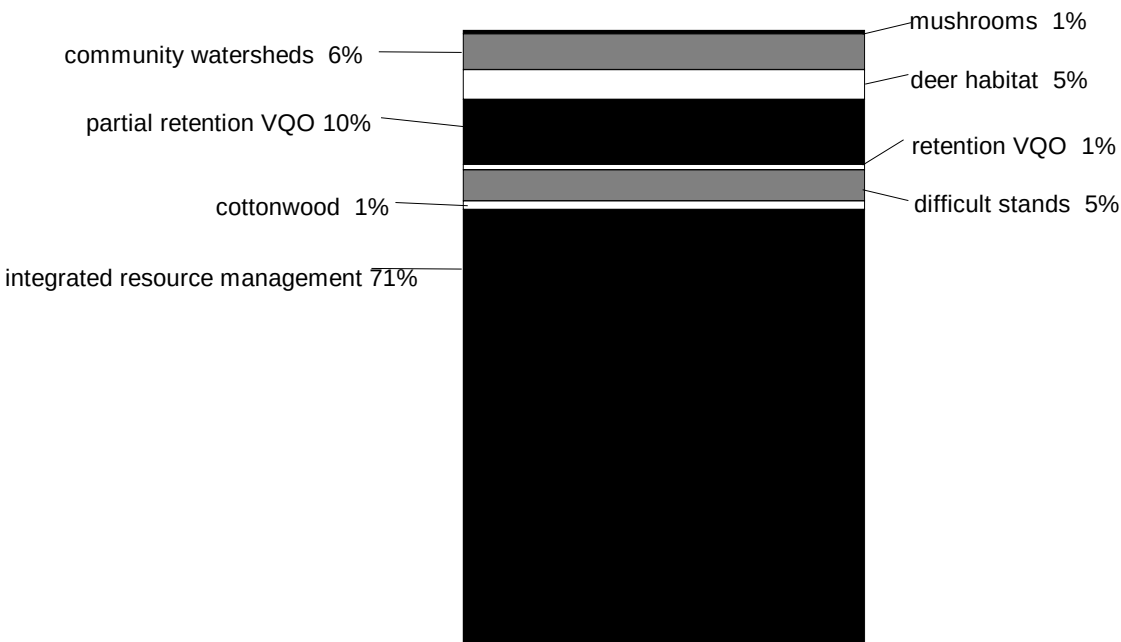


Figure 6. Area of the timber harvesting land base by management emphasis, Soo TSA.

3 Analysis Methods

The purpose of this analysis was to examine both the short- and long-term timber harvesting opportunities in the Soo TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used to aid in the assessment. A timber supply model, as distinguished from a growth and yield model, assists 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 0 to 400 years. Only the results for the first 250 years are shown graphically in this report, because the harvest flow remains constant from 250 to 400 years from now.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to 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 period, 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 this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

4 Results

4.1 Base case harvest forecast

Figure 7 shows the harvest forecast based on current forest management assumptions for the Soo TSA. This forecast is referred to as the base case harvest forecast and will be used for comparison with all other harvest forecasts in the report. **This forecast is for discussion purposes only and is not meant to suggest a particular AAC.**

The base case harvest forecast shows an initial harvest level of 506 000 cubic metres per year or about 13% below the current harvest level of 580 000 cubic metres per year. From this reduced initial rate of harvest, the harvest forecast declines another 13% in decade 2, then by 11% to a level of 394 000 cubic metres, about 11% below the long-term level. This level is maintained through decades 3 to 7, and then increases to the long-term harvest level of about 442 000 cubic metres per year in decade 8.

The base case harvest forecast shown is only one of many possible harvest flows given current forest management assumptions. The harvest forecast shown in Figure 7 was chosen as the base case for this analysis as a balance between short- and long-term timber supply interests. Starting the harvest forecast

at a higher initial level, delaying the decline, or reducing the rate of decline results in a more severe timber supply shortage in the future, as will be discussed in Section 5.1, "Alternative harvest flows."

Several important factors affect the timber supply forecast. The most important factor is that the original abundance of mature forest which historically provided great flexibility in selection of harvest levels no longer exists. One result of the past selection of harvest rates above the long-term level is that the harvest now must decline towards the long-term level to avoid serious timber supply shortfalls in the future.

Another important factor is the combined effect of the current age class distribution and the minimum harvestable ages used in the base case. As shown in Figure 3, the Soo TSA does not have many stands in the middle age classes. The large decline in harvest level is due to the fact that there is not enough existing mature timber to sustain harvest levels until the large areas of younger stands reach the minimum harvestable age. The severe timber shortage in decades 6 and 7 is minimized by reducing the harvest in the early decades. By decade 8, large areas reach the harvestable age and the harvest is easily achieved.

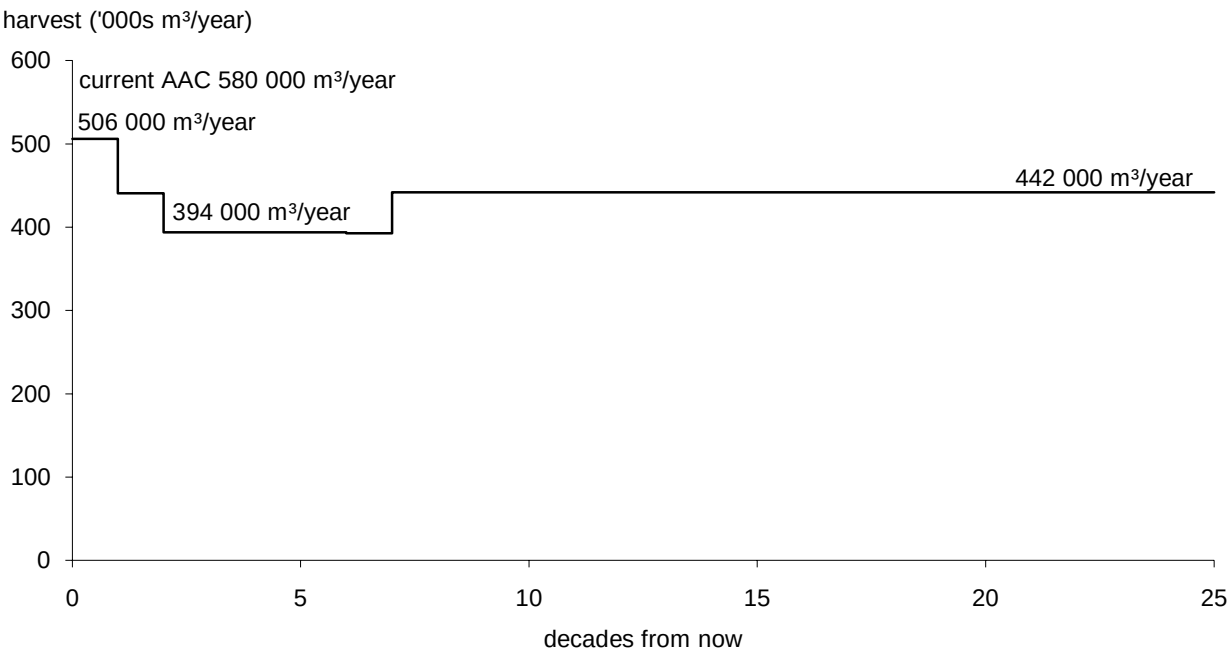


Figure 7. Base case harvest forecast for the Soo TSA.

4 Results

Also contributing slightly to the decline in timber supply are forest cover requirements for non-timber resources such as wildlife and scenic values. However, it is important to note that even if these forest cover requirements are removed, the harvest forecast will show a decline in the future because most of the original mature forest has been harvested. As discussed in Section 2.1, "Land base inventory" and shown in Figure 4, the remaining older forests, in which most harvesting is expected to occur in the short term, are on the poorer than average sites and will likely yield lower than average volumes of timber.

The harvest in the Pemberton supply block is maintained at 12% of the AAC until decade 7 when the last of the existing mature timber is harvested.

The cottonwood harvest of 4157 cubic metres per year can be maintained for 8 decades but in the long term must decline to 3500 cubic metres per year.

Figure 8 shows the total growing stock* and the volume of harvestable timber. The total volume of

the growing stock declines slightly over 30 years then rises slightly to a stable level in about 70 years. The stability of the growing stock volume over time is an indication that the long-term harvest level shown in Figure 7 is close to the maximum but does not exceed the timber growing capacity of the land base. A declining trend in total growing stock would indicate that the long-term harvest level could not be maintained in perpetuity.

The harvestable growing stock volume line of figure 8 shows the shortage of timber 60 years from now before the large areas of immature stands reach harvestable age in 80 years. There is another dip 140 years from now corresponding to the large amount of poor site areas harvested in the first decade which have not quite reached the minimum harvestable age.

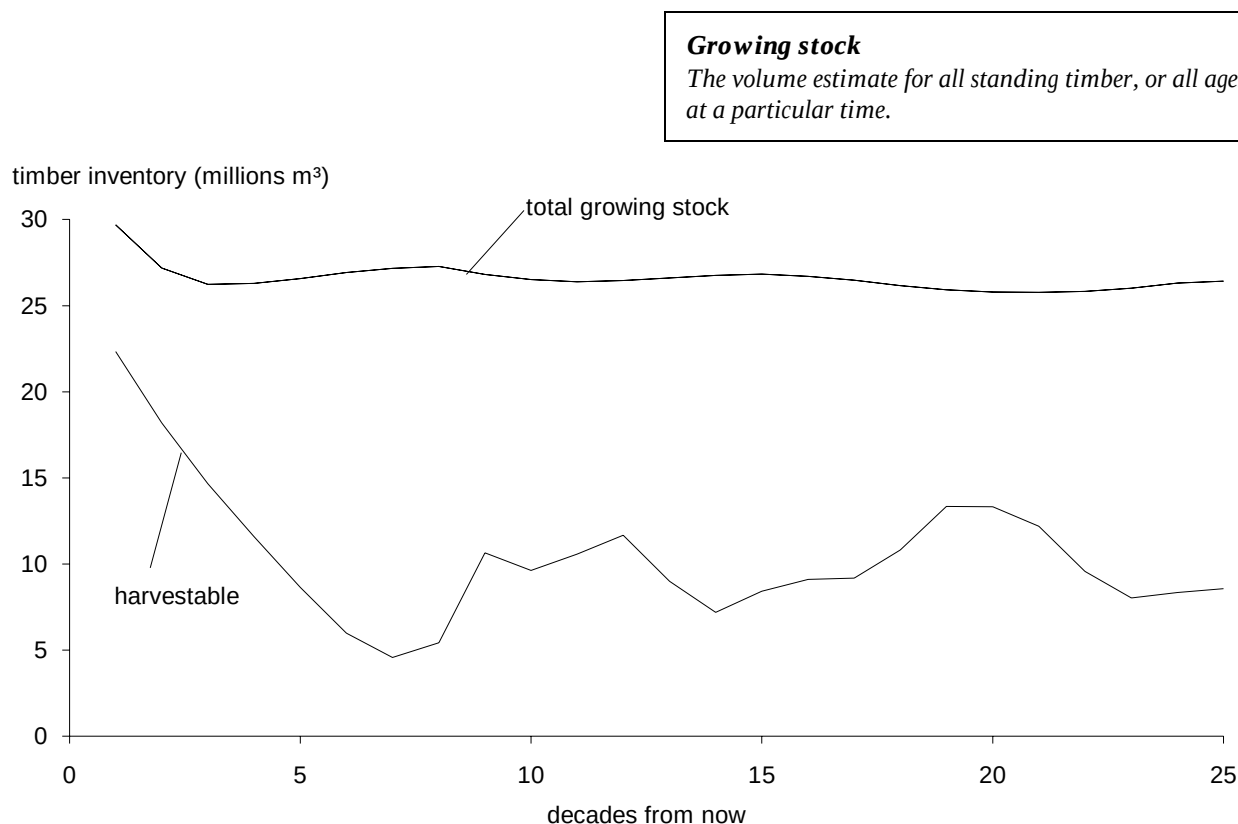


Figure 8. Total and harvestable growing stock over time, Soo TSA.

4 Results

4.2 Age class distribution over time

Figure 9 shows the changes projected to occur in the age distribution of stands in the Soo TSA under the base case harvest forecast. Over the 250 year period, the area of older stands is reduced, and the area across ages in the younger forest becomes more

balanced. By 50 years from now, almost all of the remaining older stands have been harvested and replaced with regenerated stands. The older stands that exist throughout the forecast period are the result of forest cover requirements for deer winter range, visual quality or community watershed values.

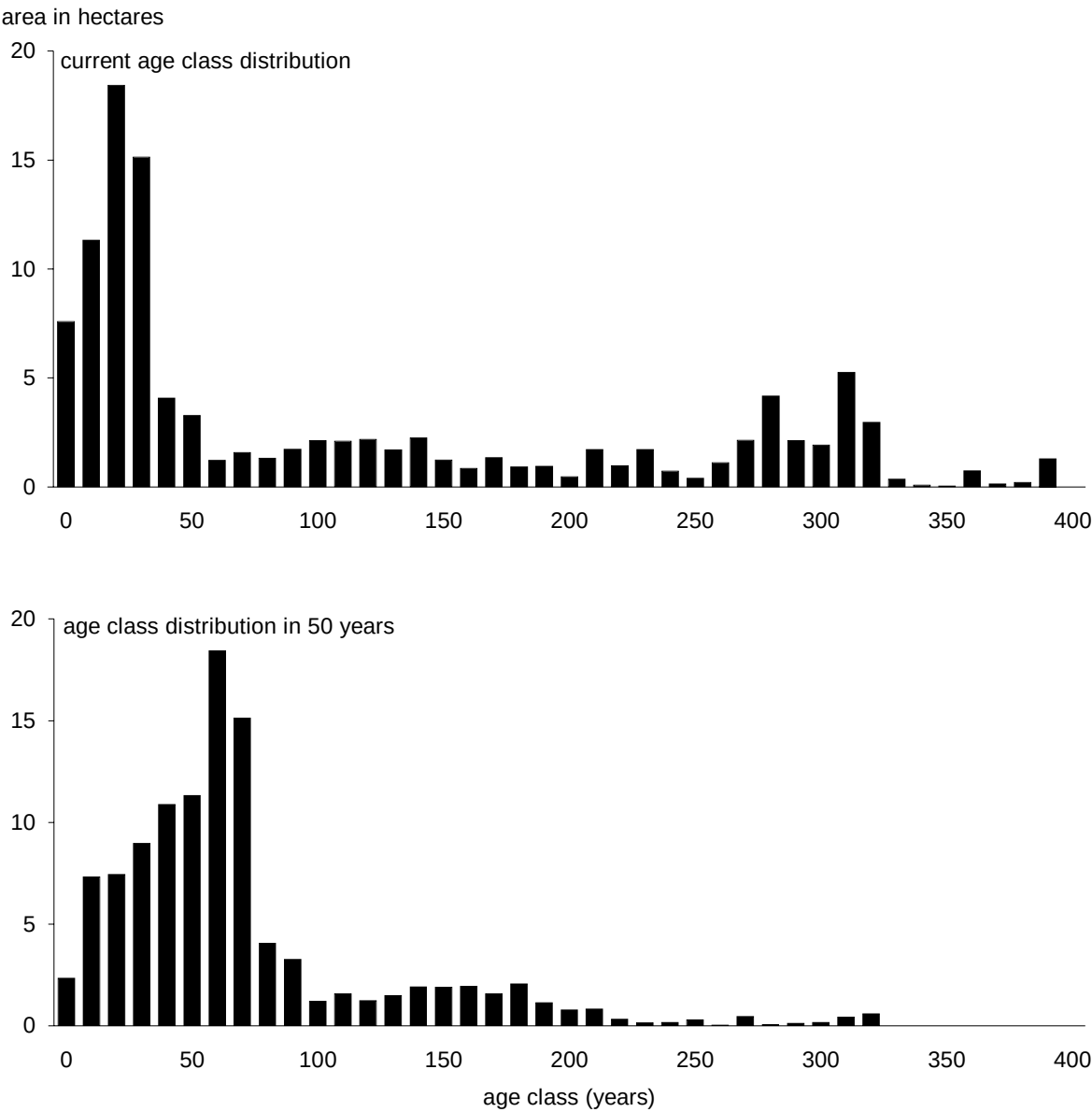


Figure 9. Age class distribution, Soo TSA. (continued)

4 Results

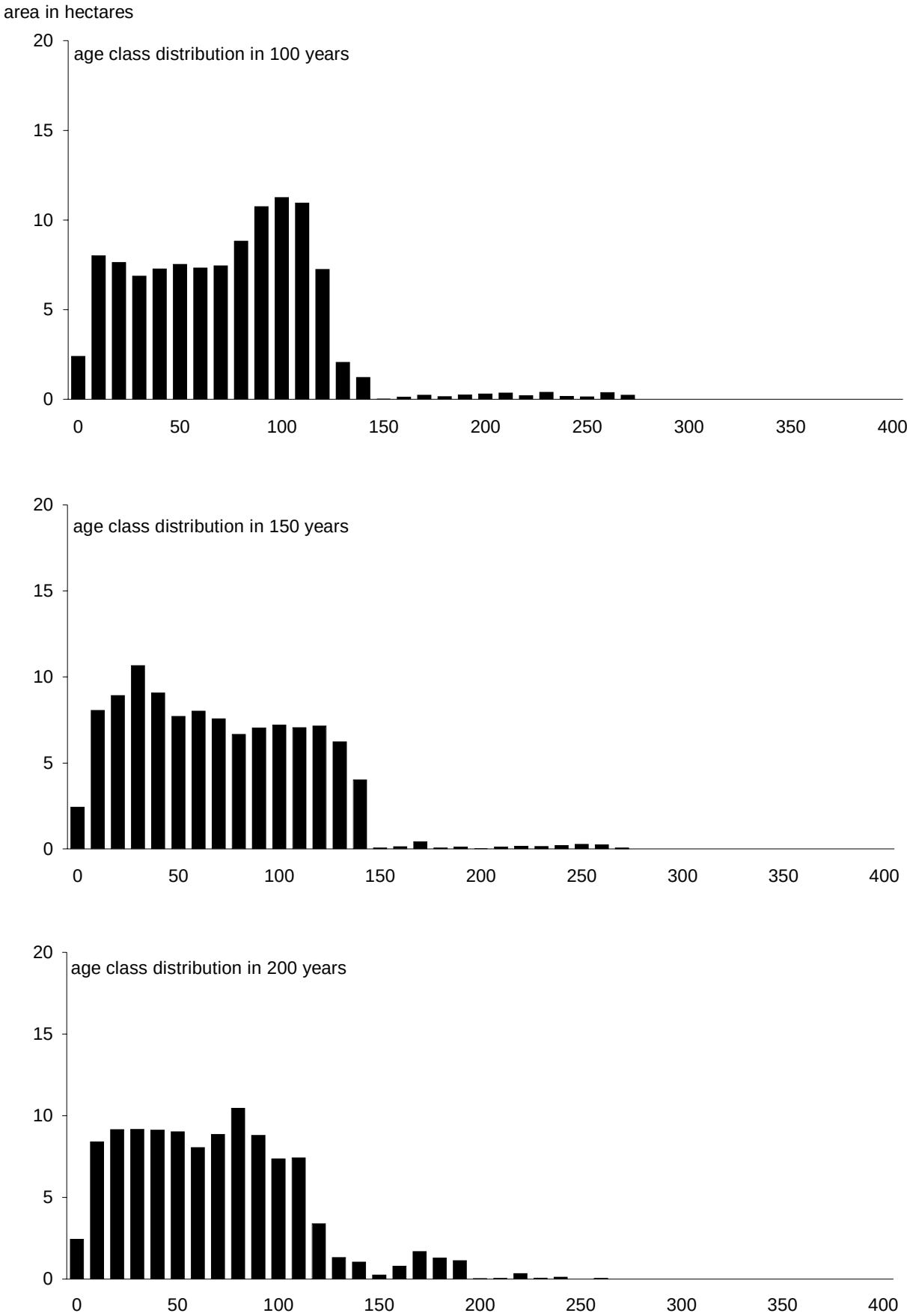


Figure 9. Age class distribution, Soo TSA (continued)

4 Results

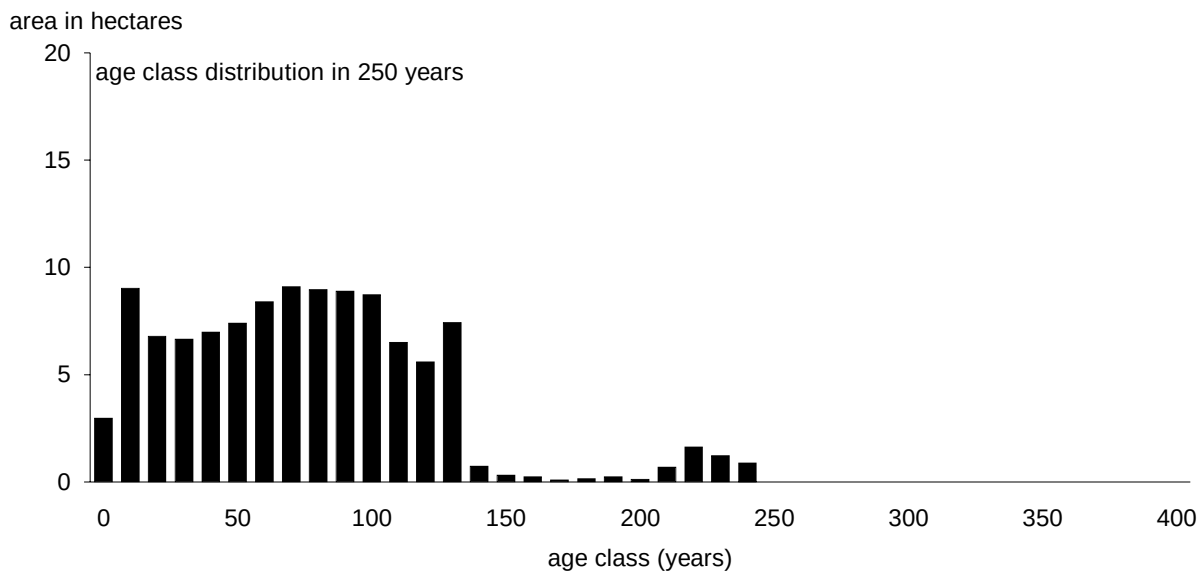


Figure 9. Age class distribution, Soo TSA.(concluded)

4.3 Average harvest age and volume per hectare

Figure 10 shows that the average harvest age declines over time from about 300 years to about 125 years. This reduction in age occurs as harvesting shifts from existing mature stands to younger regenerated stands. Figure 11 shows that the average volume of timber obtained from each hectare of forest harvested is expected to decline only slightly over time, from about 600 cubic metres per hectare to an average of about 550 cubic metres per hectare over the long term. The change in the expected volume of timber per hectare harvested is relatively small for the following reasons:

- the remaining older stands expected to be harvested over the short term are on sites with poorer than average timber productivity, and
- in general, the managed regenerated stands that will be harvested over the long term are assumed to be more productive in terms of timber than the stands that they replace.

The fluctuations in harvested volume per hectare are due to the age and site class of the stands available for harvest. Imbalances existing currently are perpetuated through the forecast period. For instance the decline about 120 years from now occurs as the poor sites harvested in the first decade reach harvestable age and are again harvested together. The increase around 200 years from now occurs because mainly medium sites are harvested.

4 Results

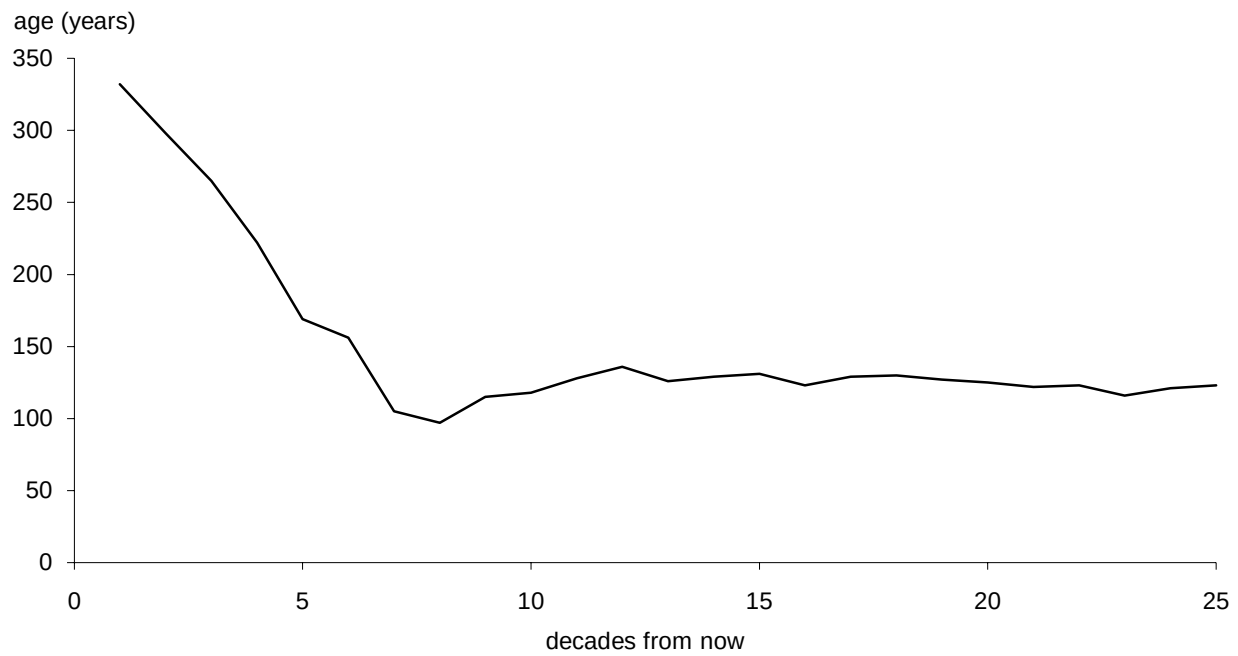


Figure 10. Average age of harvested stands over time, Soo TSA.

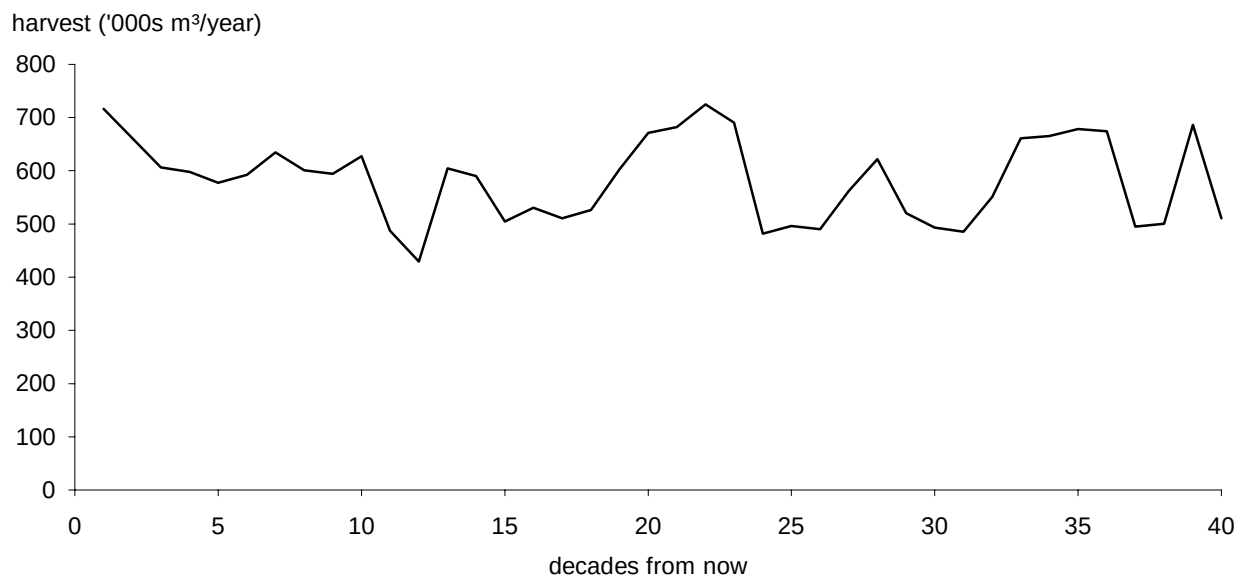


Figure 11. Average volume per hectare harvested over time, Soo TSA.

5 Timber Supply Sensitivity Analyses

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

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

Another important way of dealing with uncertainty is to assess its potential effects on values of interest, for example, timber supply. Every decision either implicitly or explicitly incorporates an attitude towards uncertainty. If we believe that existing information accurately reflects reality, we are being neutral to uncertainty, believing essentially that any inaccuracies probably balance out. Ignoring uncertainty is implicitly neutral. If maximizing timber supply were the goal, someone with an optimistic position towards uncertainty would believe that current information probably underestimates timber supply, and that problems can be resolved through human ingenuity and changes to practices. A conservative position would be that current information probably overestimates timber supply, and that decisions should minimize the potential for future timber supply shortages, or negative effects on other values.

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

Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately, decision-making. One purpose of sensitivity analysis is to highlight which variables most affect results. For example, it is possible that small inaccuracies in estimating some variables could have large effects on timber supply, or that fairly large inaccuracies in other variables could have negligible effects. Sensitivity analysis can therefore highlight priorities for collecting information for future analysis. It can also clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

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

5.1 Alternative harvest flows

This section shows some alternative harvest flows to the base harvest forecast. They illustrate the wide variety of possible harvest levels from the Soo TSA given the characteristics of the timber harvesting land base, yield estimates and current management practices already described. All of them reach the same long-term harvest level.

The alternative harvest flows shown are:

- the current harvest is maintained for 1 decade
- current harvest is maintained for as long as possible
- current harvest level is decreased immediately to the long-term harvest level
- a non-declining harvest flow.

5 Timber Supply Sensitivity Analyses

Figure 12 shows that if the current harvest level is maintained for 1 decade then the harvest must decline by about 30% to 389 000 cubic metres per year for 6 decades before it increases to the long-term level in decade 8.

Attempting to maintain the current harvest level for as long as possible (Figure 13) has drastic effects on timber supply in decades 5 to 7; however, the supply recovers in decade 8 and the long-term level is maintained.

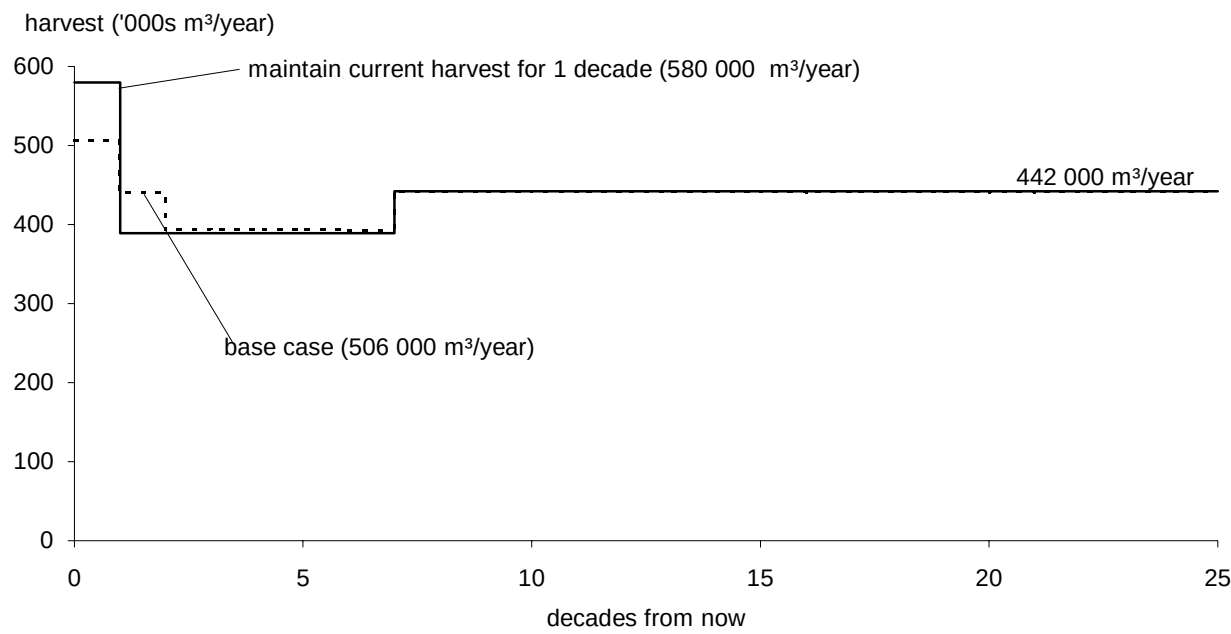


Figure 12. Harvest forecast if harvest level is maintained at current harvest level for 1 decade, Soo TSA.

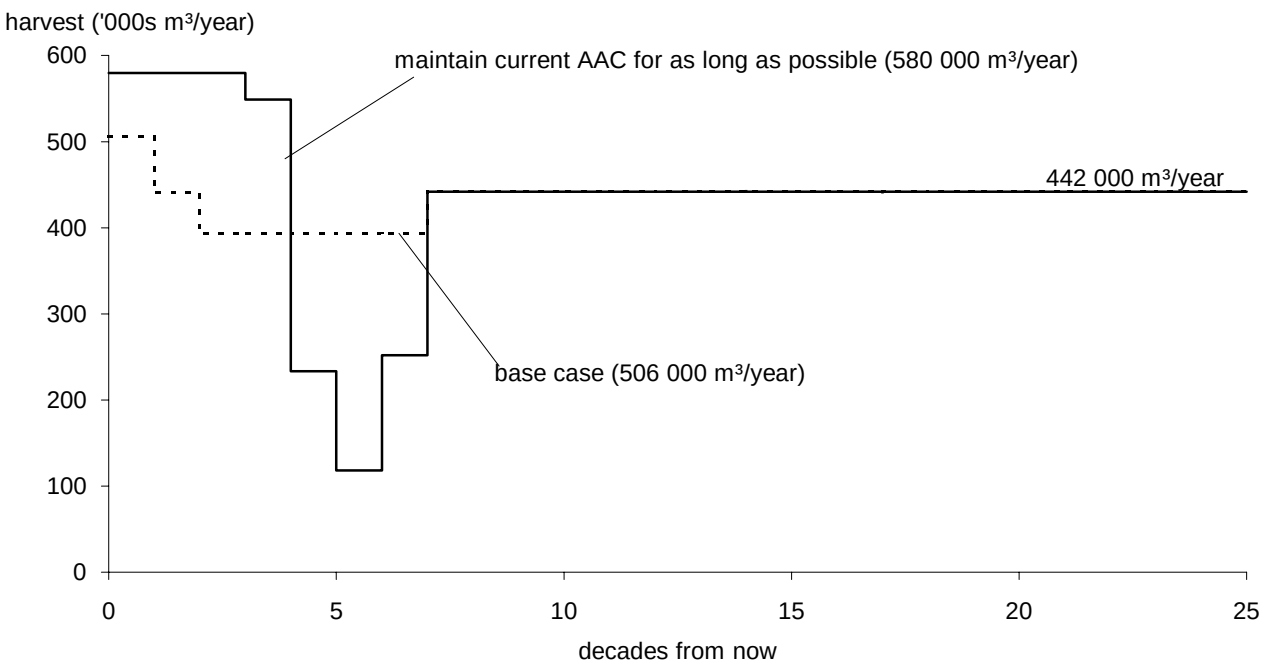


Figure 13. Harvest forecast if current harvest level is maintained for as long as possible, Soo TSA.

5 Timber Supply Sensitivity Analyses

Figure 14 shows that even with an immediate reduction to the steady long-term level, the harvest must decline about 8% below that for 5 decades before rising again to the long-term level. To achieve a non-declining harvest forecast, the initial rate of harvest must be reduced to 416 000 cubic metres per year, about 28% below the current harvest level and 6% below the long-term harvest level (Figure 15).

Although alternative harvest flows are shown only for the base case, a variety of alternatives are also possible for each of the sensitivity harvest forecasts

presented in the following sections. In general, where increased growing stock is available for harvest compared to the base case, it mitigates the shortfall below the long-term level, and then increases the initial harvest level. Reductions in the harvest rate to the long-term level are accomplished by a series of gradual reductions, rather than by pursuing an alternative such as maintaining the highest level in the short term with sudden and large reductions in the future.

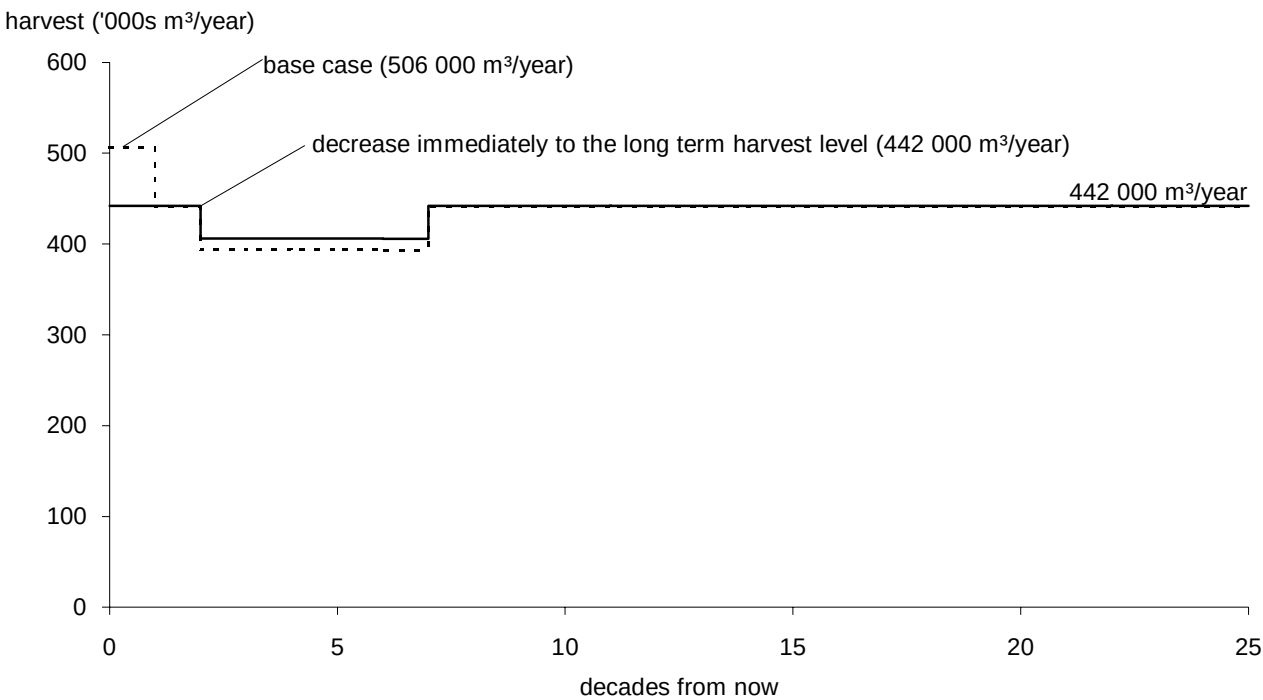


Figure 14. Harvest forecast if the initial rate of harvest is set at the steady long-term level, Soo TSA.

5 Timber Supply Sensitivity Analyses

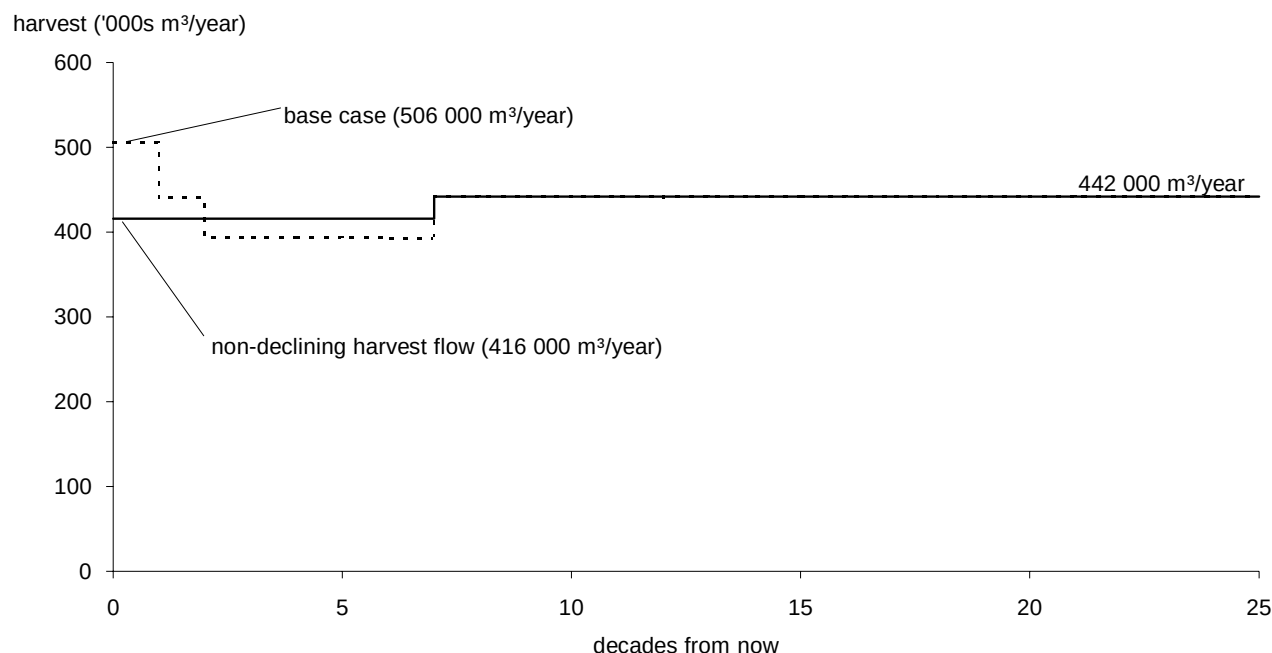


Figure 15. Non-declining harvest forecast, Soo TSA.

5.2 Sensitivity to uncertainty in minimum harvestable ages

As discussed in Section 2.3, "Management Practices," the minimum ages represent the current wood-product objectives outlined in the draft Soo TSA Plan. Uncertainty in the minimum ages stems from three factors:

- Lack of data for establishing ages. Little harvesting of second-growth stands has occurred in the Soo TSA to date, and there are few stands at or near the harvestable age that can be used to verify estimates.
- Uncertainty in the regenerated stand yield estimates from which the ages are estimated. The stands may reach the product objectives sooner or later than predicted.
- Economic uncertainty around the wood-product objectives.

The sensitivity of the harvest forecast to changing the minimum harvestable ages by 10 and 20 years is examined in this section.

The Soo TSA harvest forecast is extremely sensitive in the short term to the minimum harvestable ages. The thin solid line in Figure 16 shows the effect of increasing the minimum harvestable age by 10 years. This exacerbates the timber shortage because the existing timber must be spread over one more decade before the young stands reach the minimum harvestable age. The harvest must decrease immediately by 35% to 371 000 cubic metres per year in order to avoid major future shortages. This level is maintained until decade 9 when large areas reach minimum harvestable age and the harvest is achieved. The long-term harvest level is not changed.

The dashed line of Figure 16 shows the harvest forecast if the harvest ages are 20 years higher. The harvest level must decrease immediately by 43% to 330 000 cubic metres per year to avoid major future shortages. This level is maintained until decade 10 when the harvest rises to the long-term level of 446 000 cubic metres per year, about 1% above the base long-term level. This slight increase is possible because the stands are harvested at an older average age closer to the age that maximizes the total volume harvested over the long term.

5 Timber Supply Sensitivity Analyses

An equally dramatic effect on the harvest forecast is produced by decreasing the minimum harvestable ages by 10 years as shown by the thick solid line in Figure 16. To avoid major future shortages the harvest must decline immediately by 6% (a difference of 7% from the base case) then step down by 6% per decade to reach the long-term level in decade 4. The lower minimum age allows the large area of existing immature stands to reach the harvestable age in decade 7, thus eliminating the timber shortage. The long-term level is decreased by less than 1% from the base case. This slight decrease results because the stands are harvested at an earlier average age than in the base forecast. This age is further from the age harvested that maximizes total volume over the long term.

Although the harvest is not restricted to occur at the minimum age, in some cases the harvest is forced into this pattern because of the interaction between the age and site class distribution, and the requested

harvest level. The shortage of harvestable growing stock in the early decades forces certain stands to be harvested which perpetuate the age and site class imbalances, so that the future harvests are also affected. The result is that the long-term harvest level is slightly lower than the maximum possible.

Not shown is an alternative harvest flow in which the current harvest level is maintained for the first decade. Attempting this harvest flow produces a forecast which steps down in decades 2 and 3 by 12%, and by 3% in decade 4 to reach the long-term level.

The thickest dashed line of Figure 16 shows the harvest forecast if the minimum harvestable ages are 20 years lower. The current harvest level can be maintained for 2 decades and then the harvest level declines by 7% per decade until decade 5 when it reaches the long-term level of 434 000 cubic metres per year. This is 2% less than the base case, and is slightly lower than the maximum possible for the reasons described previously.

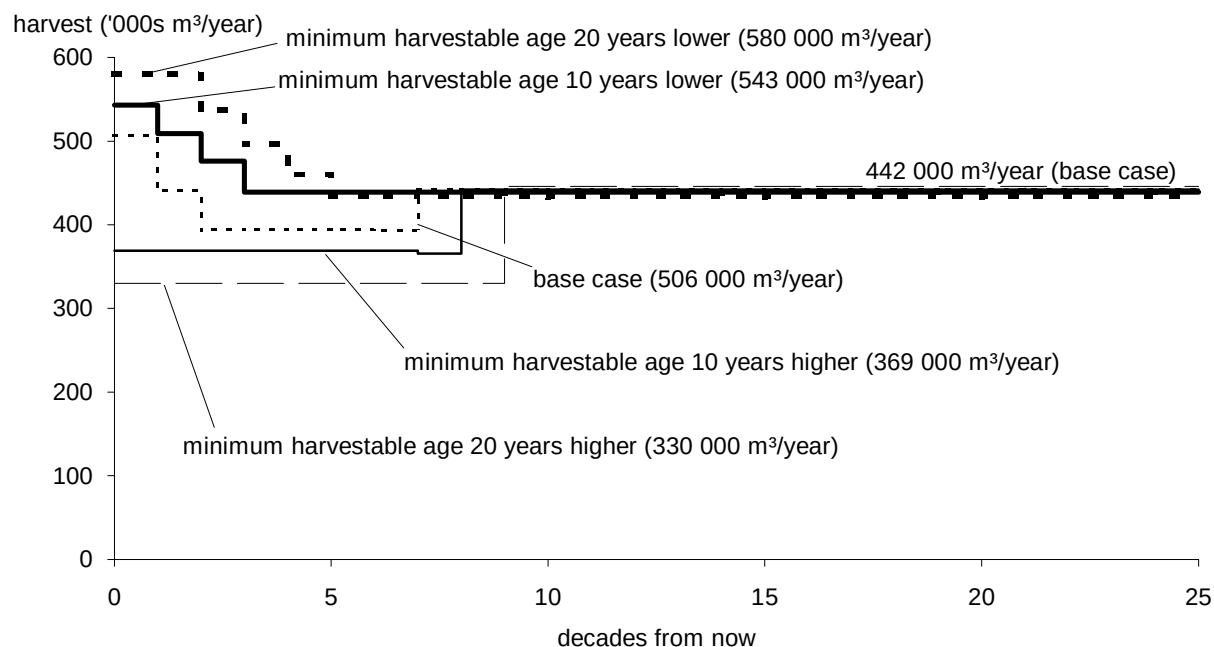


Figure 16. Harvest forecasts with minimum harvestable ages changed by 10 years, Soo TSA.

5 Timber Supply Sensitivity Analysis

Minimum harvestable age is an estimate of when a stand will be economically viable to harvest. One important indicator of the economic viability of a stand is its volume per hectare. The volumes harvested per hectare over time for the base case (Figure 11) average about 600 cubic metres per hectare harvested in periods 6 to 10. In periods 11 and 12, when mainly poor sites are harvested this declines to about 450 cubic metres per hectare. The average volume harvested per hectare remains above 500 cubic metres for most other decades in the forecast.

If the minimum harvestable ages are 20 years lower, then on average 520 cubic metres per hectare are harvested in periods 6 to 8. In periods 9 and 10 the average declines to 410 cubic metres per hectare. This results because the harvestable ages cause the harvest to move into the poor sites 20 years earlier than in the base forecast. The volume harvested per hectare is well below 500 cubic metres for most of the remaining decades in the forecast.

The total growing stock volume in the base case averages 26 million cubic metres. This is reduced by 23%, to about 20 million cubic metres, if the minimum harvestable ages are 20 years less.

5.3 Sensitivity to uncertainty in required green-up periods

As discussed in Section 2.3, "Management Practices," the required green-up periods used in the base case harvest forecast are the estimated number of growing years for the trees on a previously harvested adjacent area to reach a required height. Uncertainty in the required green-up period stems from both the uncertainty in stand height growth rates as well as the subjectivity of the height requirement before a stand is considered "greened-up." The following sensitivity analysis examines the effect that uncertainty in the required green-up period has on the harvest forecast.

The solid line in Figure 17 shows the harvest forecast if required green-up periods are 5 years shorter. This change has a minimal effect because cover requirements were not a significant limiting factor in the base case forecast. The slight increase in growing stock available is not enough to fill the shortage. Similarly, as the thin solid line in Figure 17 shows, there is little effect if the green-up periods are 5 years longer. The harvest slips to 2% below the base case in decades 3 to 7. The long-term level is unchanged.

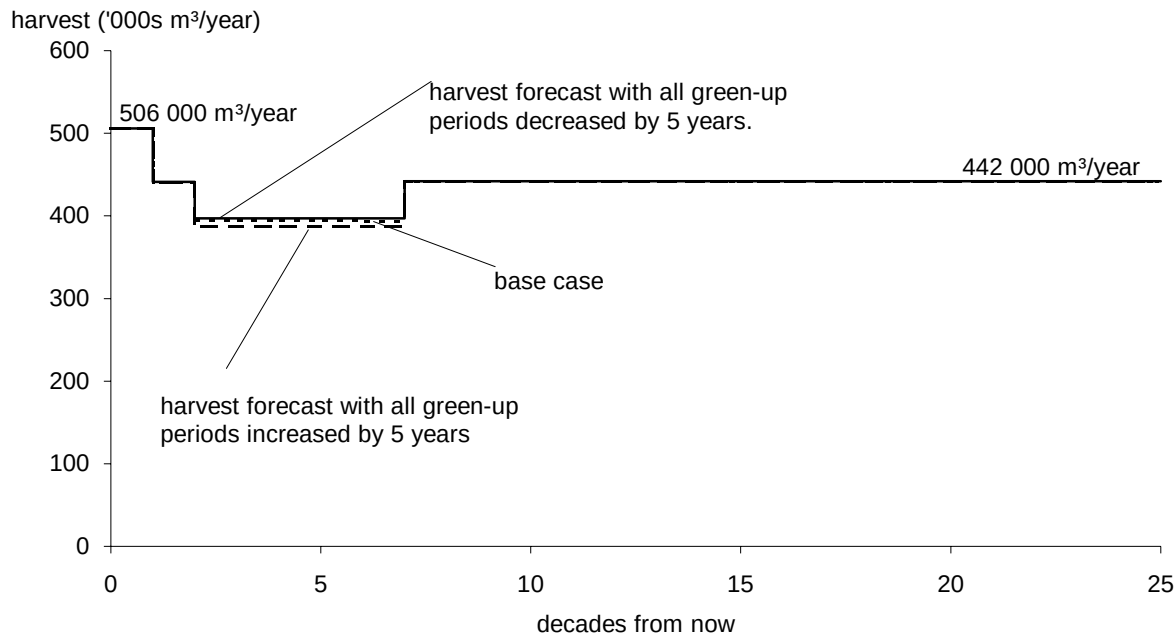


Figure 17. Harvest forecasts with all green-up periods changed by 5 years, Soo TSA.

5 Timber Supply Sensitivity Analyses

5.4 Sensitivity to cutblock adjacency requirements

In the base case, forest cover requirements used to model cutblock adjacency and green-up were based on the assumption that no more than 33% of the timber harvesting land base may be forested with stands less than 3 metres tall at any time (see Section 2.3, "Management Practices.") However, this forest cover requirement should be viewed only as an average that applies to areas with no overriding management concerns such as visual quality or wildlife habitat. Site-specific forest cover requirements will vary from this average requirement. Uncertainty in the average forest cover requirement used to model cutblock adjacency and green-up in this analysis stems from these site-specific variations from the average.

Because this forest cover requirement was not a limiting factor in the base case, the harvest forecast was not changed by relaxing the forest cover requirement to allow more area to be covered with stands less than 3 metres tall. Tightening the requirement to allow a maximum of 25% does not change the harvest forecast from the base forecast. However, if only 20% is allowed to be covered by trees less than 3 metres tall, then the forecast declines 1% in periods 3 to 7 compared to the base forecast (Figure 18). This decline occurs because the harvest target of 12% from the Pemberton Supply Block high decay stands cannot be met at this level of constraint. The integrated resource management zone is still unaffected by the more stringent adjacency requirement, but does not have enough available timber to make up the shortfall.

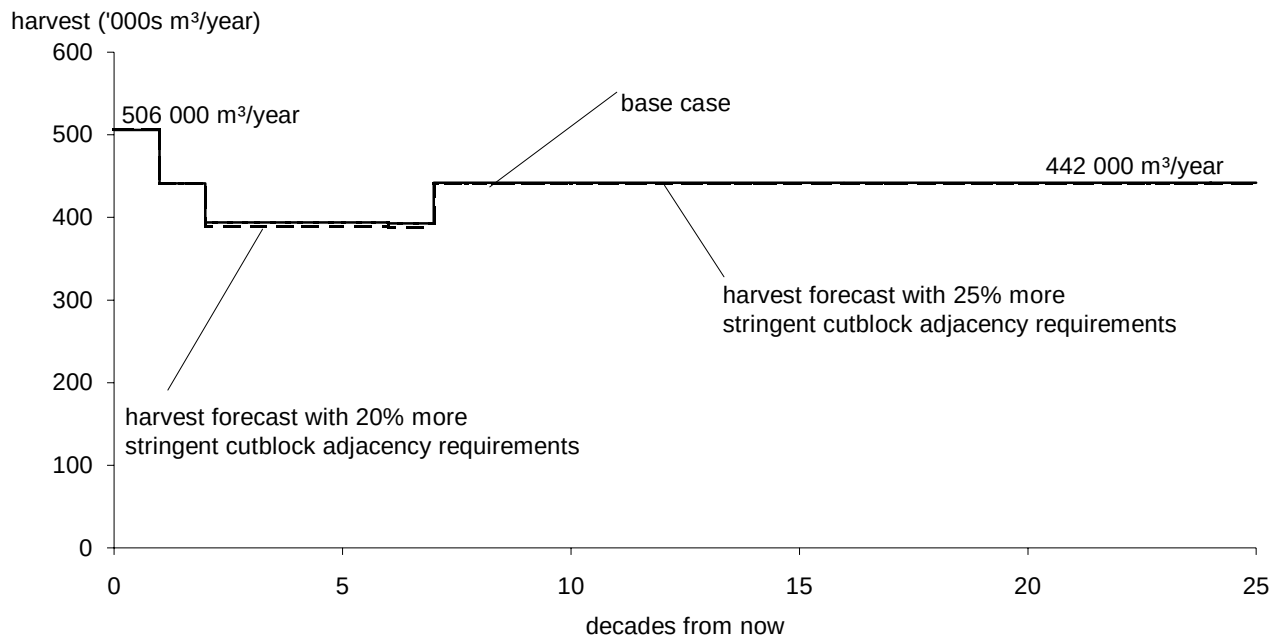


Figure 18. Harvest forecasts with more stringent cutblock adjacency, Soo TSA.

5 Timber Supply Sensitivity Analyses

5.5 Sensitivity to changing all forest cover requirements

The cover requirements applied for visual quality, wildlife habitat, community watersheds and mushroom habitat are averages which are expected to vary depending on actual site characteristics. Uncertainty in the cover requirements stems from this averaging process. There is also uncertainty about the ability of management prescriptions to maintain the non-timber resources, and whether the objectives will be met by these cover requirements or not. The requirements could be refined in the future because of new research or changing social objectives.

Since the cover requirements were not the major limiting factor in the base case, the harvest forecast's is minimally sensitive to changes in the visual quality, community watershed, wildlife habitat or mushroom habitat cover requirements (each considered separately,) is minimal and therefore these forecasts are not shown. The impact is low because the individual areas are small relative to the whole land base. To show the sensitivity to all cover requirements, the impact of changing all cover requirements is examined in this sensitivity analysis.

The thick solid line in Figure 19 shows the harvest forecast with all forest cover requirements for cutblock adjacency and green-up, visual quality, community watershed and wildlife habitat removed. As mentioned in Section 5.1, "Alternate harvest flows," the extra harvestable growing stock made available fills in the shortfall below the long-term level. Thus, the harvest for the first 2 decades is the same as the base case, and in the third decade it declines by 2% to 434 000 cubic metres per year (about 10% above the base case). This rate is maintained in decades 3 to 7 and then increases to the long-term level of 448 000 cubic metres per year (only 1% above the base long-term level) in decade 8.

The thin solid line in Figure 19 shows the harvest forecast with the cover requirements for cutblock adjacency and green-up, visual quality, community watershed, mushroom and wildlife habitat made more stringent by decreasing the area allowed to be younger than green-up period by 5%. This results in an immediate reduction of 14% from the base initial harvest. The harvest also declines by 1% from the base case in decades 3 to 7 and remains about 2% below the base harvest forecast in the long term.

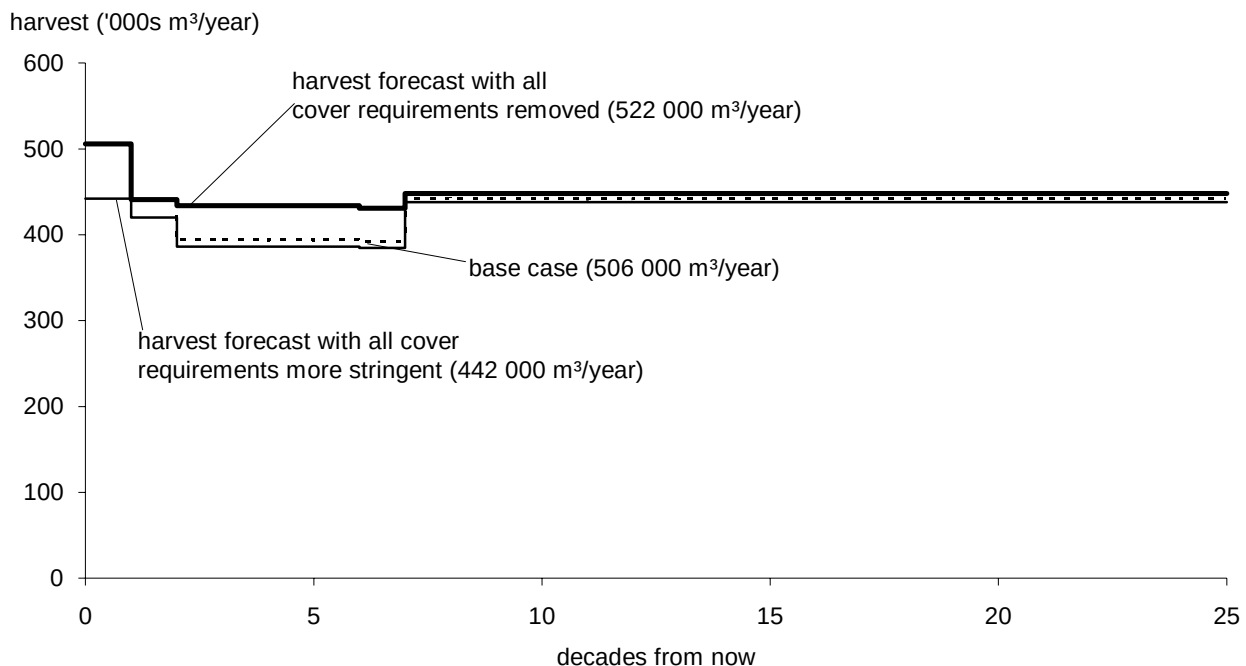


Figure 19. Harvest forecast with cover requirements, Soo TSA.

5 Timber Supply Sensitivity Analyses

5.6 Sensitivity to uncertainty in existing stand yield estimates

Uncertainty in timber yield estimates is due to the statistical process used to develop growth and yield models, uncertainty in the forest inventory, and changing timber utilization standards. The following sensitivity analyses examine the effect on the harvest forecast of uncertainty about the volume of timber that currently exists on the timber harvesting land base.

The thick solid line in Figure 20 shows the effect on the harvest forecast if the estimated timber yields from existing stands are 10% higher. The increased volume alleviates the projected shortfall below the long-term level, and allows a higher initial rate of harvest than in the base case. The initial harvest level

is 8% below the current harvest level and decreases by 8% per decade after the initial decade, to reach the long-term level in decade 3. The long-term level is unchanged.

The thin solid line in Figure 20 shows the harvest forecast if the estimated timber yields from existing stands are 10% lower. This change also has a large impact on the harvest forecast because it exacerbates the timber shortfall observed in the base case. The harvest level immediately drops by 35% from the current harvest level to 376 000 cubic metres per year and stays at that level until decade 8, when it increases by 9% per decade to reach the long-term level in decade 9. Although more area must be harvested, the main limiting factor is the lack of available timber; not the cover requirements.

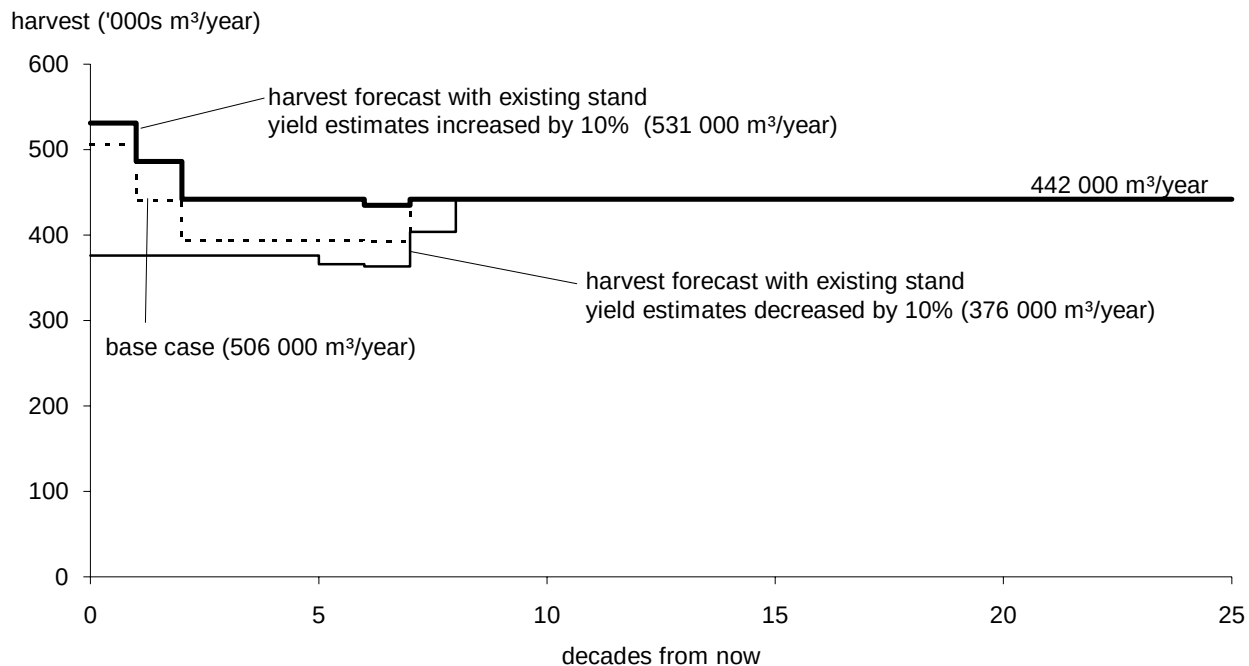


Figure 20. Harvest forecasts with existing stand yield estimates changed by 10%, Soo TSA.

5 Timber Supply Sensitivity Analyses

5.7 Sensitivity to uncertainty in regenerated stand yield estimates

Uncertainty in regenerated stand yield estimates is affected by the same factors that affect existing stand yield estimates. In addition to these factors, uncertainty about the effect of replacing existing forests with different tree species after logging, and the effects of soil degradation, pests and forest diseases on future forest productivity all effect regenerated stand yield estimates.

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

The thick solid line in Figure 21 shows the effect on the harvest forecast if the estimated timber yields from all regenerated stands are 20% higher. The effect is negligible in the short term with only a very slight increase above the base case in decades 3 to 7. This effect occurs because almost all of the harvesting in the first 7 decades occurs in existing, unmanaged

stands for which the yields are not increased. By decade 8, most of the stands available for harvest are managed stands, for which the increased yields apply. As a result, more volume is available for harvest. In the long term, when all the harvesting occurs in regenerated stands, the harvest level is 536 000 cubic metres per year, or 21% above the base case.

The thin solid line in Figure 21 shows the effect on the harvest forecast if the estimated timber yields from all regenerated stands are 20% smaller. Again, the main impact is on the long-term level because it is only in the long term that all the harvest comes from the regenerated stands. Initially the harvest is similar to the base forecast but in decade 8 it remains at the 394 000 cubic metre level instead of rising as in the base case. The long-term level of 346 000 cubic metres per year, 22% less than the base case, is reached in decade 17. A large build-up of growing stock created from the age class imbalance and the lower harvest level allows the gradual decline to the long-term level.

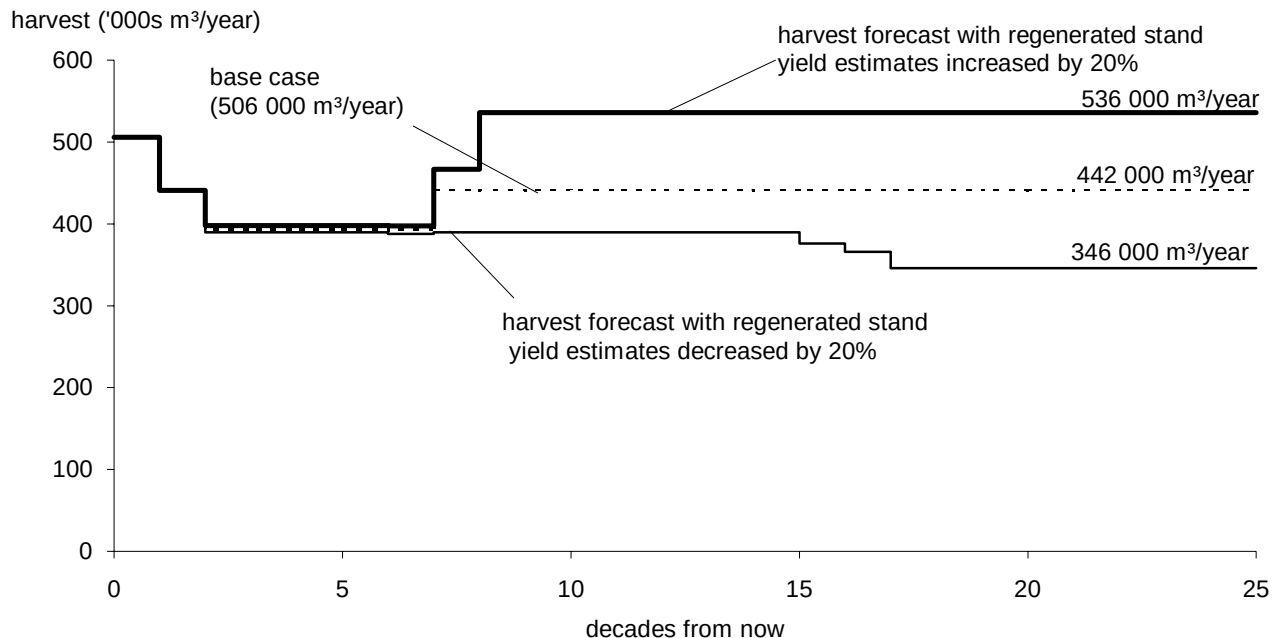


Figure 21. Harvest forecasts with regenerated stand yield estimates changed by 20%, Soo TSA.

5 Timber Supply Sensitivity Analyses

5.8 Sensitivity to changing several assumptions concurrently

The following sensitivity analyses examine the effect of changing a number of assumptions concurrently. The thick solid line in Figure 22 shows the harvest forecast with all of the following changes that increase the timber supply:

- all green-up periods 5 years shorter
- 5% more area in all zones allowed to be under cover of stands that have not reached green-up conditions
- existing volume yields 10% higher
- regenerated volume yields 20% higher
- minimum harvestable ages 10 years lower

The harvest forecast is increased dramatically by the above changes. The initial harvest is about 5% below the current harvest level (8% above the base case), and the steady long-term level reached in decade 2 is increased by 20% over the base case. The 14% decline below the long-term level in decade 25 is due to the interaction between the harvest level, the current age class and site distribution, and the harvest

ages. Although this is not shown the harvest returns to the long-term level in decade 26. The cycling of growing stock occurs in all the forecasts, but only becomes obvious in the forecasts with higher harvest levels. These variations could likely be removed by harvest strategies that ensure the harvesting of a different mix of ages and species.

The thin solid line in Figure 22 shows the harvest forecast using the following changes which decrease the available timber supply:

- all green-up periods 5 years longer
- 5% less area in all zones allowed to be under cover of stands that have not reached green-up conditions
- existing volume yields 10% lower
- regenerated volume yields 20% lower
- minimum harvestable ages 10 years higher

This causes a dramatic decrease in the timber supply forecast from the base case. The initial harvest rate is about 39% lower than in the base case, and 9% below the steady long-term level. In decade 9 the harvest level increases to the long-term level which is about 23% less than the base case.

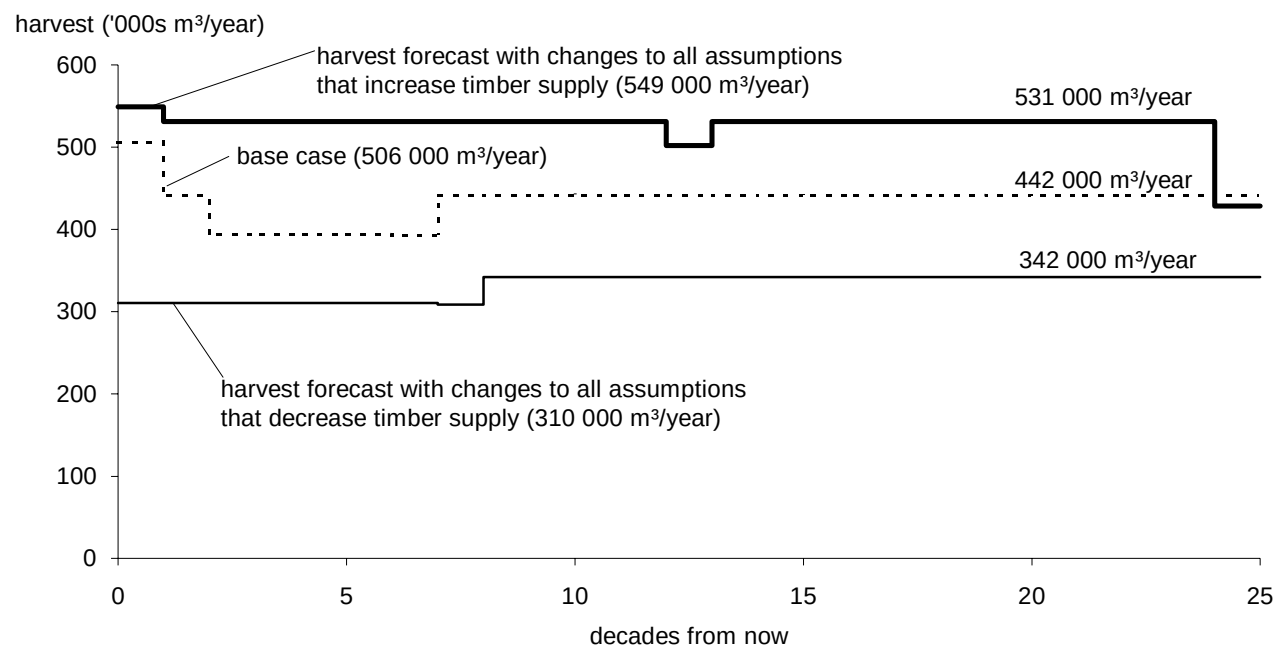


Figure 22. Harvest forecasts with changes to several forest growth and management assumptions concurrently, Soo TSA.

5 Timber Supply Sensitivity Analyses

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

The area that is assumed to be suitable and available for timber harvesting is one of the primary inputs of a timber supply analysis. In the Soo TSA, the timber harvesting land base could be larger or smaller than expected if any of the areas listed in Table 1 are different from what is expected. There are a number of reasons that these areas could be different; for example the timber harvesting land base could be larger than expected because of improved timber harvesting technology, or as a result of increases in the value of currently unmerchantable forest types. In the Soo TSA there are areas with relatively poor timber growing potential that are currently occupied by predominantly mature stands. An increase in the value of this timber would make it feasible to harvest and the timber harvesting land base would increase.

Conversely, the timber harvesting land base could be smaller than expected if harvesting costs increased, reducing the economic feasibility of harvest operations, or if road access over private land to harvestable timber in the Soo TSA is not successfully acquired. In this case areas of medium and good timber growing potential, currently occupied by predominantly immature stands would

not be accessible for timber harvesting and therefore the timber harvesting land base would be smaller.

The sensitivity of land base assumptions is analysed by increasing and decreasing the area of mature timber by about 10 000 hectares. Since most of the mature timber is on areas with poorer timber growing potential, any change would involve mostly poorer site areas. Changes in the amount of mature timber generally affect short-term harvest projections and more than long-term harvest projections. The opposite is true for immature timber and this is accentuated by the differences in timber growing potential.

The harvest forecast with the timber harvesting land base increased by 10 000 hectares of poor site area is shown by the thick solid line in Figure 23. The initial rate of harvest is about 5% lower than the current harvest level, and declines by 5% per decade to the long-term level of 475 000 cubic metres per year. The steady long-term harvest level is increased by 7% compared to the base case.

The harvest forecast with a reduced timber harvesting land base is shown by the thin solid line in Figure 23. The forecast starts 41% below the current harvest level and rises to the long-term level in decade 8. The steady long-term harvest level is decreased by about 7% from the base case.

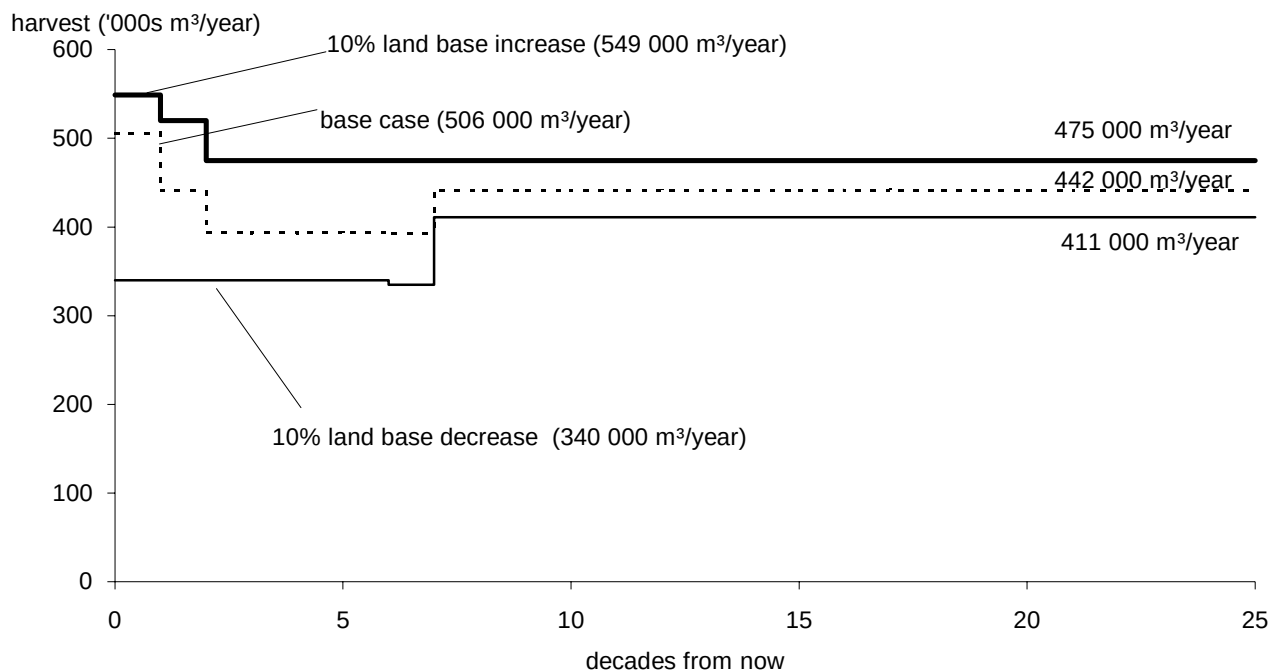


Figure 23. Harvest forecasts with the area of the timber harvesting land base changed by about 10%, Soo TSA.

6 Summary and Conclusions

The AAC for the Soo TSA was reduced by 17% in 1992 to the current rate of 580 000 cubic metres per year. The results of this analysis indicate that the current harvest levels remain above the steady long-term level. The base case harvest forecast indicates that the current harvest level cannot be maintained in the first decade without a serious decline below the long-term level in the future. The longer the harvest is kept at the current level, the more severe the future shortfalls will be. This situation results from the fact that the original abundance of mature forest which historically allowed harvest rates well above the long-term level no longer exists, and the immature stands do not yet contain sufficient volume for profitable harvesting.

The current management assumptions, from which the base case harvest forecast is produced, include minimum harvestable age assumptions based on wood product objectives for the Soo TSA. The analysis has highlighted how sensitive the timber supply forecast is to this assumption. Even a 10-year decrease in harvest ages has a large upward impact on the forecast. This effect is caused by the current age class distribution where 50% of the area consists of stands less than 40 years old; 35% consists of stands of 140 years or greater and the remaining area consists of stands in between. If the young stands

have not reached the minimum harvestable age by the time the existing mature timber has been harvested, then there is virtually nothing available to harvest. To avoid future harvest shortfalls below the long-term level the remaining mature timber must be harvested at a rate that allows the existing immature timber to attain the minimum harvestable age before all of the existing mature timber has been harvested. Any factors which affect the harvestable growing stock have a significant impact on the harvest forecast in the short term. These factors include the estimates of minimum harvestable age, existing volumes per hectare, and size of the land base.

Contributing slightly to the decline in timber supply are forest cover requirements for forest resources such as wildlife, water quality and scenic values. However, even if these forest cover requirements were removed, the harvest forecast will show a decline in the future because most of the original mature forest has been harvested. The harvest forecast is minimally sensitive to changes in the forest cover requirements.

The long-term harvest forecast is highly sensitive to uncertainty about regenerated stand yields and the size of timber harvesting land base, but is not generally sensitive to uncertainty about other information and assumptions.

7 References

- B.C. Ministry of Forests, Squamish Forest District. 1993. 1993 Draft Soo Timber Supply Area Forest Management Plan. Squamish, B.C.

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> .
Cutblock adjacency	Integrated management guidelines that specify the desired spatial relationship among cutblocks. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
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.
Green-up period	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.
Growing stock	The volume estimate for all standing timber, or all ages, at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management 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.
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.

8 Glossary

Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the Forest Service, Silviculture Branch. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective)
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity.
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 reducing the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with <i>Section 6</i> of the <i>Forest Act</i> .
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

APPENDIX A

Description of Data Inputs and Assumptions

Introduction

The following sections describe the methods and inputs used to derive the timber harvesting land base and to construct the timber supply model for the timber supply analysis of the Soo TSA. For the purposes of this analysis, this information represents current forest management in the area. Current forest management is defined as the set of land-use decisions and forest and stand management practices that are currently implemented and enforced. Future forest management objectives that may be intended, but not currently implemented and enforced, are not included here. Any changes in forest management will be included in subsequent timber supply analyses after this Timber Supply Review has been completed.

A.1 Zone and Analysis Unit Definition

A.1.1 Definition of management zones

For the purpose of the timber supply analysis, the timber harvesting land base was divided into 9 zones on the basis of differing forest management practices. Management practices vary between zones because of the emphasis on non-timber resources, or because of harvest level (i.e. AAC) requirements as described in the draft Soo TSA Plan.

Zone 1 includes all areas on which standard integrated resource management practices will be carried out.

Zone 2 includes all cottonwood types. A harvest of 4157 cubic metres per year is maintained in this zone because of an existing hardwood forest licence.

Zone 3 includes the "difficult stands" defined as age class 8 or 9, site class medium or poor, and inventory type group 15 or 19 in the Pemberton Supply Block. A harvest of 12% of the AAC must come from this zone due to requirements of the current AAC.

Zone 4 includes areas with high sensitivity to visible alteration of the landscape (a retention visual quality objective).

Zone 5 includes areas with moderate sensitivity to visible alteration of the landscape (a partial retention visual quality objective).

Zone 6 includes areas which are valuable for deer habitat. (W2d ESA) but in which some harvesting is allowed.

Zone 7 includes community watersheds. These areas were defined for the analysis by mapsheet, inventory region and compartment, and polygon lists provided by district staff. See Appendix B.

Zone 8 includes areas which are valuable for mushroom growing. These areas were defined by mapsheet and polygon lists provided by district staff. See Appendix B.

Zone 9 includes areas of the timber harvesting land base which will be lost to future roads.

A.1.2 Defining order of priority for zone assignment

Many of the areas in the Soo TSA inventory file meet the criteria for more than one of the zones listed in the previous section. However, the modelling technique used requires only one management regime or forest cover requirement for each distinct area. A priority list based on the most limiting forest cover requirement that applies to each area is shown in Table A-1.

Table A-1. Priority list for assignment to management zones

1 - Zone 2 - Cottonwood AAC
2 - Zone 4 - Retention VQO
3 - Zone 7 - Community watersheds
4 - Zone 6 - Deer habitat
5 - Zone 5 - Partial retention VQO
6 - Zone 3 - Difficult stands
7 - Zone 8 - Mushroom area
8 - Zone 1 - Integrated resource management

A.1 Zone and Analysis Unit Definition

A.1.3 Analysis unit definition

Within each forest management zone, the area was divided into analysis units, based on similar tree species compositions and similar timber growing capabilities. In the inventory file the major combinations of species are called type groups, and timber growing capability, or site quality, is indicated by a site index or site class. For the Soo TSA analysis, site groups were assigned using new site class (NSITE). Analysis units and the inventory variables used to define them, are shown in Table A-2.

Table A-2. Analysis unit definition

Analysis unit	Type groups	Site class
1 Fir+ G	1-8	G
2 Fir+ M	1-8	M
3 Fir+ P	1-8	P
4 Hem/Bal+ G	12-20	G
5 Hem/Bal+ M	12-20	M
6 Heml/Bal+ P	12-20	P
7 Cedar/Spruce+ G	9-11, 21-26	G
8 Cedar/Spruce+ M	9-11, 21-26	M
9 Cedar/Spruce+ P	9-11, 21-26	P
10 Cottonwood	35,36	all sites

A.2 Definition of the Timber Harvesting Land Base

The final timber harvesting land base was determined by deducting from the total TSA area, all areas considered to be currently unavailable for timber production.

A.2.1 Inventory file status

Forest cover polygon information in the Soo TSA inventory file (age, age class, height, height class, stocking class and type identity) is projected to January 1993.

A.2.2 Site class adjustments to the inventory file

Where special site (ssite) existed it was used to replace both nsite and site. Another minor correction was made to address district staff concerns that a small area was classified as low site which, due to the history of the area did not reflect actual productivity. The area is expected to be harvestable. These areas are identified by agecl_pr <=2, nsite=Low, operable=A, no value for ssite, and not in biogeoclimatic zones CWH-ds1, IDF-ww1, or IDF-ww2. Nsite and site were changed to poor on the identified areas.

A.2.3 Non-Crown land

Non-Crown land is all land that is not administered or managed by the B.C. Forest Service and includes such categories as provincial parks, Indian reserves and areas under federal jurisdiction. This area, identified on the inventory file by Ownership Code other than 62C, 69C or 70N, is excluded from the land base.

A.2.4 Non-forest land

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

A.2.5 Non-commercial cover

Areas with non-commercial cover (brush) identified on the inventory file as type identity code 5 were excluded from the land base.

A.2.6 Inoperable areas

Inoperable land is that part of the forested area that is not likely to be accessible for conventional ground based timber harvesting because of the combination of rough terrain, difficult access and economic factors. The inventory file operability codes were corrected based on the mapsheet and polygon listing in Appendix B. A number of polygons coded as inoperable were identified to be operable for some aerial harvesting based on current standards, and so half of each of these polygons were included in the land base (Appendix B).

A.2 Definition of the Timber Harvesting Land Base

A.2.7 Environmentally sensitive areas

Environmentally sensitive areas include areas which have moderate to high non-timber values such as wildlife or water, and areas which are prone to excessive site degradation if harvested because of geological and topographical conditions. Table A-3. shows the percentage area reduction by ESA category. All moderate recreation (r2) areas that do not have a retention or partial retention VQO in the inventory are put in the partial retention VQO zone.

Table A-3. Per cent area reductions for environmentally sensitive areas

ESA code	ESA description	Per cent area reduction
s1	high soil sensitivity	90%
s2	moderate soil sensitivity	60%
r1	high recreation value	90%
r2	moderate recreation value	0%
w1g,w1d, w1m,w1o,w1b	high wildlife value	90%
p1	high concern for regeneration problems	90%
h1	watershed buffer reserve	90%
a1	avalanche buffer	60%
w1f,w1of,w1fo	high riparian value (reduced separately as "riparian")	0%
w2g	moderate wildlife value (goat)	90%

A.2.8 Non-utilized forest types

This includes areas that are currently not utilized due to low growth potential (productivity) which makes them unsuitable for timber production, or due to lack of developed markets. The low site reductions are based on the ability of areas to meet the minimum product objectives outlined in the draft Soo TSA Plan. These areas are excluded from the land base as shown in Table A-4.

Table A-4. Per cent area reductions for non-utilized

Type group or species	Criteria	Per cent area excluded
27-32 all PI leading		100%
37-42 all Decid leading except Cottonwood		100%
all	site class =Low	100%
all (except Cottonwood)	*nsiteind<=20 and agecl_pr>2	100%
all	ht<=23m at age>140 yrs	100%

* site index is base 100, to match the inventory data

A.2 Definition of the Timber Harvesting Land Base

A.2.9 Geographically defined areas

These areas are excluded from the operable land base because they are currently not available for forest management. The mapsheet, polygon lists are in Appendix B.

Table A-5. Exclusion of specific, geographically defined areas

Identifying inventory variables	% Excluded area	Reason for exclusion
Sockeye Creek	100%	no legal access (behind Birkenhead Park)
East Howe Sound Compartment 86	100%	no technical access
21 Mile Cr. watershed	100%	agreement with Whistler
Lillooet River and South Cr.	100%	small proposal ecoreserve (FS policy)
Whistler old municipal boundary	100%	Whistler LRUP

A.2.10 Streamside management areas

Areas being retained to provide forested buffers along streams comprise 3% of the timber harvesting land base. This per cent area is excluded from all stands in the timber harvesting land base. This estimate was derived by measuring lengths of stream widths and applying buffer widths in accordance with the *Coastal Fish Forestry Guidelines*.

A.2.11 Existing unclassified roads, trails and landings

Past timber harvesting operations have resulted in a loss of productive forest land. However many of the existing roads, trails, landings and related disturbances are not accounted for in the inventory file. To account for this loss a 5.2% reduction was applied to all stands age class 4 or less (the areas assumed to have a timber harvesting history). This estimate was derived from a sample of representative mapsheets.

A.2 Definition of the Timber Harvesting Land Base

A.2.12 Future roads, trails and landings

There will also be losses in productive area as future harvesting occurs. All existing stands currently age class 5 or greater will be subject to these losses which are assumed to be 7%. This estimate was based on pre-harvest silvicultural prescriptions (PHSPs). This area is not initially excluded from the land base, but is removed after being harvested a first time in the model, to simulate recovery of the volume of timber that will be removed from the right-of-way.

A.2.13 Not satisfactorily restocked (NSR) areas

There are a total of 5594 hectares in the timber harvesting land base with a type identity of 4, 7 or 9 (NSR). 1654 hectares of NSR with species, age and site index information was added to its proper age class. No treatment is planned for these areas, and the area involved is small so no reductions were made to the yield curves. They were assigned to existing rather than managed yield curves. The remaining 3973 hectares of NSR are assumed to be restocked in the first decade and are assigned to an analysis unit and zone as described in Table A-6.

Table A-6. NSR areas restocked in the first decade

Analysis unit	Zone 1	Zone 4	Zone 5	Zone 6	Zone 7	Total area
1 Fir G	71	1	0	1	5	84
2 Fir M	960	7	46	9	68	1084
3 Fir P	693	0	0	0	48	741
4 H/B G	97	1	6	1	5	110
5 H/B M	720	6	50	9	0	785
6 H/B P	434	4	16	5	31	490
7 C/S G	49	0	3	0	3	55
8 C/S M	320	3	24	3	5	355
9 C/S P	227	1	0	2	7	237
Total	3571	22	145	30	172	3940

A.2.14 Timber licence reversions

Timber licences are a tenure in which the management of the specified area reverts to the Crown when the area is harvested and declared free to grow. They are identified on the inventory file by Ownership code 70 N. Areas of timber licences that are less than age class 5 are assumed to have been already harvested and reverted. Timber licences with age class ≥ 5 are assumed to revert according to Table A-7. The volume harvested from these areas is not included in the AAC. In the model these areas follow zero yield curves until the time that they revert. Licencees are required to restock the site according to silviculture standards so it is assumed that they revert fully stocked.

A.2 Definition of the Timber Harvesting Land Base

Table A-7. Area (hectares) of timber licence reversions

Zone	AU	Years until reversion			Total
		0 - 5	5 - 15	15 - 25	
1	2	115	14	7	135
1	3	323	38	19	380
1	5	89	10	5	104
1	6	679	80	40	799
1	8	31	4	2	36
1	9	89	11	5	105
2	10	20	2	1	24
3	5	3	0	0	4
3	6	298	35	18	351
4	2	4	1	0	5
4	3	9	1	1	10
4	6	3	0	0	3
5	2	33	4	2	39
5	3	169	20	10	199
5	4	2	0	0	3
5	5	25	3	2	30
5	6	213	25	13	251
5	9	13	2	1	15
6	2	17	2	1	20
6	3	162	19	10	191
6	9	8	1	1	9
7	2	13	2	1	15
7	3	7	1	0	8
7	5	43	5	3	51
7	6	67	8	4	79
7	8	20	2	1	24
7	9	6	1	0	7
9	2	14	2	1	16
9	3	50	6	3	59
9	4	0	0	0	0
9	5	12	1	1	14
9	6	95	11	6	112
9	8	4	1	0	5
9	9	9	1	1	10
9	10	2	0	0	2
Total		2644	312	155	3111

Note: Columns may not sum exactly due to rounding.

A.3 Forest Management Assumptions

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

A.3.1 Utilization levels

Harvesting is assumed to be carried out to a utilization level of 17.5 cm diameter at breast height (1.3 metres) for all species.

A.3.2 Utilization standards

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

A.3.3 Minimum harvestable ages

The minimum harvestable ages were determined using the product objectives outlined in the draft Soo TSA Plan. The product objectives were based on the range of log grades required in order to provide the greatest financial value from the forest and allow harvesting to be profitable. They were derived from current data on log values and harvesting costs and they vary depending on site quality. The yield curves produced for this analysis were then interpreted to determine approximately the age at which the diameter and height would meet the product objective (within about 5% of the volume at culmination of mean annual increment). Because the yield curves for the existing and unmanaged stands are quite different, the minimum ages also vary as shown in Table A-8.

Table A-8. Minimum harvestable ages for existing stands and regenerated (managed) stands

Analysis unit	Target average DBH (cm)	Target average height (metres)	Estimated minimum harvestable ages (years) (existing)	Estimated minimum harvestable ages (years) (regenerated)
1	45	40	95	75
2	40	30	105	90
3	37	25	135	120
4	42	35	95	75
5	38	30	105	85
6	35	25	135	130
7	45	35	95	70
8	43	30	115	80
9	36	25	135	120
10	--	--	65	65

A.3 Forest Management Assumptions

A.3.4 Forest cover requirements

Table A-9. specifies the forest cover requirements that are used to model the forest management objectives for each zone.

Table A-9. Forest cover requirements

Zone	Definition of green-up (m)	Green-up period (years)	Maximum area not greened-up	Age (years)	Minimum area older than age
1 IRM	3	13	33%		
2 Cottonwood	3	10	33%		
3 Difficult stands	3	14	33%		
4 R VQO	5	18	11%		
5 PR VQO	5	18	21%		
6 Deer	4	15	25%	80	65%
7 Community watershed	5	18	17%		
8 Mushrooms	5	20	25%	80	50%

The years required to achieve the various heights are area-weighted based on the years required to achieve the specified green-up heights for each analysis unit in the zone. The average site indices were obtained from the inventory file using FREDTAB and then TIPSYS was used to project the required height-age relationships.

Further information by zone follows:

Zones 1 to 3 (IRM, Cottonwood, difficult stands):

After harvesting has occurred in an area no further harvesting is allowed to occur in adjacent forested areas until the regenerated stands on the previously harvested areas have reached a height of 3 metres. This is required to satisfy free-growing standards and general wildlife habitat needs. A three-pass harvesting system is currently being implemented in the Soo TSA.

Zones 4 and 5 (R VQO and PR VQO):

The majority of the VQO areas are identified in the Sea to Sky LRUP. The forest cover requirements are based on provincial guidelines for managing forest cover in visually sensitive areas. These guidelines define the maximum per cent of the landscape that may be non-greened-up, as well as the stand height required in order to be visually greened-up. The stand height required for visual green-up is 5 metres. The maximum per cent area that may be non-greened-up varied between 1 to 5% for R VQO and 1 to 15% for PR VQO. The area allowed non-greened up reflects the current interpretation of that LRUP which assumes that the maximum per cent non-greened-up will be allowed in the majority of the areas. These values of 5% and 15% were then adjusted according to the methods outlined in *Recreation Branch Technical Report 1993:1, Procedures for Factoring Recreation Resources into Timber Supply Analyses*. The gross green/operable ratio used in the calculation was determined separately for each zone, and the default values for dispersion identified in the technical report were used.

Zone 6 (Deer):

The deer habitat requirements are based on Ministry of Environment information on thermal and hiding cover, and forage.

Zone 7 (Community watersheds):

Community watershed values are from the *Watershed Workbook (1987)*.

Zone 8 (Mushroom):

The mushroom zone cover requirements are intended to simulate selection harvesting or a slow rate of removal.

A.3 Forest Management Assumptions

A.3.5 Unsalvaged losses

Table A-10. shows the estimated average annual volume loss to catastrophic events such as wildfires and insect attacks. Regeneration of these denuded areas is expected to occur within the standard regeneration delay period of 3 years. Estimated annual losses are deducted from the gross harvested volume to determine the projected net volumes that will be harvested over time.

Table A-10. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (m ³ /year)
Insects	4 000
Fire	30 000
Total	34 000

Notes on the above categories:

Insects: Current and projected volume losses can be expected in Douglas-fir stands due to western spruce budworm. The volume loss estimate was derived by applying a loss factor to the volume of stands currently under attack.

Fire: The unsalvaged loss estimate due to fire is based on 10 years of district fire reports. The losses were reduced so that only volume loss that occurred in the timber harvesting land base is included in the estimate.

A.3.6 Silviculture and regeneration assumptions

The silviculture program reflects the mix of treatments expected to be carried out according to the Soo TSA Plan. This level of activity assumes basic silviculture on all sites plus incremental silviculture on some sites and is assumed to be continued into the future. Table A-11. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay. Managed stand yield tables (MSYTs) were created for each of the silviculture regimes. One curve was then prepared for each analysis unit that reflects the proportion to be managed under each of the silviculture regimes. The resultant MSYTs for regenerated stands are shown in Table A-13.

A.3 Forest Management Assumptions

Table A-11. Silviculture and regeneration assumptions

Zone	Analysis unit	% Treated	Establishment	Initial density (stems/ha)	Spaced to (stems/ha)	Fertilized	Regen delay
all	1	100	planted (i)	2500	600		3
except	2	25	planted	2500	600		3
those	2	75	planted (i)	2500	600	yes	3
specified	3	40	planted	1500			3
below	3	35	planted	1500	500		3
	3	25	planted	1500	500	yes	3
	4	100	natural	4000	600		3
	5	30	natural	4000	600		3
	5	70	natural	2000			3
	6	100	natural	1800			3
	7	100	planted	3000	600		3
	8	50	planted	2000			3
	8	50	planted	3000	600		3
	9	100	planted	2000			3
6	1	100	planted	2500	500		3
6	2	75	planted	2500	500		3
6	2	25	planted	2500	500	yes	3
6	3	75	planted	1500	500		3
6	3	25	planted	1500	500	yes	3
7	2	100	planted (25% i)	2500	600		3
7	3	40	planted	1500			3
7	3	60	planted	1500	500		3

Notes:

- 1) Fertilizer is applied at ages 20, 30 and 40 years at 200 kg/ha. Research Branch provided these curves from TASS runs.
- 2) (i) means that genetically improved planting stock is used. A 2% volume increase is applied to the curves developed for these regimes.
- 3) Cottonwood regenerates along the VDYP curve as there are no MSYTs for Cottonwood.
- 4) Operational adjustment factors (OAFs) of 15% for OAF1 and 5% for OAF2 were applied.
- 5) C/S medium and C/S poor assume a hybrid of Sitka and Englemann which is represented by White spruce yield curves. No planting of Sitka on good sites due to sitka spruce weevil.

A.3.7 Existing managed stands

All existing stands with age class=1 are assigned to managed stand yield tables described in Section 4.2, "Yield tables for regenerated stands."

4.3.8 Conversion of alder stands

About 1000 hectares of alder stands were identified to have conversion potential, either via the difficult stands strategy or natural succession to coniferous types. This conversion will occur over the next 50 years, and no volume will be assumed to be harvested from these areas until they have been converted. All will be added back to the IRM zone (zone 1) as in Table A-12.

Table A-12. Alder conversion

Analysis unit	PFTs or NC/brush	
	Area (ha)	Rate of restocking (ha/decade)
2 Fir - M	334	67
5 H/B - M	333	66
8 C/S - M	333	66
Total	1000	

A.4 Yield Assumptions

A.4.1 Yield tables for existing stands

The yield tables applied to most existing stands in the analysis are shown in Table A-13. These tables were generated for each analysis unit using the Variable Density Yield Prediction (VDYP) model. They are based on close utilization less decay, and reduced for waste and breakage. Aggregated waste and breakage (W2B) factors are developed from the *Inventory Metric Diameter Class Loss Factors Manual* (B.C. Ministry of Forests 1976) by averaging over diameter class and risk group and combining the separate factors for waste and breakage. In this way, a single W2B factor is developed for each of two age ranges (older immature and mature) and each PSYU, species and utilization level.

A.4.2 Yield tables for regenerated stands

Yield tables applied to future regenerated stands, NSR areas (except for the areas discussed in Section A.2.13 "Not satisfactorily restocked (NSR) areas"), and to existing young stands which are assumed to be managed (Section A.3.7 "Existing managed stands") are presented in Table A-18. These yield tables were produced using the Table Interpolation Program for Stand Yields (TIPSY) growth and yield model developed by the Research Branch of the Forest Service. To construct the tables for the analysis, average site productivity (site index) for each analysis unit, and the silviculture regeneration assumptions described in Section A.3.6, "Silviculture and regeneration assumptions" were applied. One curve was then prepared for each analysis unit that reflects the proportion to be managed under each of the silviculture regimes. To account for operational conditions, a 15% reduction was applied to all yield values (OAF 1). Yields were further reduced by applying an of OAF 2 to 5% to account for increasing decay, waste and breakage in the older ages.

A.4 Yield Assumptions

Table A-13. shows the existing and regenerated stand yield tables for all species and site types in the analysis. The appropriate regeneration delays are applied within the timber supply model and are not accounted for in these yield tables.

Table A-13. Yield tables for all species/site types

Age	Exist Fir, good	Exist Fir,medium	Exist Fir,poor	Exist Hem/Bal, good	Exist Hem/Bal,medium	Exist Hem/Bal, poor	Exist C/S,good
10	0	0	0	0	0	0	0
20	2	0	0	7	0	0	1
30	144	47	1	157	33	0	91
40	296	162	41	298	136	9	204
50	426	261	108	418	232	60	311
60	538	346	168	522	319	122	408
70	635	419	219	609	392	182	493
80	721	483	264	686	458	232	569
90	792	537	302	747	512	276	631
100	854	585	337	800	560	315	683
110	909	627	368	844	601	350	729
120	955	664	395	881	636	381	765
130	996	695	417	922	673	412	807
140	1032	721	435	958	708	441	845
150	1060	741	449	991	738	467	877
160	1081	756	458	1019	766	491	905
170	1095	764	464	1043	790	513	928
180	1104	769	466	1066	813	534	950
190	1119	778	471	1087	834	553	972
200	1135	788	477	1107	855	572	994
210	1150	798	483	1126	874	589	1015
220	1165	808	489	1144	891	605	1041
230	1180	817	494	1160	908	620	1066
240	1194	826	499	1175	924	635	1090
250	1207	834	504	1189	938	648	1113
260	1208	835	505	1197	947	658	1116
270	1208	836	506	1203	954	668	1118
280	1209	836	506	1209	962	677	1119
290	1209	837	507	1214	968	685	1121
300	1210	838	508	1219	974	692	1122
310	1210	838	508	1223	979	700	1123
320	1210	838	509	1227	984	706	1124
330	1211	839	509	1230	989	713	1125
340	1211	839	510	1233	993	719	1125
350	1211	840	510	1235	997	725	1126

continued

A.4 Yield Assumptions

Table A-13. Yield tables for all species/site types

All other zones

Age	Exist C/S medium	Exist C/S poor	Exist Cottonwood	Regen Fir, good	Regen Fir, medium	Regen Fir, poor	Regen Hem/Bal good	Regen Hem/Bal; medium	Regen Hem/Bal, poor
10	0	0	0	0	0	0	0	0	0
20	0	0	3	6	0	0	3	0	0
30	23	1	44	132	69	3	99	5	0
40	91	14	85	283	179	38	247	74	2
50	177	47	123	452	292	91	414	171	15
60	256	83	152	600	382	141	572	268	48
70	327	124	174	734	467	183	737	368	102
80	391	168	191	845	541	220	885	461	157
90	442	206	205	940	607	254	1018	545	210
100	487	240	215	1023	666	287	1146	630	259
110	525	270	224	1093	720	317	1265	713	304
120	555	295	231	1152	767	344	1356	789	348
130	589	321	238	1197	808	369	1440	854	391
140	620	345	243	1239	844	392	1521	912	429
150	647	365	247	1277	874	411	1590	970	462
160	670	383	248	1311	903	428	1649	1022	492
170	689	398	248	1332	927	443	1701	1072	519
180	708	412	248	1348	948	457	1754	1121	548
190	726	426	249	1362	965	469	1802	1166	574
200	744	439	250	1362	980	480	1844	1205	598
210	760	452	251	1362	980	480	1879	1236	621
220	780	466	251	1362	980	480	1911	1264	642
230	799	480	252	1362	980	480	1940	1289	663
240	817	493	252	1362	980	480	1967	1312	683
250	834	505	253	1362	980	480	1995	1338	701
260	837	509	253	1362	980	480	1995	1338	701
270	839	512	253	1362	980	480	1995	1338	701
280	842	516	253	1362	980	480	1995	1338	701
290	844	518	253	1362	980	480	1995	1338	701
300	845	521	253	1362	980	480	1995	1338	701
310	847	524	253	1362	980	480	1995	1338	701
320	848	526	253	1362	980	480	1995	1338	701
330	850	528	253	1362	980	480	1995	1338	701
340	851	530	253	1362	980	480	1995	1338	701
350	852	532	253	1362	980	480	1995	1338	701

continued

A.5 Yield Curves

Table A-13. Yield tables for all species/site types (concluded)

Age	regen C/S G	regen C/S M	regen C/S P	Deer zone regen Fir, good	Deer zone regen Fir, medium	Deer zone regen Fir, poor	Community watershed zone regen Fir,medium	Community watershed zone regen Fir,poor
0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
20	2	0	0	7	0	0	0	3
30	105	4	0	121	47	4	40	29
40	272	64	0	264	137	42	134	80
50	443	163	4	429	226	89	219	130
60	632	270	38	575	316	132	312	172
70	798	348	83	707	403	169	401	209
80	974	436	137	819	476	204	474	242
90	1122	517	185	916	541	236	539	278
100	1257	590	231	1004	601	270	598	308
110	1374	648	275	1078	654	299	652	337
120	1496	699	311	1141	701	327	698	363
130	1598	763	338	1187	741	352	737	386
140	1681	820	360	1228	778	375	772	406
150	1757	865	379	1265	809	395	803	423
160	1824	902	398	1298	838	412	830	439
170	1884	935	416	1320	863	428	854	452
180	1944	964	432	1337	885	442	876	464
190	1996	992	446	1352	905	454	895	476
200	2042	1016	458	1352	923	465	913	487
210	2083	1037	469	1352	923	465	929	498
220	2135	1065	481	1352	923	465	943	507
230	2183	1065	494	1352	923	465	956	515
240	2235	1065	505	1352	923	465	967	523
250	2283	1065	515	1352	923	465	976	523
260	2283	1065	515	1352	923	465	976	523
270	2283	1065	515	1352	923	465	976	523
280	2283	1065	515	1352	923	465	976	523
290	2283	1065	515	1352	923	465	976	523
300	2283	1065	515	1352	923	465	976	523
310	2283	1065	515	1352	923	465	976	523
320	2283	1065	515	1352	923	465	976	523
330	2283	1065	515	1352	923	465	976	523
340	2283	1065	515	1352	923	465	976	523
350	2283	1065	515	1352	923	465	976	523

Appendix B

Polygon Lists

B.1 Operability Corrections

Table B-1. Polygon list for operability corrections

Mapsheet #	Corrected operability label	Polygon number applied to
92G068	A (all X on FIP)	144 155,156 161 385
92G069	A (all N on FIP)	11,12,14,17 21,22,24,25 36,37,38, 42,44, 177,178, 180,181,182,183,185,186, 200,201,204,205,206,207,208,209, 210,212,218, 391
92G080	I (all X on FIP) <i>NOTE: all polygons on this mapsheet NOT on this list must be changed to operability=A</i>	17,18,19, 20,21,22,23,24,25,26,27,28, 31,32,33,35,38,39, 40,41,42,43,44,45,46,47,48,49, 50,51,52,53,54,55, 125, 136,137, 140,141,142,143,144, 150,151,152,153,154,155,158, 234,236,237, 240,244, 255,256, 414, 423,424,425,426,427,428, 431,432,433, 626
92G085	A (incorrectly coded I on FIP)	12,13,14,15,18,19 20,21,22,23,24 107,109 110,111,112,113,114,115,116 137,138,139 140,141,142,149 279 280,284,285,286,287,288,289 290,291,292,293,294 337,339 340 622 712

Continued

B.1 Operability Corrections

Table B-1. Polygon list for operability corrections (concluded)

Mapsheet #	Corrected operability label	Polygon number applied to
92G085	I (incorrectly coded A on FIP)	26,27,28 30,31,32,33,34,35,38 98,99 100,101,102,103,104,105,106 143,144,145,146,147,148 150,151,152,153 277,278 342,343,345 605,609 610,611 639
92J014	A (all N on FIP)	19 20 31,33,34,35,36, 48, 53,55
92J024	A (all N on FIP)	26,27,28,29 30
92J026	A (incorrectly coded I on FIP)	125,126,127,128,129 134
92J047	I (incorrectly coded A on FIP)	464,467,469 495,496,499 501,502,503,505 650,651 663,665,666,667 684,685,686,687,689 690,691

B.1.2 Aerial Operability Polygons

To approximate the area actually expected to be aerially operable, 50% of the area of these polygons was included in the timber harvesting land base.

B.1 Operability Corrections

Table B-2. Aerial operability polygons

Mapsheet	Polygons
092G046	1504,1539
092G055	0148,0270
092G056	0134,0812,0834
092G064	0888
092G065	0507
092G066	1530,1544,1925
092G068	0032,0044
092G069	0179
092G074	0518,0523,0679
092G075	0008
092G076	1776,1880
092G079	0020,0037,0111,0336,0342,0356,0364,0408,0439,0465, 0486,0541,0658,0682,0787, 0789, 0792, 0814, 0837
092G080	0032,0424
092G084	0274,0550,0571,0583,0672,0676,0698
092G085	0235,0250
092G088	0028
092G089	0127,0768
092G094	0008
092G095	0006,0125
092G098	0140,0298,0428
092G099	1534,1857
092J005	0568,0571,0797,0801,0850
092J006	0189
092J008	0013,0587
092J009	1595,1851,1884
092J026	0282,0870
092J027	0276,0299,0347,0356,0374,0394,0433,0440
092J028	0724
092J035	0125
092J036	0320,0586
092J046	0193,0199,0200

B.1 Operability Corrections

B.1.3 Geographic exclusions

Region 9, compartment 86 (East Howe Sound area) is 100% excluded.

Table B-3. Polygon lists for geographic exclusions

Area name	Mapsheet	Polygons to exclude
Sockeye Creek (operable area only)	92J057	13,19
		22,28,29
		31,32,33
		48,49
		50,51
		60,61
		71,73,74,75,76,77,79
		81,82,83
		103,104,105,106,50% of 110
	92J067	1514,1519
		1520,1528
		1536
		1541,1543,1547
		1576,1578
		1584,1585,1586,1588
		1599
		1600
		1632,1633
21 Mile Creek (operable only; outside of "Old Whistler Municipal Boundary" only)	92J015	663,664
		671,672,673,674
		681
South Creek (proposed Ecological Reserve)	92J054	518
		580,581,583,584,585,586,587,588,589
		590,591,592,593,594,595,596,597,598,599
		631,632
Lillooett River (proposed Ecological Reserve)	92J054	6,9
		30% of 11
		50% of 22,50% of 29
		60% of 30,40% of 31,30% of 37,38,30% of 39
		30% of 45
		75,76
	92J064	40% of 254
		10% of 10
		20% of 191
		50% of 234,235,236,237,238,239
		240,241,20% of 242,243,244,30% of 246,248
		20% of 268, 269
		270,271,272,273,274,275,276

Continued

B.1 Operability Corrections

Table B-3. Polygon lists for geographic exclusions

Area name	Mapsheet	Polygons to exclude
Old Whistler Municipal Boundary	92J005	75% of 169
		178,179
		180,75% of 181,182,75% of 183,30% of 186
		191,197,75% of 198,199
		200,201,202,203,204,209
		50% of 216,218
		221,222,223,224,226
		232,235,236,237,238
		240,242,246
		251,252,254,255,258
		268
		273,276,277,50% of 278
		280,281,75% of 282,283,30% of 284,50% of 285
		887,888
		30% of 891
	92J006	exclude all except:
		69
		72
		167,168,169
		171,172,173,174,175,176,177,178,179
		180,181,189
	92J015	190
		554,555,559
		560,562,569
		665,667
		676

Continued

B.1 Operability Corrections

Table B-3. Polygon lists for geographic exclusions (concluded)

Area name	Mapsheet	Polygons to exclude
Old Whistler Municipal Boundary (cont'd)	92J016	51,53,57 87 50% of 208 211 50% of 268 270,271,272,276,278 283,284,286,287 315,317,318 320,321,322,324,325 342,348 354 362,363,364,366,368 370,374,375,378,379 380,383 427 433,434 441,443,445,446,449 450,451,455 495 501,503,504,505 546,547,549 550,552 600,608 611,612 622,627 630,634,639 70% of 653,656 663 814,815,50% of 818

Table B-4. Mushroom zone polygons

Mapsheet	Polygons to include in this zone
92J058	1604, 1606, 1608, 1609 1610, 1611 1680, 1681, 1682, 1683, 1684, 1685 1698, 1699 1700, 1701, 1702, 1703, 1704 1855, 1857, 1858 1860, 1861, 1862, 183, 1864, 1865, 1866, 1867, 1868, 1869 1871, 1873, 1874, 1875 1916 1924, 1925

B.1 Operability Corrections

Table B-5. Community watershed zone polygons

Watershed name	Excluded from land base due to:	Criteria for inclusion in community watershed zone:
Montizambert Cr.	Comp. 86/Cypress Park	n/a
Charles Cr.	Comp. 86	n/a
Rundle Cr.		
Harvey Cr.		
Alberta Cr.		
Magnesia Cr.		
Furry Cr.	n/a	Region 9, Compartment 89
Mineral Cr.		
Mill Cr.	n/a	Region 28, Compartment 3
Woodfibre Cr.		EXCEPT: 92G054 all region 28, compartment 3 92G064 665 746 904,907,908,909 910,911,912,913,915,916,917,918,919 920,921,922,923,924,925,926,927,928,929 930,931,932,933,935,936,937,938,939 941,947,948,949 950,951,952,953,954,958 960,962,963,964,965,966,967,968,969 970,975,976,977,978 980,981,982,983,984,985 1043 1067,1068,1069 1078 1080,1082,1084 1100,1101,1102
Stawamus River	n/a	Region 9, Compartment 92
Mashiter Cr.	n/a	Polygons to be included: 92G075 20% of 76,50% of 78,50% of 79 80,50% of 81,50% of 88, 50% of 89 90,91,92,93,94,95,96,97,60% of 98, 30% of 99 102,103,104,105,106,107,108,109 110,111,112,113,114,115,116,117,119 120,121,122,123,124,125,126,15% of 127 130,50% of 131,132,133,134, 60% of 135,136,137,138,139 140,141,142,60% of 143,144,20% of 148,149 50% of 157 50% of 330,50% of 331,50% of 332 92G085 455,456,457,458,459 460,461,462,463,464,465,466,467

continued

B.1 Operability Corrections

Table B-5. Community watershed zone polygons

Watershed name	Excluded from land base due to:	Criteria for inclusion in community watershed zone:
Brew Creek Retta Lake Pinecrest Lake	n/a	Operable polygons to be included: 92J005 789 792,793 800,802,803,804 811,813,815,816,817,819 820,821,822 831,832 881
Agnew Cr. 21 Mile Cr. Van West	"OWMB" and 21 Mile Cr. n/a	n/a Operable polygons to be included: 92J015 551
Unnamed Cr. Rideau Brook	part out: "OWMB"	Polygons to be included: 92J016 252, 60% of 253,254,259 25% of 266
Blackcomb Cr. Whistler Cr. Alpha Cr.	"OWMB"/Park part out: "OWMB"	n/a Polygons to be included: 92J005 40% of 284,287,288,289 291,292,293,294 660 92J006 68,69 70,71,72,50% of 73 50% of 160
Pemberton Cr.	n/a	Operable polygons to be included: 92J036 429 430 517 521,522,523,526,527,529 530,531,532,533,534,535,536,537,538,539 541,547 550,554 568,569 572,573,574,575,576,577,578,579 590,592 616 92J026 all R27C28 AND ownership 69C
Peq Cr. Ivey Lake	all inoperable n/a	n/a Operable polygons to be included: 92J037 478 506,507,508,509 511,512,513 567,568,569 570,571,572,573,574,575
Rogowski Cr.	all inoperable	n/a

continued

B.1 Operability Corrections

Table B-5. Community watershed zone polygons (concluded)

Watershed name	Excluded from land base due to:	Criteria for inclusion in community watershed zone:
Twin One Cr.	n/a	<p>Operable polygons to be included:</p> <p>92J028 170,171 184,189 190,191,192,193,195,198,199 200,201,202,203,204,206,207,208,209 210,211,212 220,221,222,223,224,228 232,233,238,239 243,244,245,246,247,248,249 250,251,252,253,257,258,259 270 364,365,366,367,368,369 370,371,372,373,374,375,376,377,378 383,384</p> <p>92J029 1501,1502,1503,1504,1505,1506,1509 1510,1514,1515,1516,1518 1520</p>
D'Arcy Cr.	n/a	<p>Operable polygons to be included:</p> <p>92J058 1590 1628,1629 1630,1631,1632,1633,1637 1643,1644,1645,1646,1647,1648,1649 1650,1656</p>
Spruce Cr.	n/a	<p>Operable polygons to be included:</p> <p>92J048 1834,1836,1837,1838,1839 1843,1849 1850,1851 1886 1911,1917,1918 1934</p> <p>92J058 1961 1973,1974,1975 2060,2061,2062,2068,2069 2070,2071,2072,2075,2076,2077,2078,2079 2080,2081,2082,2083,2084 2097,2098,2099 2100,2101,2103,2104 2249 2250,2251,2252</p>