Okanagan 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 purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) 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 the timber supply, based on the best available information and reflecting current management direction.

Unlike past analyses, which normally assessed the implications of several forest management scenarios, this report focuses on a single scenario — current management practices. This approach will expedite the analysis process, and allow an analysis of all TSAs in the province to be completed by the end of 1994. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called *sensitivity analysis*.

Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

This report is the first of four documents that will be released for each TSA as part of the Timber Supply Review. It provides detailed technical information on the results of the timber supply analysis. The second report includes the results of the socio-economic analysis. The third report summarizes the information in the first two reports to provide a focus for public discussion of possible timber harvest levels. The fourth report contains the Chief Forester's decision and supporting documentation.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Okanagan Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the next 200 years. It also examines the potential changes in the timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report only indicate the timber supply implications of current practices and their associated uncertainty. The forecasts are to be used for discussion purposes only; they do not imply any particular allowable annual cut (AAC) recommendations.

The Okanagan TSA covers approximately 2.17 million hectares, of which about 1.04 million hectares are considered available for timber harvesting under current management practices. The present AAC for the Okanagan TSA is 2.615 million cubic metres per year. The entire AAC for the Okanagan TSA is fully allocated among its three forest districts - Salmon Arm, Vernon and Penticton.

While much of the Okanagan TSA is managed for integrated resource activity, approximately 53% of the land base is assigned special management requirements to account for wildlife habitat, community watersheds, visual quality, selection harvesting, and areas deferred from harvesting under approved Local Resource Use Planning.

Given current management assumptions, the analysis shows that the present AAC of 2 615 000 cubic metres per year can be maintained for another 20 years without causing a sharp drop in future harvest levels. Beginning in 20 years harvests decrease by 10% per decade until the long-term harvest level of 2 022 000 cubic metres per year is reached in 40 years.

Although the present AAC can be maintained for another 20 years, the mountain pine beetle epidemic in the southern portion of the Okanagan TSA has resulted in a temporary increase of 189 000 cubic metres per year to the AAC. The temporary AAC is now 2 804 000 cubic metres per year. The temporary AAC can only be maintained for 10 years followed by declines at the beginning of the second and third decade to the long-term harvest level 30 years from now.

Many of the data and assumptions used in the analysis are subject to varying degrees of uncertainty. Sensitivity analysis was used to determine how the data and assumptions impact the results of the timber supply analysis. Short-term timber supply is primarily sensitive to volume estimates for existing stands and forest cover requirements. Higher yield estimates for existing stands permit the present AAC to be maintained for 60 years while lower existing stand yield estimates require a 30% drop in initial harvest rates. Relaxing the forest cover requirements permit the present AAC to be maintained for up to 40 years while tighter forest cover requirements cause the initial harvest rate to decline by 6%. Changes in regenerated stand yields have no impact on short-term harvest rates although the long-term harvest is significantly affected.

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Introduction

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

Assessing the timber supply involves considering physical, biological and socio-economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study, in addition to 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 on 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. Deciding whether a stand is available for harvest depends on how its harvest could affect another aspect of the forest, such as a wildlife or a recreation area.

These factors are also subject to 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 — a debate that is complicated by changes in social objectives over time. Thus, before an estimate of the timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and the uncertainties affecting those 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 on which they are based is relevant. Thus, it is important that re-analysis occur 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 throughout British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and assessment of the implications on the AAC resulting from changes in management practices and objectives.

Timber supply analysis involves three main steps. The first is the collection and preparation of information and data. The British Columbia Forest Service forest inventory* plays a major role in this. The second step involves using this information with a timber supply computer model or models to make a projection or estimation of possible harvest levels over time (called harvest forecasts).

**Throughout this document, an asterisk after a word or phrase indicates a definition in a box at the foot of the page.*

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.

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

Introduction

These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step in the timber supply analysis is the interpretation and reporting of results.

The following sections outline the timber supply analysis for the Okanagan TSA. Section 1 provides a brief description of the Okanagan TSA. Data preparation and formulation of the assumptions are discussed in Section 2. The analysis methodology and results are then presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions. The report summary and conclusions are presented in Section 6.

For the more technically oriented reader, Appendix A contains further details about the data and assumptions used in this analysis. They are included for completeness, but their review is not necessary to attain a basic understanding of the Okanagan TSA timber supply.

1 Description of the Okanagan Timber Supply Area

The Okanagan TSA is one of the largest and most ecologically complex TSAs in the province. Approximately 320 km long and 140 km wide, it stretches from the Seymour River watershed, that flows into Shuswap Lake; south to the Canada-United States border. From east to west it extends from the Okanagan Range to the Monashee Mountains. It is administered by the Salmon Arm, Vernon, and Penticton Forest District offices (Figure 1).

One of the fastest developing areas in the province, the Okanagan TSA supports some of British Columbia Interior's largest population centres. The area's expanding population places significant demands on resources. For example, there is an ongoing need to maintain high quality water supplies. There is also a growing demand for various types of outdoor recreational experiences, for both residents and tourists.

The diverse economy of the area maintains several industries. The main industries are forestry, agriculture, tourism, manufacturing, and service to a large retired population in the Central Okanagan. Tourism and recreation are especially important and this has a major impact on the management of forest resources.

The forest industry provides a substantial source of revenue and employment for the communities in the area, supporting approximately 10% of the work force in the overall TSA, accounting for approximately 25% of the economic activity in the northern part of the Okanagan TSA.

The Okanagan TSA contains important wildlife and fisheries resources and supports the greatest diversity of wildlife in the province.

Figure 1. Okanagan TSA.

2 Information Preparation

Many pieces of information are required to conduct a timber supply analysis. Each piece falls into one of three categories: land base inventory, timber growth and yield, 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 British Columbia Forest Service Inventory Branch in 1993. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area, and nature of the forest cover (such as presence or absence of trees, number of trees, species, age, and timber volume).

Initially, this file is a representation of the land base for the entire Okanagan TSA. It includes data for areas on which timber harvesting operations are not expected to take place, and which, 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 Okanagan TSA are described below). Before this land base file is used to make timber supply projections, it is important that data for these non-contributing areas be removed, to arrive at a file that represents the timber harvesting land base*.

It is important to remember that removal of data for areas not contributing to the timber supply does not imply withdrawal of areas from the TSA. The British Columbia 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—known as integrated resource management. The timber supply analysis in this report is consistent with this philosophy.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term *timber harvesting land* base in this report does not mean that an area is open to unrestricted harvesting activities. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites with adequate environmental resilience — to accommodate timber harvesting with due care for other resources and within the context of the *Okanagan TSA Integrated Resource Management Timber Harvesting Guidelines (1992).*

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

- Non-Crown land — areas not managed directly by the British Columbia Forest Service.
- Non-forest land — areas not occupied by productive forest cover (for example: rock, swamp, and alpine areas).
- Not satisfactorily restocked (NSR) areas*— these areas are initially removed, but a portion of the total NSR area considered available for timber is added back into 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.

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

2 Information Preparation

- Non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- Inoperable areas — areas defined as unavailable for harvest because of terrain-related characteristics. Characteristics used in defining inoperability include steepness of slope, topography, elevation, and the presence of gullies or exposed rock.
- Environmentally sensitive areas (ESAs)*
- Sites with low timber growing potential (low site index)*.
- Problem forest types (PFTs) — forest types of poor timber quality or low timber volume that cannot be economically harvested.
- Deciduous forest types.
- Riparian areas — a 1.5% area reduction was applied to account for areas of land adjacent to wetlands or water bodies.
- Forest roads, skid trails, and landings — to account for the loss of productive forest land that has occurred during past timber harvesting and development, 12% of all areas currently younger than 40 years and 1.5% of all areas greater than 40 years are removed. As harvesting occurs, the British Columbia Forest Service timber supply model deducts future losses related to timber harvesting.
- Timber licences — areas from these old tenure arrangements do not currently contribute to the current productive land base for the TSA. However as these areas are harvested they will revert to the Crown and become part of the long-term productive land base.

Table 1 summarizes the areas represented by these categories. A more detailed description of these categories and the rationale for the removals and additions are provided in Appendix A.

Environmentally sensitive area
An area with significant non-timber values, fragile or unstable soils, problems in establishing a new tree crop or where timber harvesting may cause avalanches.

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, Okanagan TSA, 1993

Classification	Area (ha)	Area (ha)	% of total area	% of productive forest area
Total land base		2 173 271	100.00	
Non-Crown land		414 755	19.08	
Non-forest land		355 206	16.34	
Total productive forest		1 403 309	64.57	100.00
Reductions to productive forest:				
Inoperable areas	115 112		5.30	8.20
Low quality site	11 797		0.54	0.84
Environmentally sensitive areas	43 298		1.99	3.09
Deciduous forest types	33 669		1.55	2.40
Problem forest types	120 013		5.52	8.55
Non-commercial cover	5 196		0.24	0.37
Riparian areas	15 003		0.69	1.07
Roads, landings, and trails	38 138		1.75	2.72
Not satisfactorily restocked	65 310		3.01	4.65
Total current reductions	447 536	447 536	20.59	31.89
Current productive land base		955 773	43.98	68.11
Additions to productive forest:				
Not satisfactorily restocked	65 310			
Timber Licence reversions	17 106			
Rehabilitation*	900			
Total additions	83 316	83 316	3.83	5.94
Total productive land base		1 039 089	47.81	74.05
Future road reductions	67 461	67 461	3.10	4.81
Long-term timber harvesting land base		971 628	44.71	69.24

Rehabilitation
The conversion of potentially productive land which is presently occupied by undesirable species to a condition appropriate for establishing desired tree species.

2 Information Preparation

Figure 2 summarizes the land base categories for the Okanagan TSA. The figure shows that almost two-thirds of the Okanagan TSA is Crown forest land and that approximately 68% of that land is available for timber harvesting. Current timber harvesting land base accounts for about 44% of the total Okanagan TSA (Table 1).

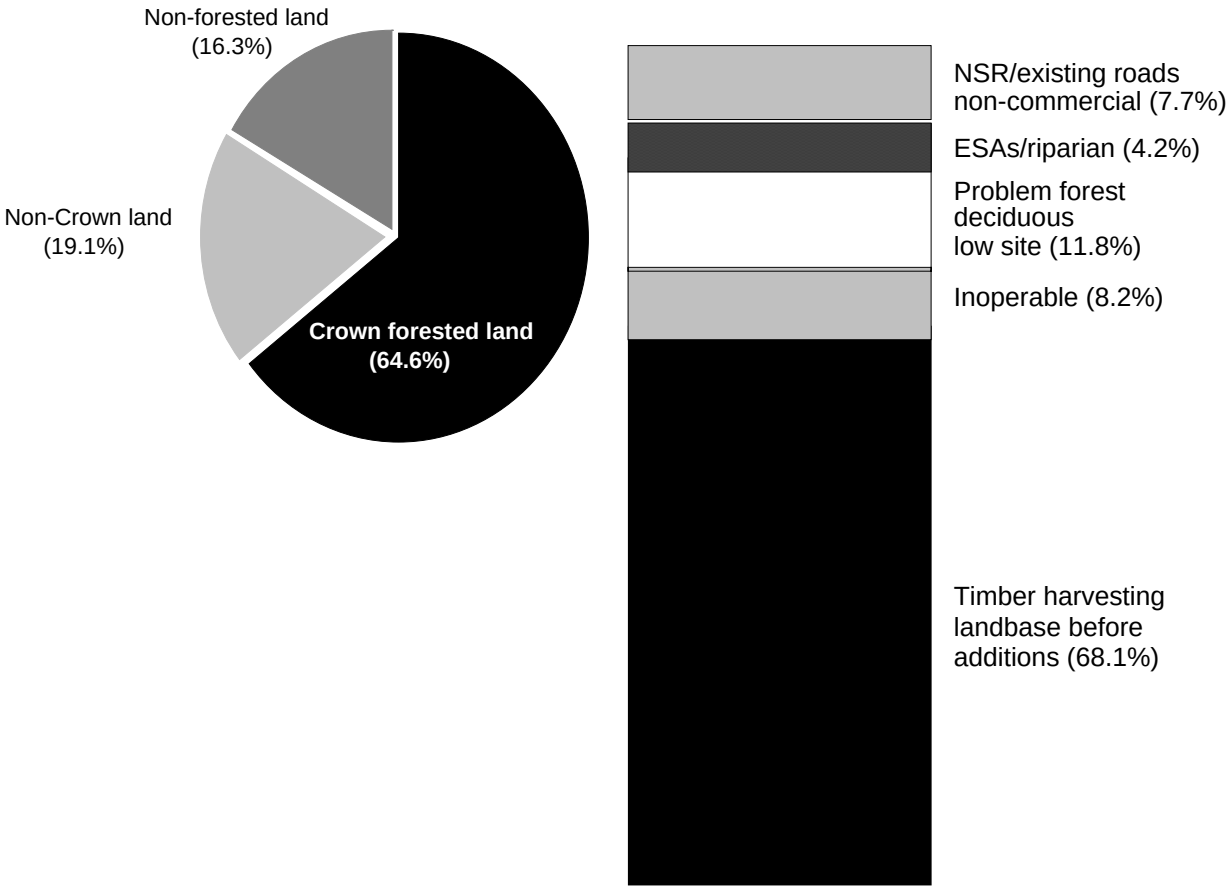

Figure 2. Classification of the Okanagan TSA

2 Information Preparation

Figure 3 shows the area by species and maturity for the timber harvesting land base. Overall, 62% of the land base consists of mature stands (that is, those greater than the minimum harvest age). The wet-fir types, which make up about 20% of the current productive land base, have undergone the greatest amount of disturbance with approximately 53% of these stands being immature. Balsam/spruce stands (approximately 28% of which are immature) have had the least amount of disturbance relative to their area.

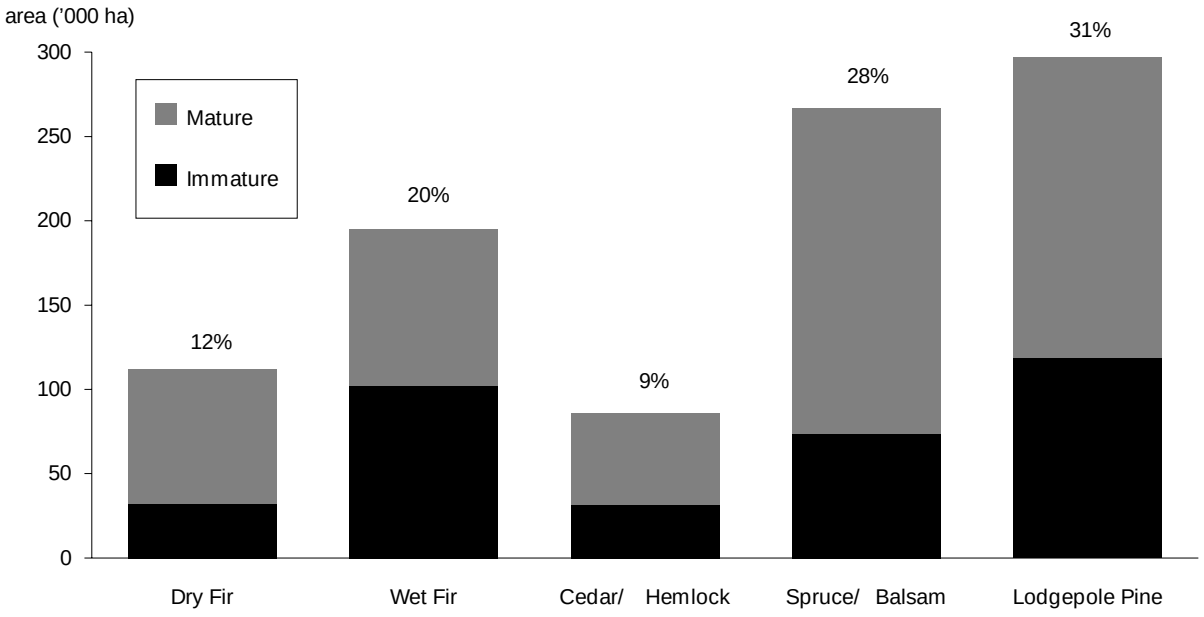

Figure 3. Area by dominant tree species for the Okanagan TSA - timber harvesting land base.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of 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 establish minimum size limits for trees and logs that can be harvested and must be removed from a site. Utilization levels specify a maximum stump height and minimum diameters at the tree base and top.

The timber volumes of existing stands are based on the Variable Density Yield Prediction (VDYP) model developed by the B.C. Forest Service Inventory Branch. Timber volumes for managed stands are based on the Table Interpolation Program for Stand Yields (TIPSY) model developed by the B.C. Forest Service Research Branch. These models provide estimates of volume for forest stands according to their age. 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 activities. 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 Salmon Arm, Vernon, and Penticton Forest Districts provided descriptions for the following management assumptions. A more detailed description of these management assumptions can be found in Appendix A.

- Basic silviculture levels — defines reforestation activities required to establish free-growing* stands of acceptable species after harvesting, as well as the basic silvicultural systems used in the TSA. In the Okanagan TSA most areas are managed using a clear-cutting harvesting system followed by planting, but selection management is being practiced on about 11% of the timber harvesting land base.
- Forest health and unsalvaged losses — expected timber losses due to fire, pest (insect, disease, and animals), and wind damage. Unsalvaged losses are estimated to be 126 610 cubic metres per year. The harvest forecast volumes shown in this report have been reduced by this amount.
- Utilization levels — tree and log size limits that must be harvested. The utilization levels are presented in Appendix A.
- Minimum harvest ages — the time it takes for stands to grow to harvestable size. The minimum harvest age defines the lower limit for harvesting. Actual harvest age depends on many factors, including the ages of other stands, limits on overall harvest level, and forest cover requirements. The minimum harvest ages for all units in this analysis are presented in Appendix A.
- Rate of restocking current and backlog NSR — schedule of restocking by species and area as presented in Appendix A.
- Old-growth cover objectives — forest cover guidelines that specify a minimum per cent of area that must be older than a prescribed age. Maintenance of biodiversity and areas of old-growth timber are goals of current forest management in the Okanagan TSA.
- Cutblock adjacency and green-up — guidelines that specify the spatial pattern of cutblocks and the amount of time (green-up period) required for regenerated stands to reach some desired condition before adjacent mature timber may be harvested.
- Forest cover objectives — specify the desired distribution of areas by age class groupings. These objectives are used to specify general adjacency and green-up guidelines as well as desired conditions for wildlife habitat and aesthetics.

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

2.4 Management zones

The delineation of specific areas into management zones was done within the context of the *Okanagan TSA Integrated Resource Management Timber Harvesting Guidelines.* The goal of these guidelines is to ensure that future forests in the Okanagan TSA are vibrant and represent a full variety of forest life and processes, while promoting a vigorous and efficient forest industry. Forest management zones were specified where certain resource values, such as water, wildlife, visual quality, or timber, are particularily important. The timber harvesting land base was divided into six different management zones. Figure 4 summarizes the area breakdown by management zone.

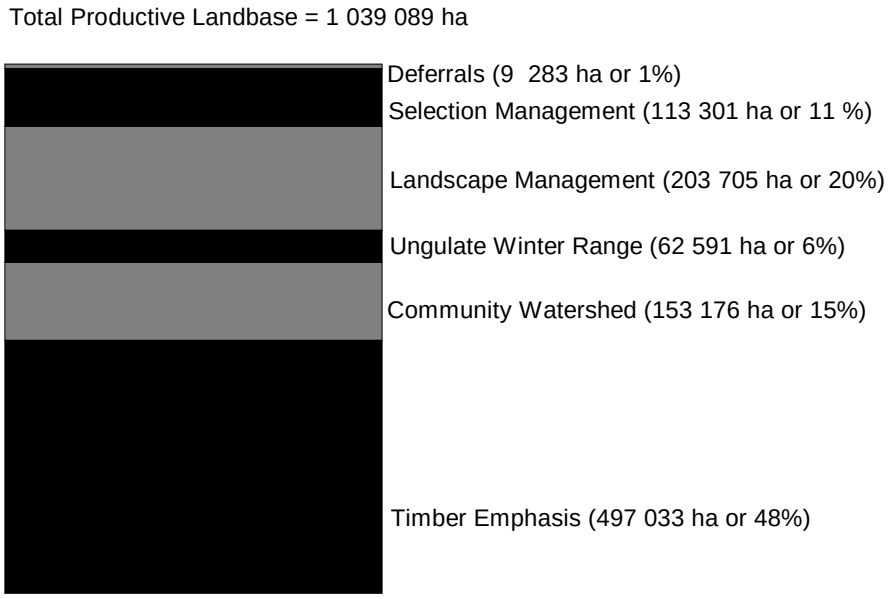

Figure 4. Management zones for the Okanagan TSA timber harvesting land base.

The management emphasis for each zone follows:

- Ungulate winter range zone — to maintain or enhance forage production by dispersing the harvest throughout the winter range. The cover requirements specify that no more than 20% of the area is below 3 metres in height and that at least 27% of the area is greater than 75 years of age at any one time.
- Landscape management zone — to minimize the visual impact of timber harvesting along corridors where people live, work, recreate, and travel. The cover requirements are that no more than 15% of the area may be below 6 metres in height. To maintain old-growth and biodiversity at least 5% of the area must be greater than 140 years of age.
- Community watershed zone — to protect water resources through the maintenance of water quality, water quantity, and timing of runoff. The cover requirements specify that no more than 26% of the area may be below 6 metres and that at least 5% of the area is greater than 140 years of age.
- Selection management zone — this zone encompasses TSA areas which are managed through the use of selection systems. Normal forest cover requirements do not apply as only small cleared patches are created during harvest and it is assumed that these types of harvesting systems will satisfy all requirements for cover.

- Deferral zone — areas for which timber harvesting is not permitted, as specified in Local Resource Use Plans. These areas were identifed and deferred from the timber harvesting land base for a period of 50 years. Once harvesting is allowed to commence the cover requirements are the same as the timber harvest emphasis zone.
- Timber harvest emphasis zone — this zone includes all areas which do not conflict with previously mentioned zones. The emphasis is for long-term optimum harvest of forest products while protecting basic resources through the *Basic Integrated Resource Management Guidelines*. Cover requirements for this zone specify that no more than 35% of the area may be below 6 metres in height and that at least 5% of the area must be greater than 140 years of age.

3 Analysis Methods

The purpose of this analysis was to examine both the short- and long-term timber harvesting opportunities in the Okanagan TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used to aid in the assessment. A timber supply model, as distinguished from a growth and yield model, assists in determining how a whole forest, or collection of stands, provides a harvest flow or supply of timber over time given a specific set of forest management practices, or conversely how the forest should be managed in order to obtain a specfic or desired harvest flow. 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 400 years. However, because the harvest flow remains constant from years 200 to 400, only the results for the first 200 years are shows graphically in this report.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections, and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. However, the Forest Service model differs from other models in that it allows the use of forest cover guidelines that specify the desired age composition of the forest. These cover 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 per cent of the area can be younger than a specified green-up age; or that some minimum per cent of the area must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model tests such guidelines to examine their effects 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 when 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 or principles. **However, the results of the analysis do not imply an AAC recommendation.**

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. 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, however, help ensure that the timber harvest level supports rather than hinders sound sustainable forest management in the field.

4 Results

This section presents the results of the timber supply analysis based on the timber harvesting land base and current management practices already described.

4.1 Harvest forecast

The harvest forecast based on current management assumptions for the Okanagan TSA is shown in Figure 5. (The AAC has been temporarily increased to 2 804 000 cubic metres per year to address Mountain Pine Beetle epidemics in the southern portion of the TSA. Refer to Section 4.4). The present AAC of 2 615 000 cubic metres per year may be maintained for 2 decades. The harvest level then declines by 10% per decade, reaching the long-term harvest level of 2 022 000 cubic metres per year in 40 years time. The harvest flow pattern illustrated in Figure 5 is based on a modelling assumption of maintaining the present AAC for as long as possible, followed by an orderly decline of approximately 10% per decade to the long-term level, without causing harvests to drop below the long-term level.

The long-term level was set to maintain growing stock* at a near constant level once most of the initial forest is replaced by a second-growth forest. A constant growing stock serves as an indicator that a particular harvest level can be sustained over the long-term. A declining total growing stock indicates that the long-term harvest level exceeds the productive capability of the land. Figure 6 illustrates the impact of this harvest flow on growing stock. The present volume of 195 million cubic metres declines to an approximate long-term level of 125 million cubic metres. The initial drop in growing stock reflects the conversion of the timber harvesting land base from an older forest to a younger, managed forest.

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

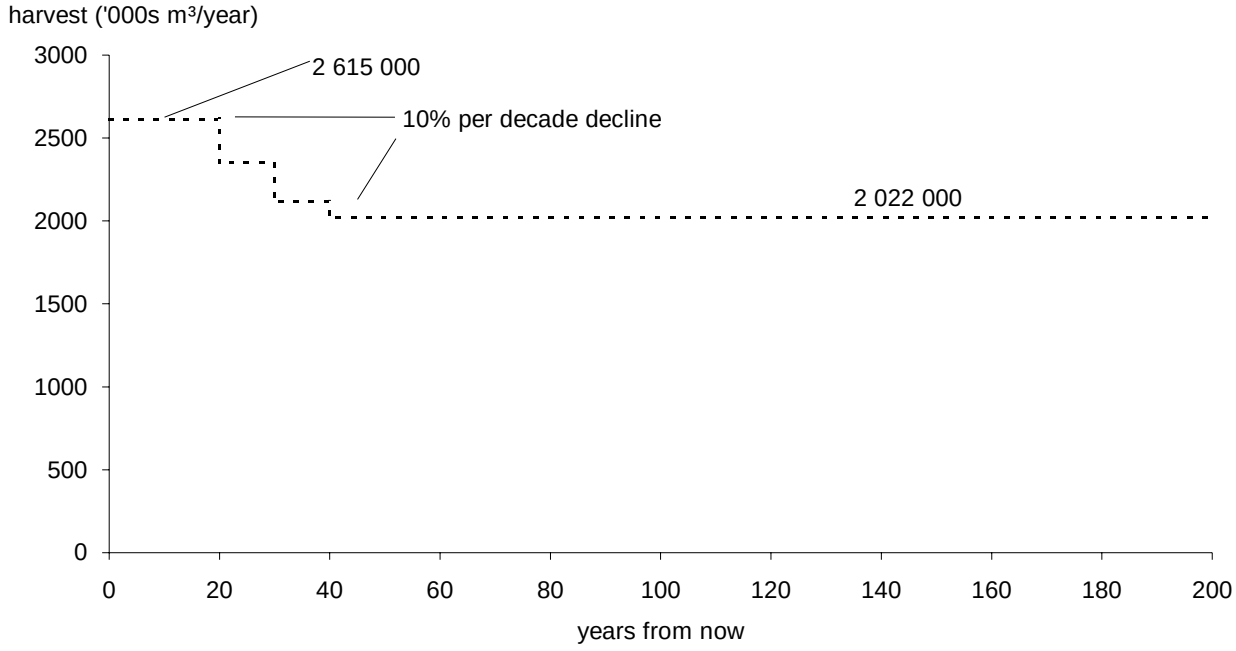

Figure 5. The base case harvest forecast for the Okanagan TSA.

4 Results

The mature growing stock, which is the growing stock above minimum harvest age, is also shown in Figure 6. The low level in decade 12 occurs primarily because the existing mature growing stock has been drawn down through harvest and there is limited second growth timber of a harvestable age. In decade 13 more areas become mature and the amount of available timber increases. Note in Figure 6 that, due largely to forest cover requirements, the inventory of timber above minimum harvest age is maintained at approximately 65 million cubic metres.

It is important to note that the long-term harvest level of 2 022 000 cubic metres per year is not to be interpreted as being the same as a theoretical maximum sustainable harvest level based on the culmination of mean annual increment(MAI).* The theoretical level of approximately 2 401 000 cubic metres per year, is not achievable for several reasons. First, the losses from fire and other causes must be deducted from the theoretical maximum. This reduces the maximum to about 2 274 000 cubic metres per year. Second, stands are almost always harvested at ages other than those which maximize volume production. This can be caused by specified minimum harvest ages, forest cover guidelines and require alternate harvest flow patterns over time.

Note that the harvest forecast shown here, as well as those in Section 5, provide an upper limit on timber supply, given the land base and management practices discussed earlier. **This forecast is for discussion purposes only and is not intended to suggest a particular AAC.**

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

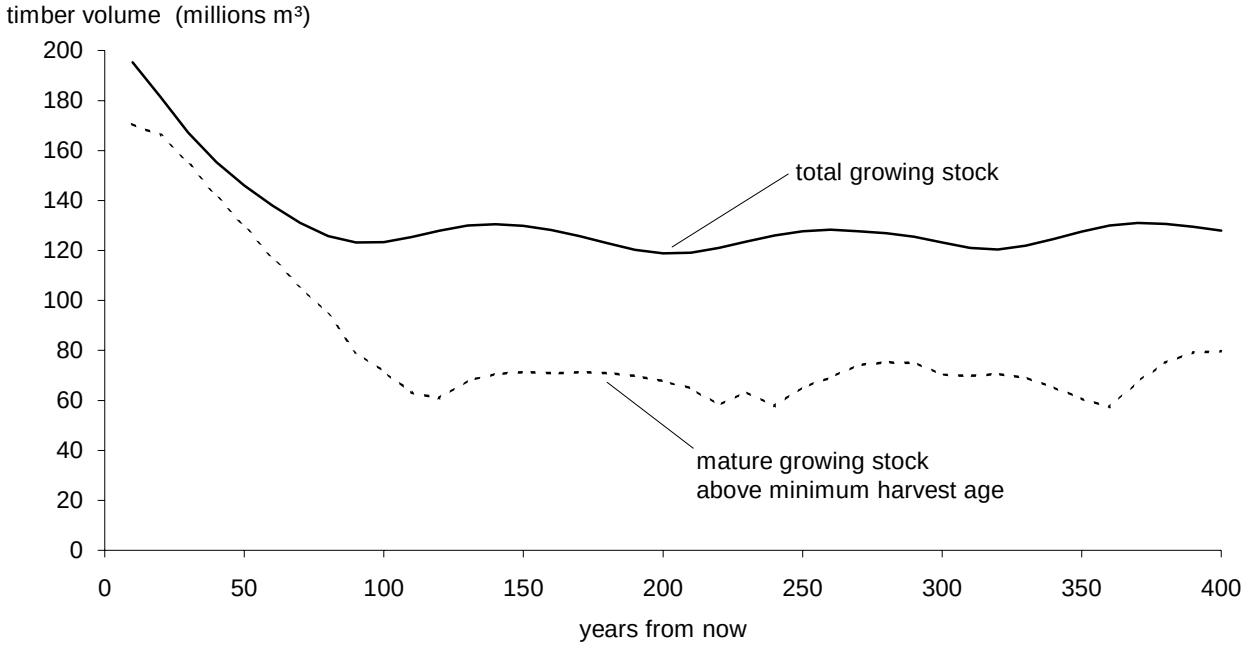

Figure 6. The base case growing stock over time for the Okanagan TSA.

4.2 Age class distribution over time

Figure 7 shows the changes that occur in the forest age class distribution over the 200 year planning horizon. Initially the forest has 33% of the area over 140 years and 21%‘ less than 50 years. A large amount of area, 36% falls within the range of 80 to 140 years, a range which encompassess the minimum harvest ages used in this analysis. This indicates that a large amount of timber, 69%, is or will soon be available for harvest. Over the planning horizon, the age class distribution gradually becomes more balanced. As Figure 7 shows, the forest cover guidelines for old-growth and VQOs result in 7.5% of the area remaining above age 140 at all times.

4 Results

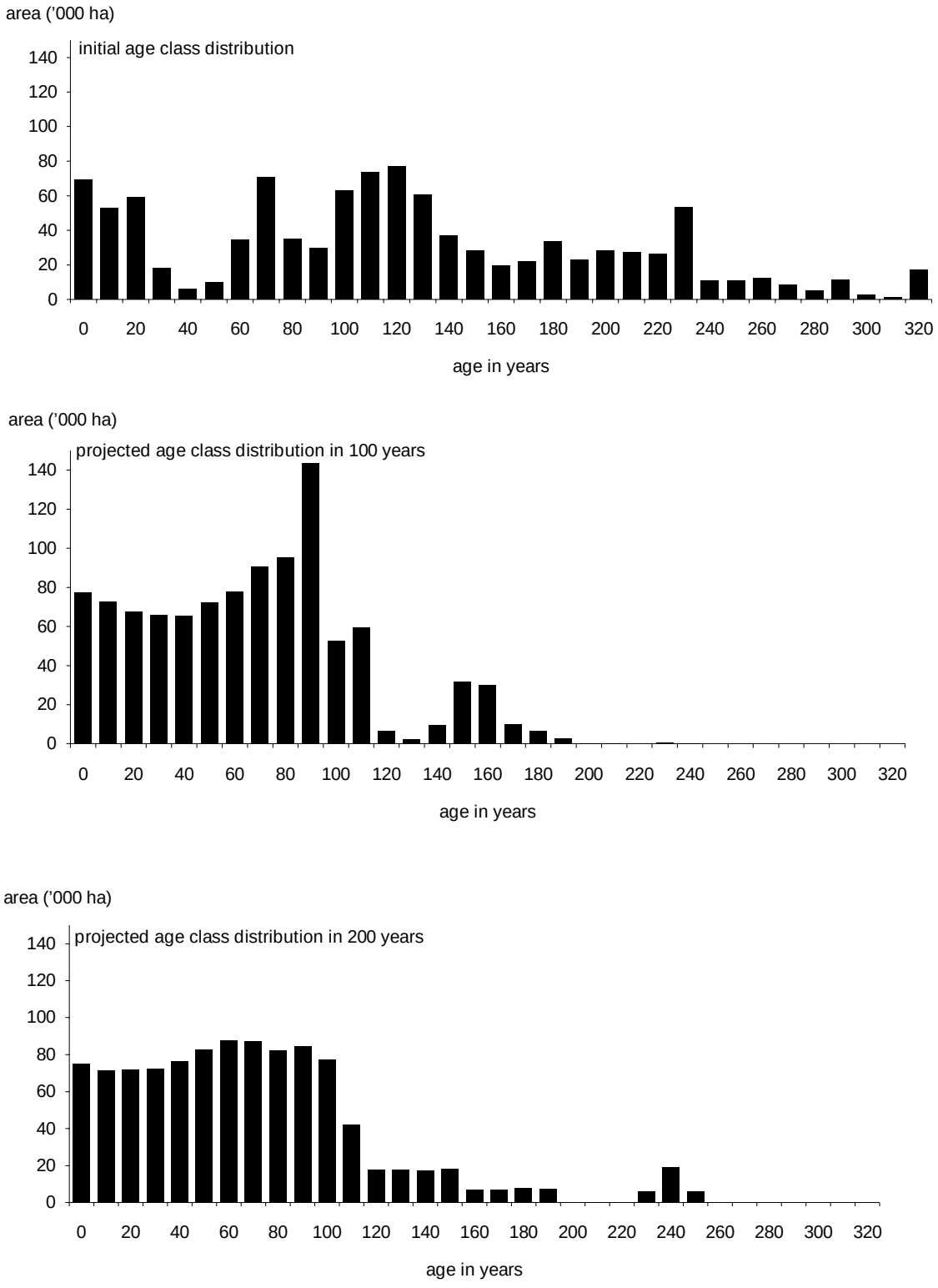

Figure 7. Changes in the age class distribution for the Okanagan TSA over time.

4.3 Average area harvested, harvest ages, and volume per hectare

The average area harvested, shown in Figure 8, starts at approximately 8700 hectares, reaches a maximum in decade 2 at 9400 hectares, then declines steadily to a low of 6550 hectares in decade 6. The decline is due to a decrease in target volume requests in decades 3 through 5 and because of an increase in average harvest volume per hectare in decades 3 through 6. (Figure 9). After this point there is an increasing trend in average area harvested as regenerated stands begin to be harvested. The trend in average volume per hectare is downward as these second-growth stands are harvested at younger ages, and therefore have less volume per hectare. The area required to maintain the long-term harvest level will be approximately 7700 hectares per year with the average volume per hectare of approximately 280 cubic metres per hectare as shown in Figure 9.

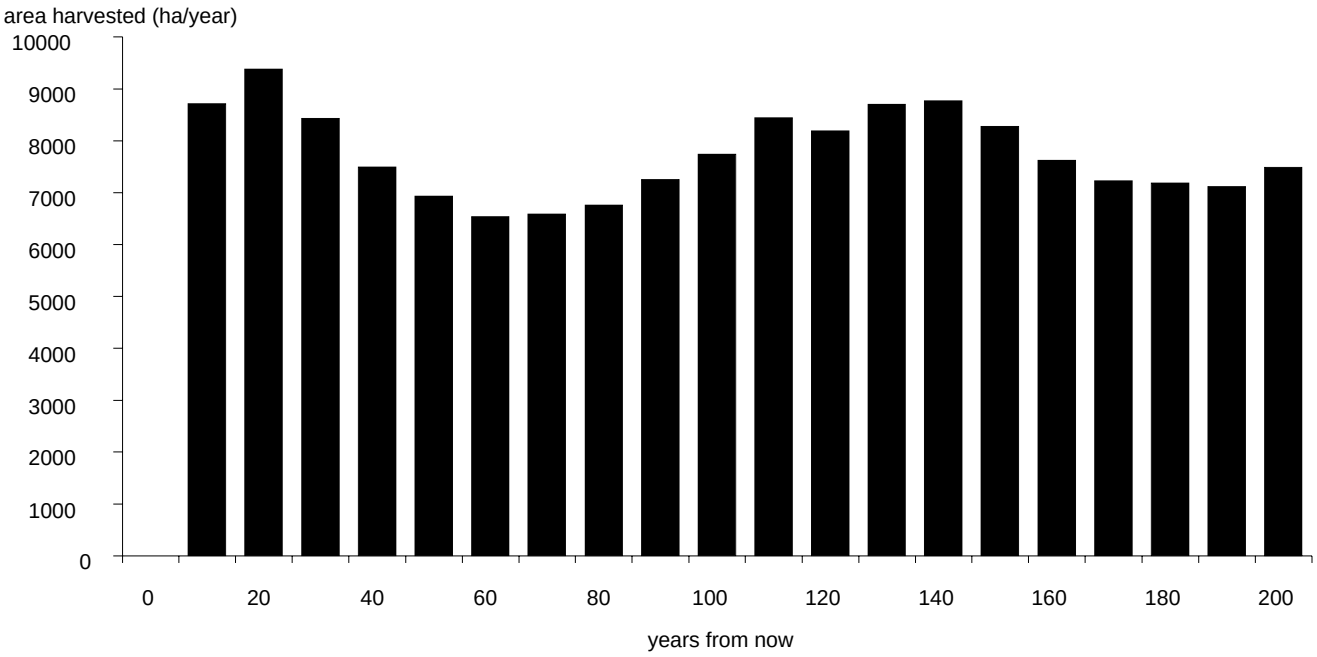

Figure 8. Area harvested annually for base case.

4 Results

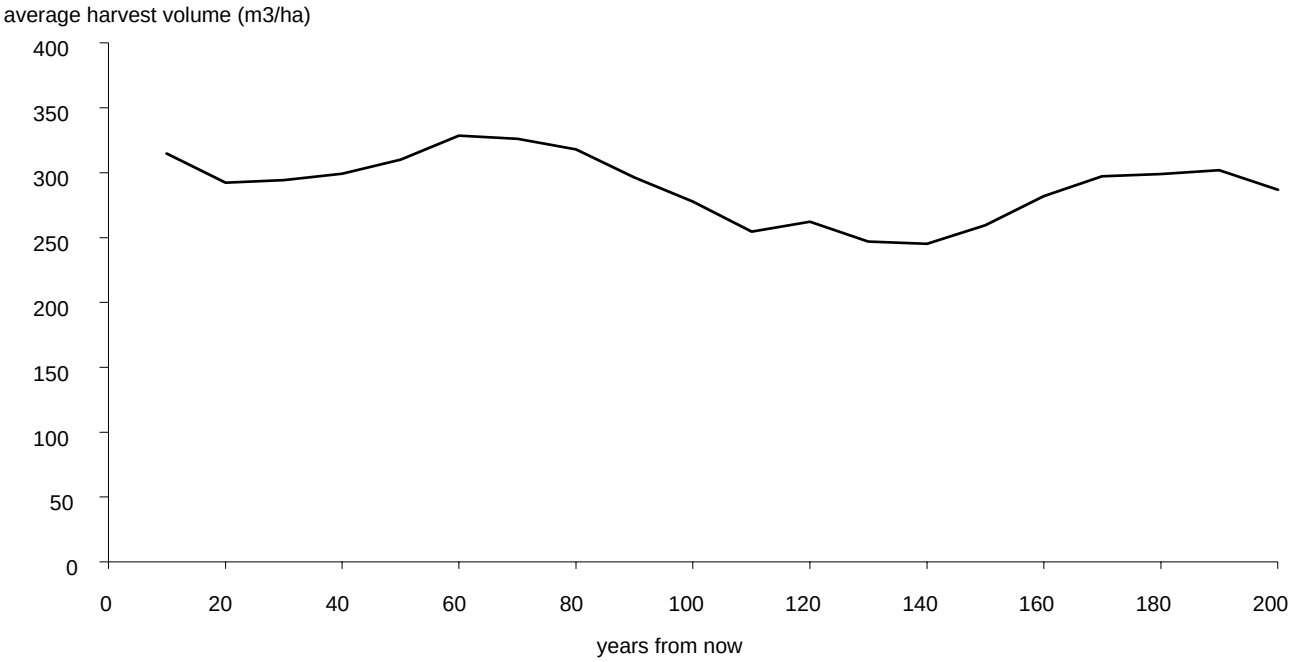

Figure 9. Average harvested volume per hectare.

The average age of timber being harvested, shown in Figure 10, gradually declines as the mature timber inventory is depleted. The average harvest age is approximately 270 years in the first decade due to the large amount of timber in older age classes. The small increase and then plateau of average harvest age between 60 and 90 years from now is due to harvesting occurring in areas initially deferred from harvest. The average age of timber being harvested approaches 120 years at the end of the 200 year planning horizon.

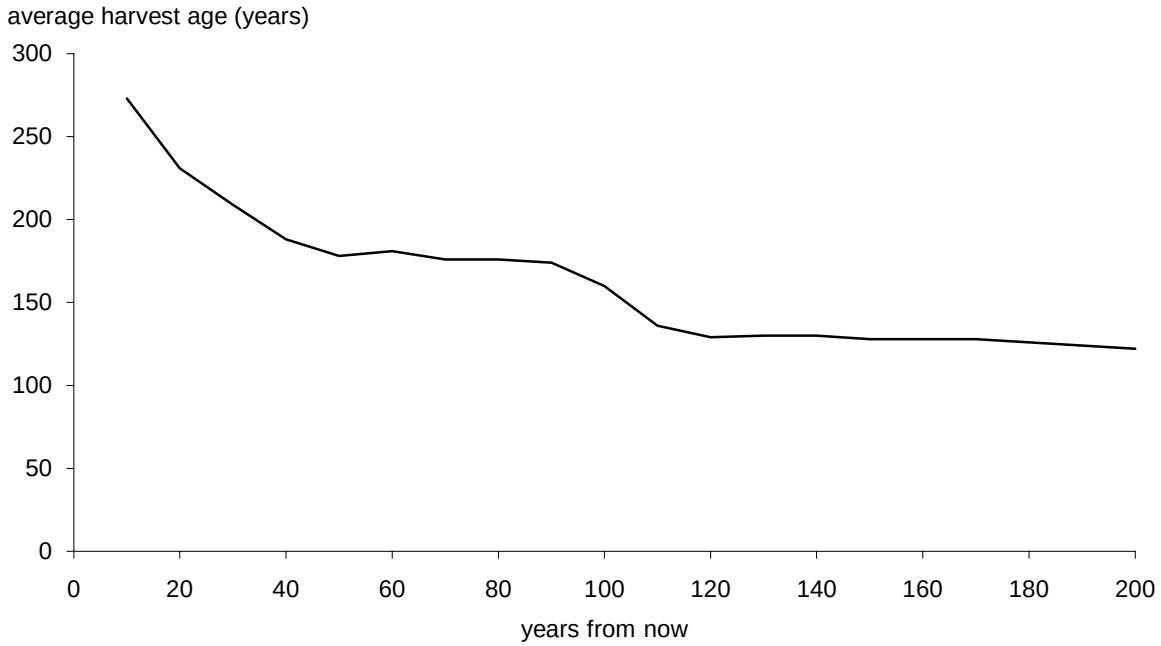

Figure 10. Average age of harvested stands over time.

4.4 Species harvested for the first ten years

Figure 11 illustrates the compostion of the short-term harvest. The first bar represents the harvest by species as modelled by the B.C. Forest Service timber supply model. The model simulates harvesting stands using an oldest-first rule to establish priority. The current, or actual, harvest species profile is strongly affected by the mountain pine beetle epidemic in the southern portion of the Okanagan TSA. Since these stands are not amongst the oldest in the TSA, a different profile is selected by the model. Varying the order in which stands were harvested in an attempt to model more closely the current harvest species, showed no effect on the base harvest forecast.

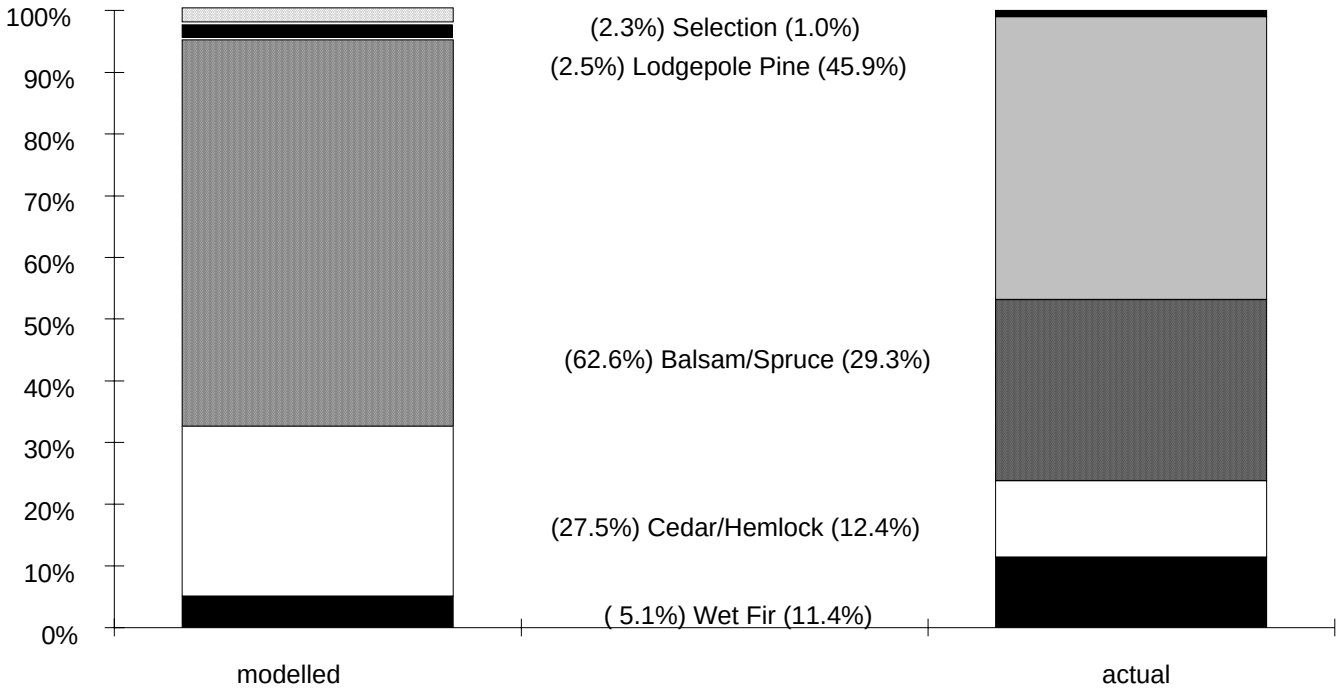

Figure 11. Harvest profiles for decade 1.

4 Results

Figure 12 illustrates how an elevated level of harvest for the first 10 years, to respond to mountain pine beetle infestations, can effect the harvest forecast. If, to combat the mountain pine beetle, the harvest level is maintained at the maximum possible without allowing future harvest levels to drop below the long-term level then an increase in the first decade's harvest to 2 809 000 cubic metres per year is possible. This is basically equivalent to the 2 804 000 cubic metres per year that is currently being harvested. After this, harvest levels must be reduced by 10% per decade to meet the long-term level 30 years from now. This harvest level represents a 7% increase in the decade 1 harvest and the long-term level is achieved 10 years earlier.

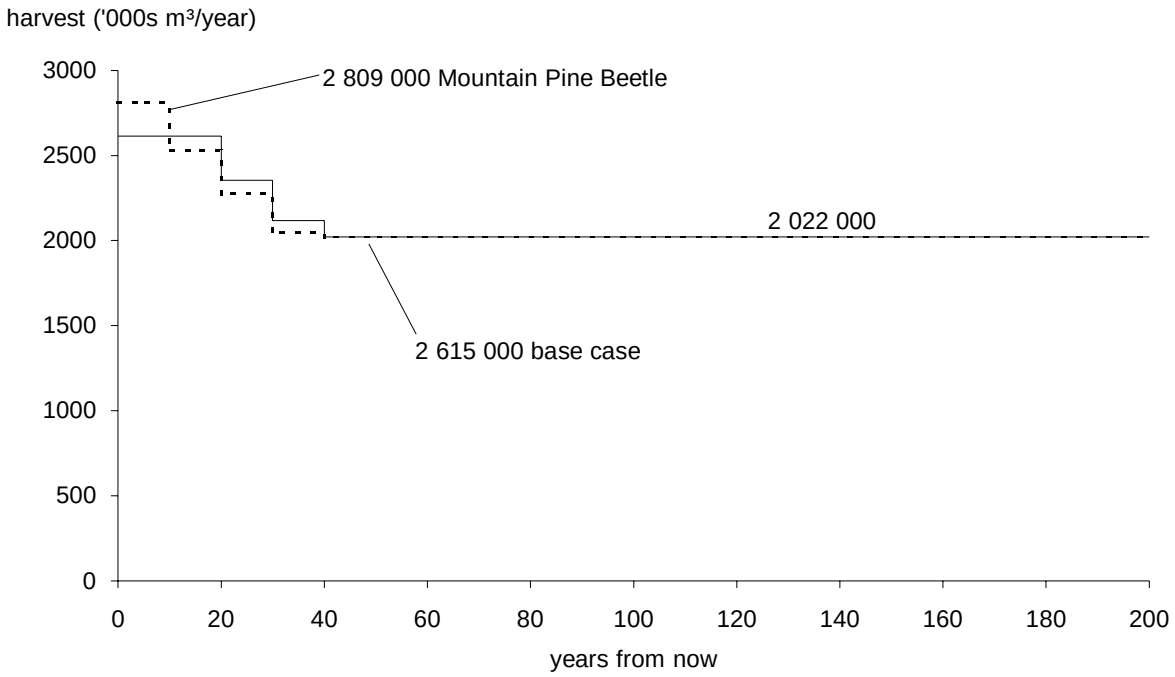

Figure 12. Elevated harvest level to account for mountain pine beetle salvage.

5 Timber Supply Sensitivity Analyses

Sensitivity analysis is the exercise of examining how uncertainty in data and assumptions affect the outcome of the analysis. The main purpose of timber supply sensitivity analysis is to highlight which variables most affect the results. It is an important aid to decision making, since uncertainty surrounds estimates of many variables used in timber supply analysis.

The best available information on forest inventories and management practices is used to analyze the implications of current forest management on timber supply. However, it is possible that small inaccuracies in some variables could have large effects on results. On the other hand, fairly large inaccuracies in other variables may have negligible effects. Sensitivity analysis can therefore highlight priorities for collecting information for future analyses. As well, it can clarify for decision makers whether current best estimates are safe bases for decisions, or whether high uncertainty around important variables necessitates more conservative decisions.

In this Section, results of several sensitivity analyses are outlined. The results that are based on current forest management assumptions (shown in Figure 5) are referred to as the base case.

5.1 Changes in harvest flow over time

The base case harvest forecast in this analysis starts at 2 615 000 cubic metres per year for 20 years, then declines by 10% per decade until the long-term harvest level of 2 002 000 cubic metres per year is achieved 40 years from now. This is a result of trying to achieve the present AAC for as long as possible while maintaining a reasonable rate of decline to, and not falling below, the long-term level. Many other harvest flows (patterns of harvest over time) are possible. This section examines two flow alternatives. It must be noted that the base case harvest species profile is not the same as the current harvest species profile as was explained in Section 4.4.

In determining the base, a rate of flow was established such that the harvest would not fall below the long-term level over a period of 400 years. It may be difficult to meet the target harvest volume since the areas harvested in the first decades are primarily on poor sites. To achieve the target harvest levels from these low volume sites, more area must be harvested. Limits to the area available for harvest defined by cover requirements are reached much more rapidly under these circumstances.

Figure 13 shows the alternative of starting the harvest level as high as possible while allowing a maximum drop below the long-term level of 10%. It is possible for the first decade's harvest to increase by 9%, then decline by 10% to reach the long-term level 40 years from now. Although not shown in Figure 13, at this initial harvest level the harvest forecast falls 10% below the long-term level in decade 36.

The second alternative forecast looked at the implications of dropping the starting harvest level to within 10% of the long-term level. The resulting harvest forecast in Figure 13, shows a harvest that begins at 2 224 200 cubic metres per year, then drops 10% to 2 022 000 cubic metres per year 80 years from now. The starting level is 15% below the base case starting level. It is not possible to maintain the starting level any longer than 8 decades because the forest cover guidelines reach their limits in four of the five management zones with forest cover guidelines.

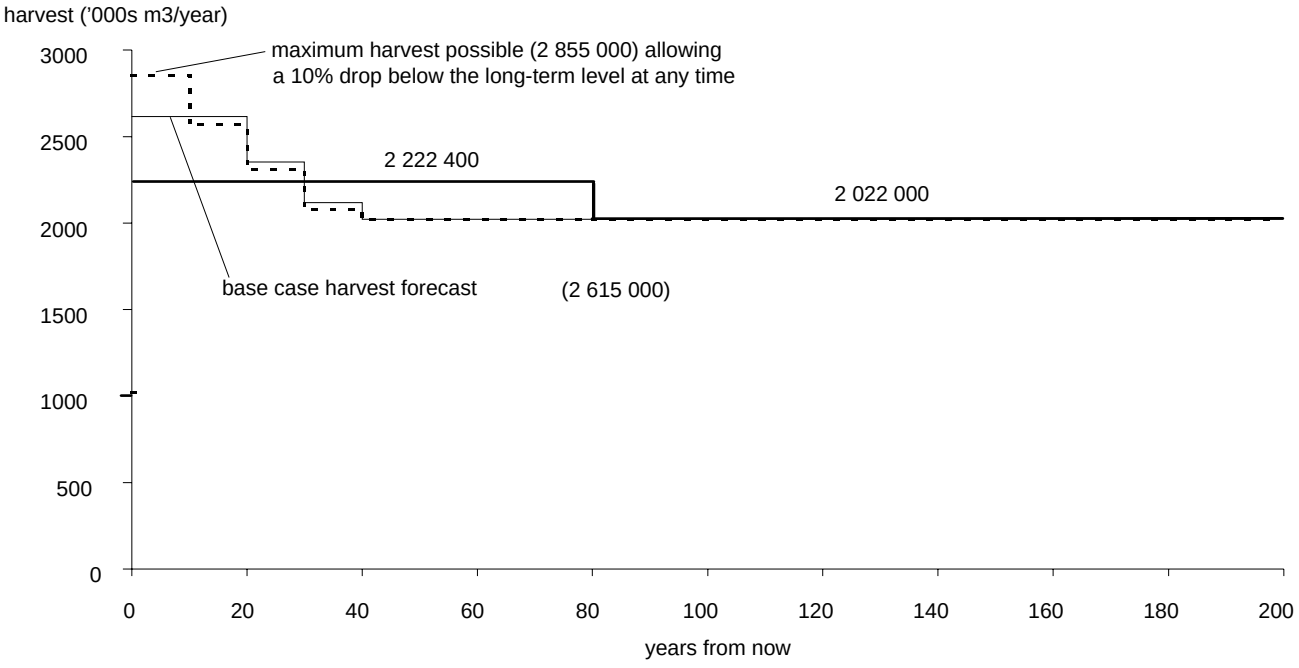

Figure 13. Harvest forecast, alternative harvest flow.

5.2 Sensitivity to uncertainty in minimum harvest ages

In the base case, minimum harvest ages were based on cutting-age priorities assigned by the three forest districts of the Okanagan TSA and then weighted by the area of each species type within each forest district. The indicated average weighted rotation age is approximately 98 years. In the base case, actual average harvest ages remained above 135 years until 120 years from now (Figure10).

Figure 14 shows the results of changing the minimum harvest ages by 20 years. With an increase of 20 years in minimum harvest ages, more time is required before a previously harvested stand becomes available for a second harvest. The indicated average weighted rotation age is 118 years. As a result, the present AAC can be maintained for only 1 decade, followed by 10% per decade declines to a harvest level of 1 873 000 cubic metres per year in 50 years . This harvest level is maintained until second-growth stands become readily available for harvest in decade 15. The harvest level then rises to the long-term level of 2 045 000 cubic metres per year, 1% above the base case long-term level. The increase in the long-term level is due to more stands being harvested at ages closer to the age which maximizes the volume produced over time, MAI age. The indicated average maximum MAI rotation age is 114 years. Under current management assumptions, if the harvest flow was to be kept from falling below the long-term level, it would be necessary to reserve some of the volume harvested in the initial decades for the harvest shortfall between 50 and 150 years from now.

Reducing minimum harvest ages by 20 years increases initial available volumes by 10% and makes more timber available in the transition period between harvest of existing stands and second-growth stands. The indicated average weighted rotation age is 81 years. The present AAC can be maintained for 4 decades, declining thereafter by 10% per decade, achieving a long-term level of 1 984 000 cubic metres per year in 60 years from now. This long-term level is 2% below the base case long-term level.

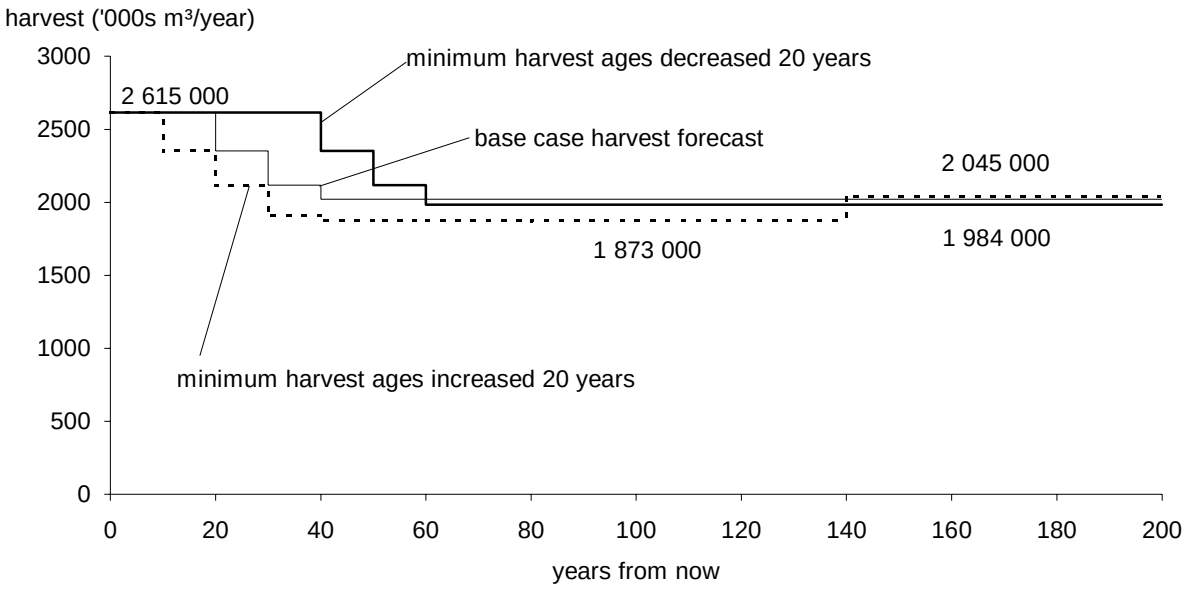

Figure 14. Harvest forecast if minimum harvest ages are 20 years younger or older than assumed for the base case.

5.3 Sensitivity to uncertainty in existing stand volumes

Volume estimates from the Variable Density Yield Prediction (VDYP) model were used in the base case for existing stands. The purpose of this sensitivity analysis is to estimate the effects on timber supply of existing stand yields that are greater or less than the yields estimated for the base case. The impacts of uncertainty in regenerated yields are examined in Section 5.4.

Figure 15 shows that if current yields are 10% higher than was assumed for the base case, the initial harvest level can be maintained for 60 years, declining by 10% per decade to the long-term level in 80 years from now. If, however, current yields are 10% lower than was assumed, intial harvest levels must be reduced to 1 820 000 cubic metres per year for 60 years before climbing back up to the long-term level in 70 years from now. This initial harvest level is 30% below the base case initial harvest level and 10% below the long-term level. This large reduction in the first decades of harvest is required so that timber may be reserved to meet the forecast shortages 90 to 120 years from now. Note that in both cases, changes in estimates of existing stand volumes do not impact on the long-term harvest level.

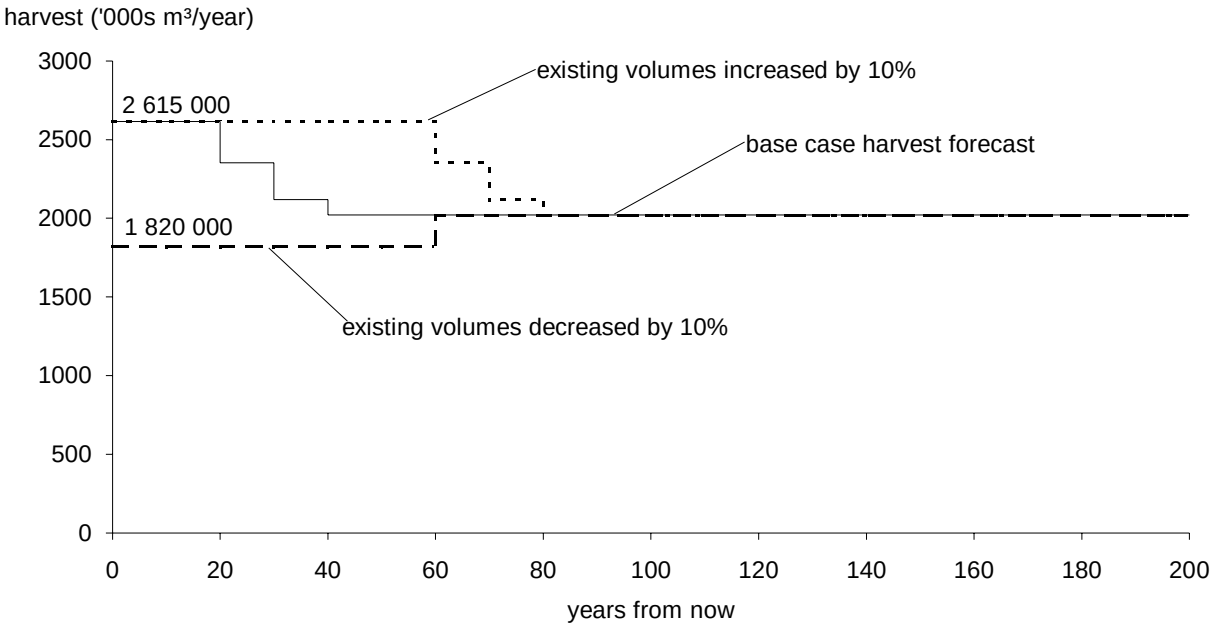

Figure 15. Harvest forecast if existing volumes are 10% higher or lower than assumed for the base case.

5.4 Sensitivity to uncertainty in regenerated stand volumes

The Table Interpolation Program for Stand Yields (TIPSY) model was used in the base case for regenerated stands. The purpose of this sensitivity analysis is to estimate the effects on timber supply of regenerated stand yields that are greater or less than the yields estimated for the base case. In general, the yields which were estimated from the TIPSY model are 27% higher than those estimated from the VDYP model, at the average weighted rotation ages provided by the forest districts.

Figure 16 illustrates the results. When regenerated volumes are lowered by 10%, the 10% per decade declines of the base case continue for 50 years, stabilizing at a long-term harvest level of 1 811 000 cubic metres per year.

If regenerated stand volumes are 10% higher than those of the base case, the long-term harvest level rises to 2 224 000 cubic metres per year. The increased volumes however, do not affect short-term harvest levels. The effects of the increase are reflected in greater timber availability beginning 40 years from now but are more pronounced when only second-growth stands are being harvested, starting 120 years from now. Under current management assumptions, if the harvest flow was constrained such that it could not drop below the long-term level, it would be necessary to reserve some of the initial timber volumes from the first 30 years to meet the shortage between 40 and 120 years from now.

If minimum harvest ages are reduced by 20 years in conjunction with the increase in regenerated volumes, it is possible to increase the harvest between 40 and 120 years from now to 2 182 000 cubic metres per year. This 5% increase in volumes is not possible, however, unless growing stocks are allowed to steadily decline over the planning horizon. This would reduce long-term harvest levels.

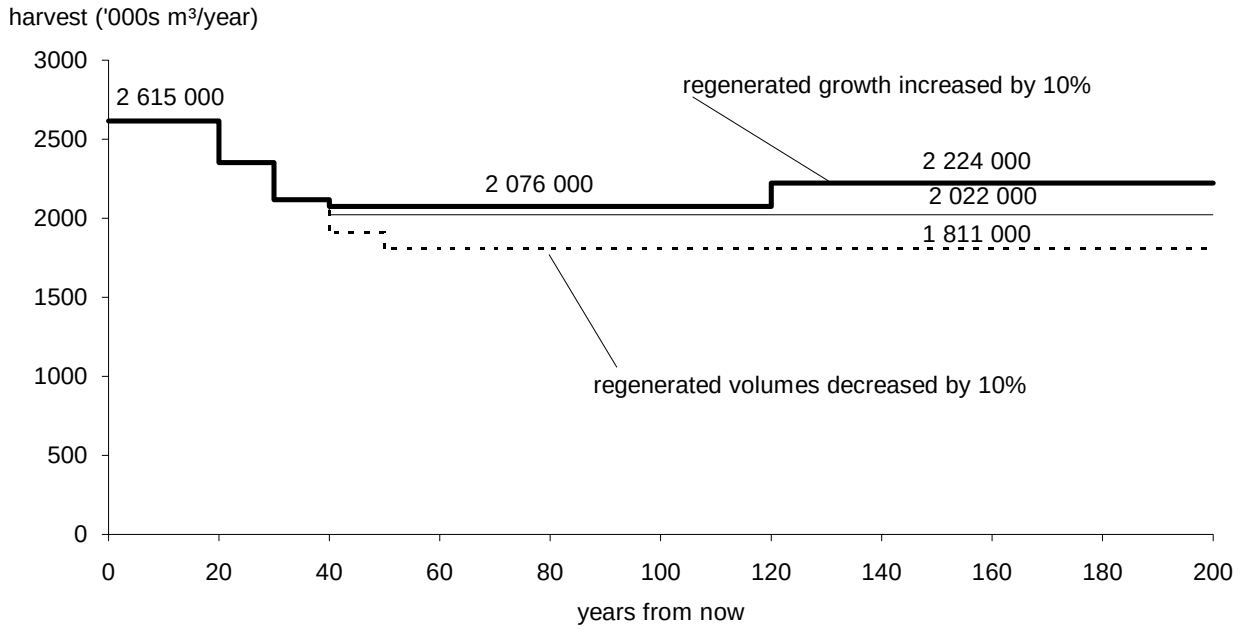

Figure 16. Harvest forecast if regenerated stand volumes are varied by 10%.

5.5 Sensitivity to uncertainty in regeneration delays

The regeneration delay is 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. Since the majority of the areas harvested in the Okanagan TSA are planted, the regeneration delays were assumed to be 5 years for lodgepole pine and 4 years for all other species. This sensitivity analysis examines impacts of extending regeneration delays to 10 years and of reducing regeneration delays to 0 years.

As summarized in Figure 17, eliminating the regeneration delay does not effect the short-term harvest forecast. The long-term harvest level can be increased by only 1% due to second-growth stands being available a few years earlier.

When regeneration delays are increased to 10 years the starting harvest level can only be achieved for 1 decade, followed by a steady decline to a long-term level of 1 913 000 cubic metres per year 30 years from now, 5% below the base case long-term level. The extension of when second-growth stands can be harvested requires additional volumes from the initial periods to be reserved to fill the transition from existing to regenerated stands.

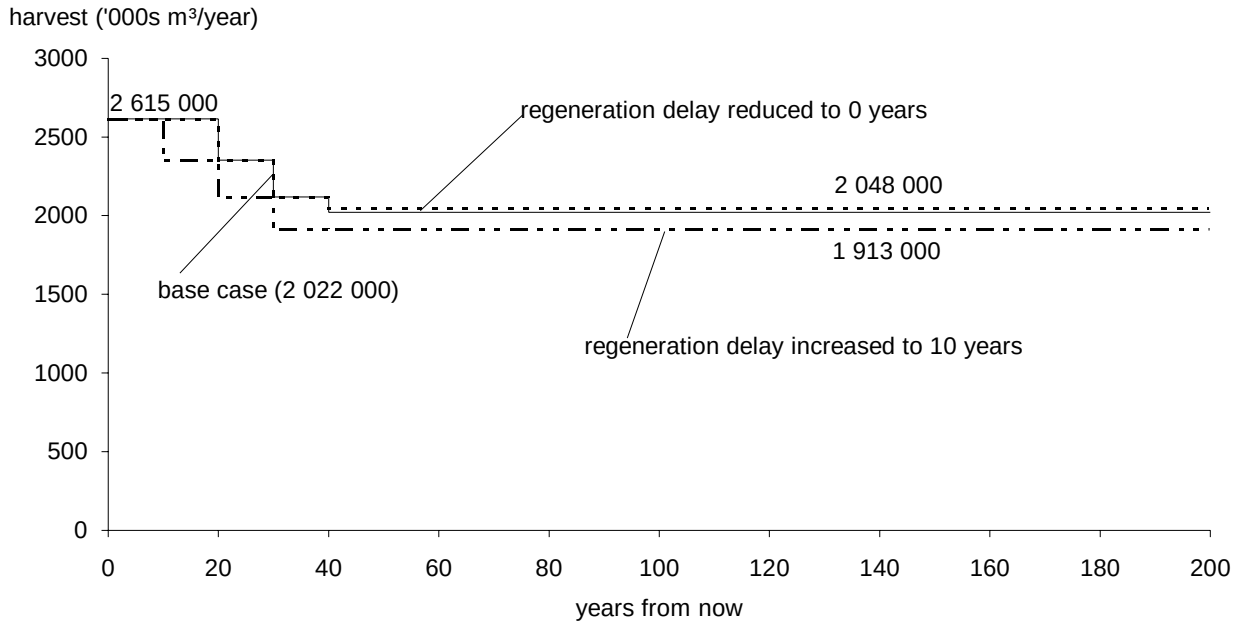

Figure 17. Harvest forecasts if regeneration delays are lower than those assumed in the base case.

5.6 Sensitivity to uncertainty in green-up periods and old age criteria

Forest cover requirements specify desired distributions of areas by age-class groupings. The B.C. Forest Service timber supply model simulates harvests by (i) limiting the area which may be younger than a specified age, and (ii) maintaining a desired amount of area older than a different specified age. Sensitivity testing of the impact of varying the young and old age requirements was undertaken.

5 Timber Supply Sensitivity Analyses

The uncertainty around green-up periods is examined in this analysis. In the Okanagan TSA, a hydrologic green-up* of 6 metres is required for all zones. The exceptions are the ungulate winter range zone, which requires a 3-metre green-up; the selection zone, in which it is assumed that green-up criterion will be satisfied, through selection management; and the landscape zone, which still requires a 6-metre green-up but for visual quality reasons. To determine the timber supply effects, the green-up ages of all zones, except the selection zone, were varied by 5 years.

As green-up periods are lenghtened, a higher proportion of the total inventory is unavailable for harvest. The opposite occurs as the ages are shortened.

The effects of reducing the green-up period by 5 years is shown in Figure 18. The intial harvest rate can be maintained for 40 years, declining to a long-term level of 2 042 000 cubic metres per year, 1% above the base case. Reducing the green-up period reduces the effective green-up height for all affected management zones. The green-up height for ungulate winter range zone declines to approximately 1.6 metres. The average green-up height for the remaining zones is also reduced to about 4.6 metres.

Increasing the green-up period by 5 years causes the short-term harvest forecast to decline. As shown in Figure 18, the intial harvest rate drops to 2 456 000 cubic metres per year, declining each decade to the long-term level of 1 976 000 cubic metres per year in 30 years, 2% below the base case. Increasing the green-up period increases the effective green-up height for all affected management zones. The ungulate winter range zone green-up height increases to about 5 metres. The average green-up height for the remaining zones increase to about 7.8 metres.

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

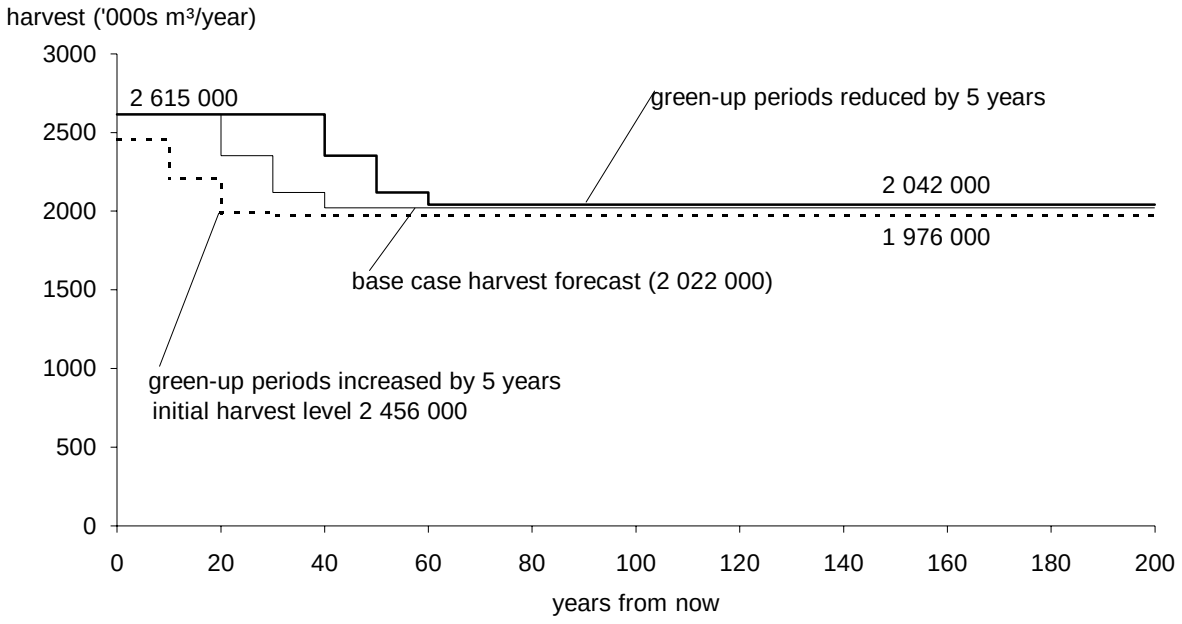

Figure 18. Harvest forecast if green-up periods are 5 years longer or shorter than those assumed in the base case.

5.6.2 Sensitivity to uncertainty in old age criteria

The uncertainty around mature cover age is examined in this analysis. The Okanagan TSA requires that a certain percentage of the TSA area remains above 140 years old and that mature cover is maintained within the ungulate winter range zone. The sensitivity analysis examines the possibility that these age requirements may vary by 20 years.

As illustrated in Figure 19, neither increasing or decreasing the mature cover requirement age by 20 years had any effect on the short-term harvest forecast. Decreasing mature cover ages by 20 years allowed the long-term harvest level to increase by 3% to 2 077 000 cubic metres per year. Increasing mature cover ages by 20 years caused the long-term level to drop by 1% to 2 005 000 cubic metres per year.

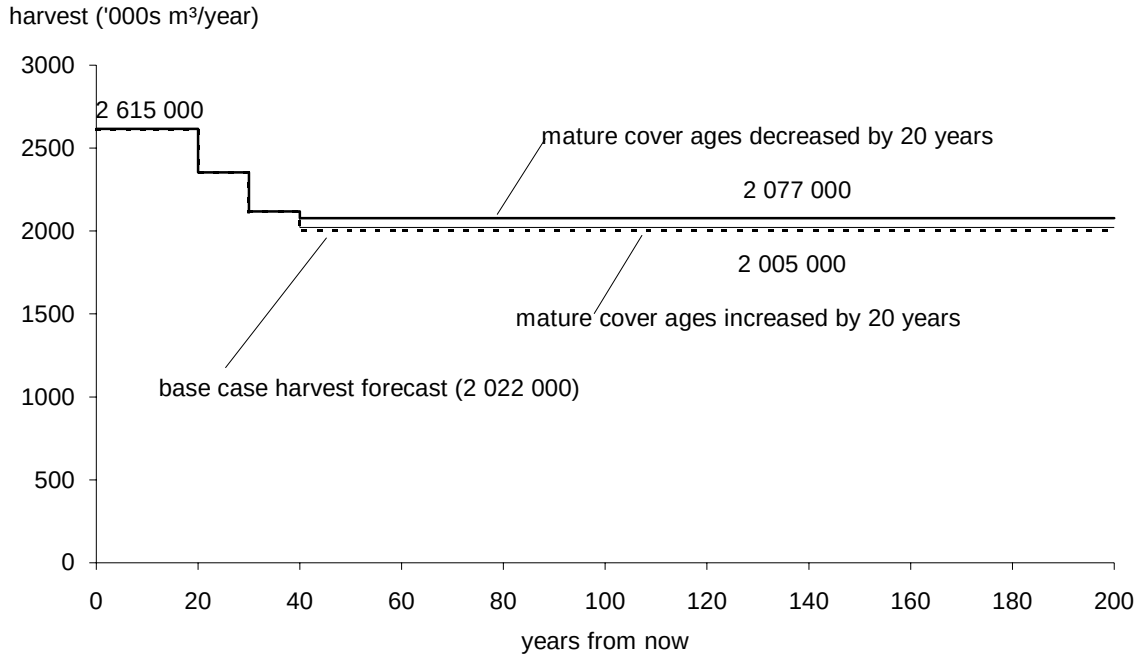

Figure 19. Harvest forecast if mature cover ages are 20 years older or younger than those assumed in the base case.

5.7 Sensitivity to uncertainty in forest cover guideline area requirements

Forest cover guidelines limit the amount of area that can be less than the green-up age or require a minimum amount of the area be older than a specified age. The timber supply effects of changes in these limits are discussed below. Analyses were done in which the percentage of area was increased or decreased by 5%. For example, a forest cover guideline that ensured that no more than 35% of the area could be below 28 years of age would be relaxed so that no more than 40% of the area could be younger than 28 years or the guideline could be tightened so that no more than 30% of the area could be younger than 28 years.

5.7.1 Maximum area below green-up ages

The green-up area requirement was relaxed by increasing the area requirements by 5% for all management zones. Figure 20 shows the results. The initial harvest rate can be maintained for 40 years before declining to a long-term level of 2 047 000 cubic metres per year, 1% above the base case long-term level.

Tightening the green-up area requirement by decreasing the area requirements by 5% for all management zones has a much larger effect on initial harvest rates. The harvest rate for decades 1 and 2 must fall to 2 082 000 cubic metres per year, 20% below the base case. As shown in Figure 20, this reserves some growing stock which may be harvested beginning 30 years from now where the harvest level increases to 2 545 000 cubic metres per year. The harvest level then declines to the long-term level of 1 904 000 cubic metres per year 60 years from now, 6% below the base case long-term level.

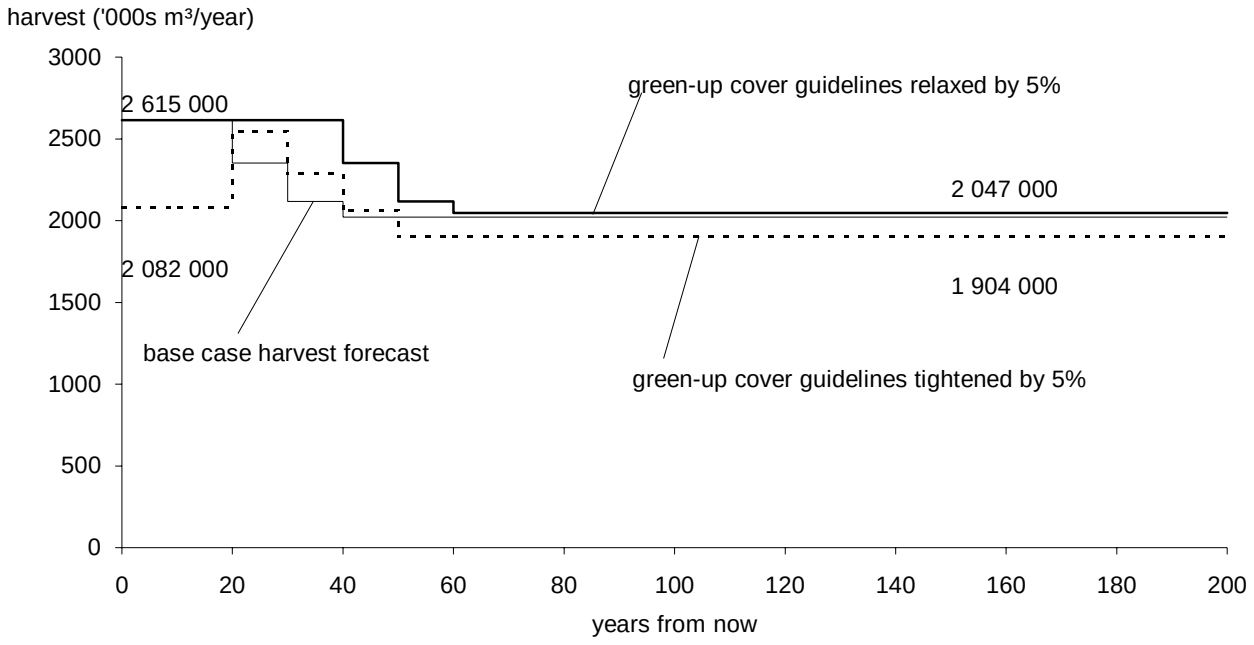

Figure 20. Harvest forecast if green-up area requirements are 5% higher or lower than those assumed in the base case.

5.7.2 Maximum area over old age criteria

Sensitivity testing was undertaken by increasing or decreasing by 5%, the area required to be over the old age criteria in each management zone. As shown in Figure 21, neither an increase or a decrease had any effect on the short-term harvest forecast. Relaxing the old age constraint allowed the long-term harvest level to increase to 2 101 000 cubic metres per year, a 4% increase over the base case. Tightening the old age constraint caused the long-term harvest level to decrease to 1 956 000 cubic metres per year, 3% below the base case long-term level.

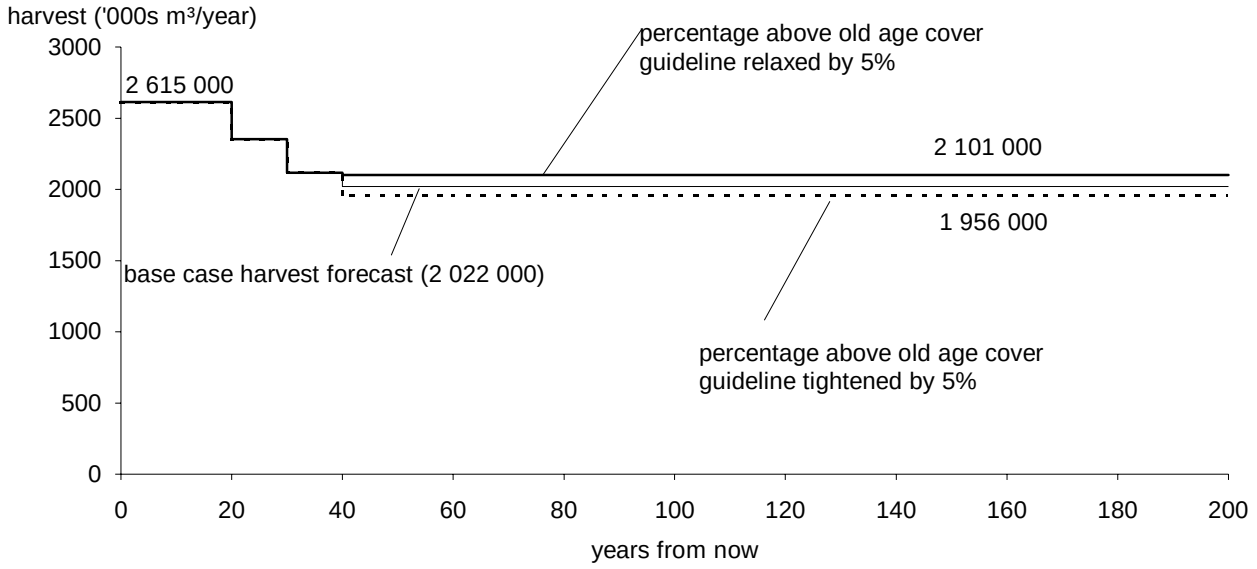

Figure 21. Harvest forecast if old age criteria requirements for each management zone are 5% higher or lower than those assumed in the base case.

5.8 Sensitivity to area requirements for individual zones

Sensitivity analyses were done to determine the timber supply effects of altering forest cover guideline area requirements within individual zones. Testing was only performed on the maximum area allowed to be below green-up age as in Section 5.7.2. Varying the minimum area allowed to be over the old-age critierion, showed only minimal effects. Community watershed, landscape, timber emphasis, and ungulate winter range zones were evaluated. The effects of relaxing or tightening the area requirement by 5%. The community watershed zone showed no change from the base case when the constraint was relaxed by 5% and only a minor shortfall in the long-term level (2 016 000 cubic metres per year) when the constraint was tightened by 5%. The ungulate winter range zone showed no change from the base case. Because these zones showed no change, the following discussion focuses on the landscape and timber emphasis zones.

5.8.1 Maximum area below green-up ages — Timber emphasis zone

In relaxing the maximum area allowed to be below green-up age from 35% to 40%, there was no change from the base case harvest forecast. When the area constraint was tightened to 30% however, the initial harvest rate declined. As shown in Figure 22, the harvest level for the first 2 decades is reduced to 2 417 000 cubic metres per year, 8% below the base case. The harvest level then increases to 2 579 000 cubic metres per year in 30 years from now as the growing stock reserved in the first 2 decades can be harvested. The harvest level then declines to the base case long-term level of 2 022 000 cubic metres per year.

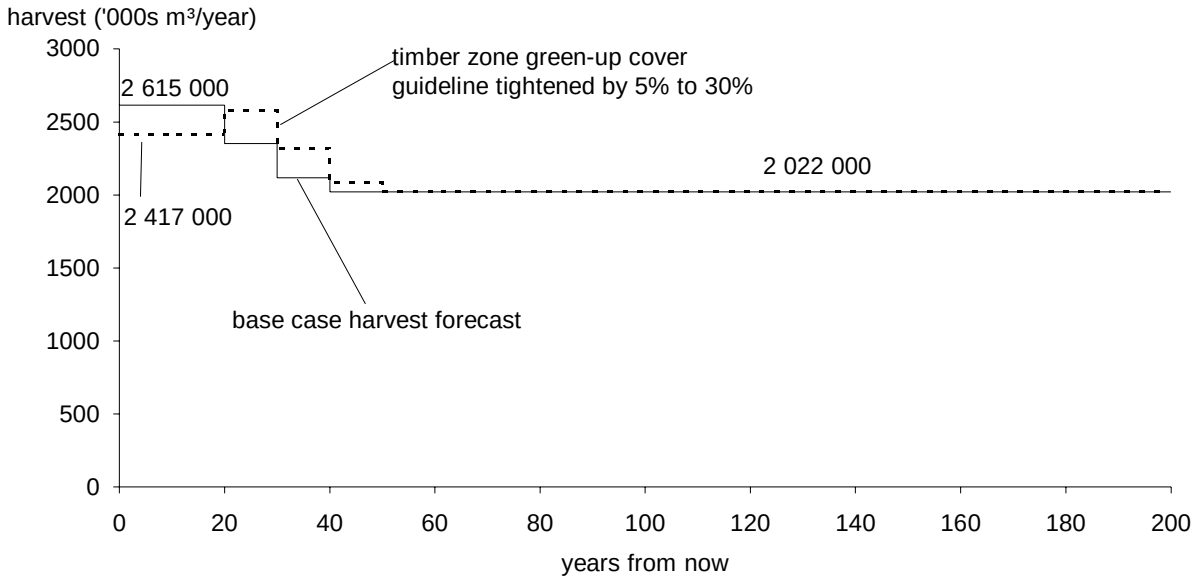

Figure 22. Harvest forecast of the green-up cover guideline for the timber emphasis zone is 5% lower than that assumed in the base case.

5.8.2 Maximum area below green-up ages — landscape management zone

As illustrated in Figure 23, relaxing the green-up cover guideline to 20% from 15% allowed the initial harvest rate to continue for 40 years. The harvest level then declines by 10% to the long-term-level of 2 047 000 cubic metres per year, 1% above the base case. Decreasing the green-up cover guideline to 10% from 15% still allows the initial harvest rate to be maintained for 1 decade. Thereafter, the harvest level declines by 10% and the long term level of 1 914 000 cubic metres per year, 5% below the base case, is achieved 40 years from now.

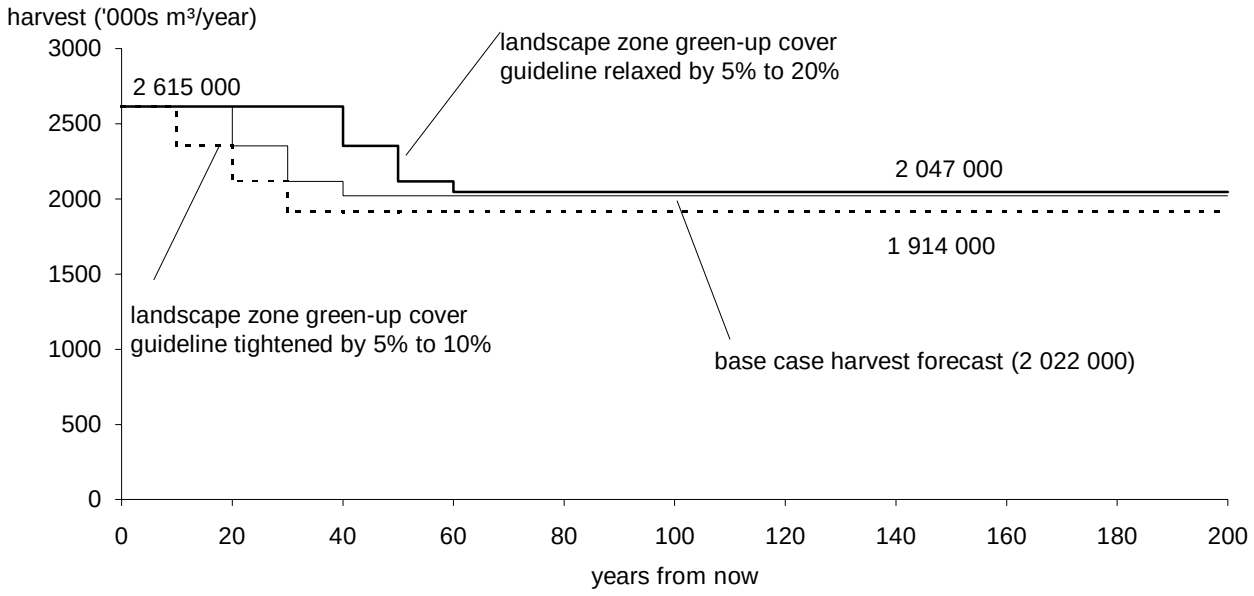

Figure 23. Harvest forecast if the green-up cover guideline for the landscape management zone is 5% higher or lower than that assumed in the base case.

5.9 Sensitivity to basic forest cover guidelines

Because the application of forest cover guidelines is new in timber supply analysis, there is an interest in knowing the timber supply effects of these guidelines. These forest cover guidelines are meant to approximate spatial harvesting rules that in the past have not been accounted for adequately. To determine the overall effect of all the specific forest cover guidelines applied to each management zone, a harvest forecast was produced where all zones, with the exception of the selection zone, had the same cover constraints applied. It was assumed that no more than 35% of any zone could be below a 3 metre green-up height. There was no constraint applied to the amount of area that would be required in old-growth. These constraints are considered to be the minimum limits that would be applied if there were no individual integrated resource management zones. The green-up forest cover guideline describes a harvesting system where an average block size of 30 hectares with a buffer width of 400 metres is allowed. The 3-metre green-up height is the minimum requirement to ensure adequate regeneration on adjacent blocks.

Figure 24 illustrates the harvest forecast with the changes outlined above. The initial harvest level can be maintained for 40 years. The long-term harvest level of 2 153 000 cubic metres per year is 6% above the base case. This harvest forecast is somewhat similar to those in Figure 20 and 23 where forest cover guidelines are so relaxed that they are no longer binding. The results of this analysis are governed by the desire for a reasonable rate of decline to and never below the long-term level.

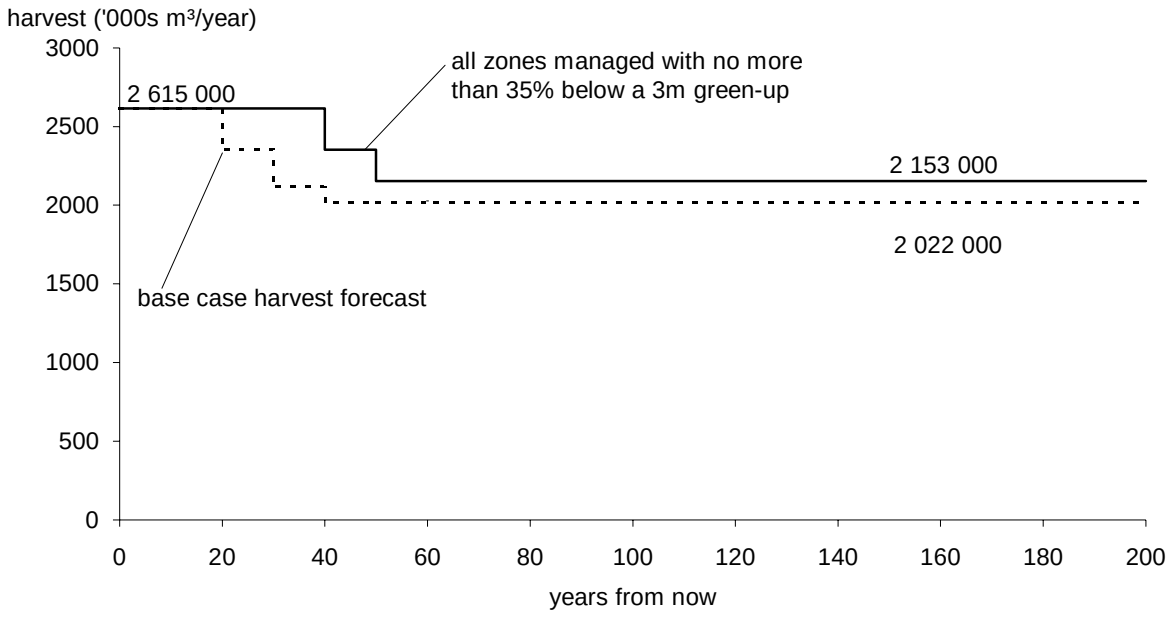

Figure 24. Harvest forecast with all zones at the basic forest cover guidelines.

6 Summary and Conclusions

The analysis for the Okanagan TSA indicates that given current management assumptions, an initial harvest of 2 615 000 cubic metres per year can be maintained for 20 years. Harvests then begin to decline by 10% per decade until the long-term harvest level of 2 022 000 cubic metres per year is reached 40 years from now.

Although the present AAC can be maintained for another 20 years, the mountain pine beetle epidemic in the southern portion of the Okanagan TSA has resulted in the AAC being increased temporarily to 2 804 000 cubic metres per year. This temporary AAC can only be maintained for 10 years followed by 10% declines per decade to the long-term level 30 years from now.

Table 2 summarizes the range of initial harvest levels discussed in this report. These harvest levels apply to the timber harvesting land base as defined. Changed forest management assumptions, and land base additions or withdrawals would change the values in Table 2.

Table 2. Summary of initial harvest levels for the Okanagan TSA

Harvest forecast	Section	Initial harvest level (m3/year)	Years maintained
Base case, current AAC	4.1	2 615 000	20
Maximum harvest	4.4	2 809 000	10
Long-term harvest violation	5.1	2 855 000	10
Long-term harvest	5.1	2 222 400	80
10% lower existing volumes	5.3	1 820 000	60
Green-up period increased 5 years	5.6.1	2 456 000	10
Green-up requirements increased 5%	5.7.1	2 082 000	20
Timber zone green-up increased 5%	5.8.1	2 417 000	20

This analysis employs the best estimates of all variables used to describe forest management in the Okanagan TSA. However, many of the estimates contain some degree of uncertainty. Short-term timber supply is mainly sensitive to volume estimates for existing stands, and would be affected by tighter forest cover requirements. Higher yield estimates for existing stands permit the present AAC to be maintained for up to 60 years. Decreased estimates for existing stand volumes cause the initial harvest rate to decline by 30%. Relaxed forest cover requirements permit the AAC to be maintained for 40 years while tighter forest cover guidelines cause the initial harvest rate to drop by 6%. Changes in regenerated stand yields have no impact on short-term harvest rates although the long-term harvest is significantly affected. A brief summary of the factors which have significant short- or long-term impacts on the harvest forecast are shown in Table 3.

6 Summary and Conclusions

Table 3. Summary of impacts of sensitivity analyses.

Sensitivity analysis	Varied by	Refer to Figure	Impact		
			Low	Medium	High
Minimum harvest ages	20 years	14		----------	
Existing stand volumes	10%	15			----------
Regenerated stand volumes	10%	16	----------		
Regeneration delay	0 or 10 years	17	----------		
Green-up requirements	5 years	18		----------	
Old age requirements	20 years	19	**----------**		
Forest cover requirements	5%	20, 21		----------	
Individual zone requirements	5%	22, 23		----------	
Minimum cover requirements	no constraints	24		----------	

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B.C. Ministry of Forests. 1987. Okanagan Timber Supply Area Timber Supply Analysis Information Report. Kamloops, 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 Section 7 of the *Forest Act*.

Environmentally sensitive area — An area with significant non-timber values, fragile or unstable soils, problems in 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 and a database describing the location and nature of forest cover, including size, age, timber volume, and species composition as well as a description of additional forest values such as recreation and visual quality.

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

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

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

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

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

Rehabilitation — The conversion of potentially productive land which is presently occupied by undesirable species to a condition appropriate for establishing desired tree species.

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 Section 6 of the *Forest Act*.

Appendix A
Description of Data Inputs and Assumptions

Introduction

The following sections outline the methods and inputs used to derive the timber harvesting land base and to construct the timber supply model data set for the timber supply analysis of the Okanagan TSA. 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 is currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced, are not included here. Changes in forest management, when and if they occur, will be included in subsequent timber supply analyses after the Timber Supply Review has been completed.

A.1 Management Zone and Analysis Unit Definitions

A.1.1 Definition of management zones

The timber harvesting land base in the Okanagan TSA is divided into management zones on the basis of differences in forest cover guidelines and management practices. Although all zones are managed according to the principles of integrated resource management each zone has its priority management consideration as follows:

- Selection management zone
  Priority management consideration: selection harvesting of dry fir species types;

- Deferral zone
  Priority management consideration: managing for old-growth, wilderness and recreation values;

- Landscape management zone
  Priority management consideration: managing for Visual Quality Objectives (VQOs);

- Ungulate winter range zone
  Priority management consideration: maintaining the winter range resource for ungulates;

- Community watershed zone
  Priority management consideration: maintaining the water resource;

- Timber harvest emphasis zone
  Priority management consideration: managing for the long-term optimum harvest of timber.

The above zones are listed in descending order of the stringency of their guidelines. Where zones overlap, the zone with the most stringent guidelines will apply. Management within the selection zone meets the requirements for all of the zones, except Deferrals.

The Deferral zone encompasses the areas within approved Local Resource Use Plans (LRUPs) where decisions have been made to defer logging for consideration of wilderness values, old-growth preservation and recreation use. These areas include:

- Graystoke Recreation Reserve Area (Zone 1);

- Old-growth sites in the Upper Shuswap River Integrated Resource Management Plan (USRIRMP); and,

- Greenbush Wilderness Study Area (As defined in the USRIRMP)

These areas have had extensive public input into the decision making process. The areas identified will remain within the operable land base, but their timber supply will not contribute to the allowable annual cut during the deferral period.

A.1 Management Zone and Analysis Unit Definitions

A.1.2 Definition of analysis units

An analysis unit (AU) represents a group of similar stands. Generally an AU contains stands that possess similar tree species compositions and similar timber growing capabilities. In the inventory file the major combinations of species are called type groups. Timber growing capability, or site quality, is indicated by a site class.

The site class is an interval into which the site index range is divided for the purpose of classification and use. The site index is an expression of the forest site quality of a stand, at a specified age and height.

For the Okanagan TSA, analysis units were assigned using new site class (NSITE) or, where available, special site class (SSITE). Special site is a field corrected site class that can be assigned when the normal site class does not reflect site quality.

The six management zones were divided into analysis units based on several species/site combinations as detailed in Table A-1. Within the species groups, site classes were combined based on the relative area of each site class within the proposed type groups and the similarities of the species site class yield curves.

A.1 Management Zone and Analysis Unit Definitions

Table A-1. Analysis units

Forest Management Zone	Analysis Units	Inventory Type Group	Forest Inventory Zone	Site Class
Selection Silviculture System	1	1-8, 32 (Dry Fir)	•FIZ D and FIZ E, PSYU 124 and 187	G,M,P
Landscape management	2	1-8, 33, 34 (Wet Fir)	•1-8 of FIZ G and FIZ E, PSYU 126	G M, P
	3			
	4	9-17 (Cedar/Hemlock)	•Entire TSA	G, M, P
	5	Cedar/Hemlock > 140 yrs.	•Entire TSA	G, M, P
	6	18-26 (Balsam/Spruce)	•Entire TSA	G M,P
	7			
	8	18-20 (Balsam) > 140 yrs.	•Entire TSA	G, M, P
	9	28-31 (Lodgepole Pine)	•Entire TSA	G M, P
	10			
Ungulate Winter Range	11	1-8, 33, 34 (Wet Fir)	•1-8 of FIZ G and FIZ E, PSYU 126	G M, P
	12			
	13	9-17 (Cedar/Hemlock)	•Entire TSA	G, M, P
	14	Cedar/Hemlock > 140 yrs.	•Entire TSA	G, M, P
	15	18-26 (Balsam/Spruce)	•Entire TSA	G M,P
	16			
	17	18-20 (Balsam) > 140 yrs.	•Entire TSA	G, M, P
	18	28-31 (Lodgepole Pine)	•Entire TSA	G M, P
	19			

G = Good; M = Medium; P = Poor

A.1 Management Zone and Analysis Unit Definitions

Table A-1. Analysis units (cont.)

Forest Management Zone	Analysis Units	Inventory Type Group	Forest Inventory Zone	Site Class
Community	20	1-8, 33, 34	•1-8 of FIZ G and FIZ	G
Watershed	22	(Wet Fir)	E, PSYU 126	M, P
	23	9-17	•Entire TSA	G, M, P
		(Cedar/Hemlock)		
	24	Cedar/Hemlock	•Entire TSA	G, M, P
		> 140 yrs.		
	25	18-26	•Entire TSA	G
	26	(Balsam/Spruce)		M,P
	27	18-20 (Balsam)	•Entire TSA	G, M, P
		> 140 yrs.		
	28	28-31	•Entire TSA	G
	29	(Lodgepole Pine)		M, P
Timber Production	30	1-8, 33, 34	•1-8 of FIZ G and FIZ	G
	31	(Wet Fir)	E, PSYU 126	M, P
	32	9-17	•Entire TSA	G, M, P
		(Cedar/Hemlock)		
	33	Cedar/Hemlock	•Entire TSA	G, M, P
		> 140 yrs.		
	34	18-26	•Entire TSA	G
	35	(Balsam/Spruce)		M,P
	36	18-20 (Balsam)	•Entire TSA	G, M, P
		> 140 yrs.		
	37	28-31	•Entire TSA	G
	38	(Lodgepole Pine)		M, P

G = Good; M = Medium; P = Poor

A.1 Management Zone and Analysis Unit Definitions

Table A-1. Analysis units (cont.)

Forest Management Zone	Analysis Units	Inventory Type Group	Forest Inventory Zone	Site Class
Deferral (50 years)	39	1-8, 33, 34	•1-8 of FIZ G and FIZ	G
	40	(Wet Fir)	E, PSYU 126	M,P
	41	9-17 (Cedar/Hemlock)	•Entire TSA	G, M, P
	42	Cedar/Hemlock > 140 yrs	•Entire TSA	G, M, P
	43	18-26	•Entire TSA	G
	44	(Balsam/Spruce)		M,P
	45	18-20 (Balsam) > 140 yrs.	•Entire TSA	G, M, P
	47	28-31	•Entire TSA	G
	48	(Lodgepole Pine)		M, P

G = Good; M = Medium; P = Poor

Table A-2 shows the timber harvesting land base for each management zone by analysis unit.

Table A-2. Timber Harvesting Land Base by Management Zone and Analysis Unit

Analysis Unit	Selection	Deferral	Landscape	Ungulate	Water-Shed	Timber	Total ha
Dry Fir (GMP)	111 864						111 864
Wet Fir (G)		189	24 471	11 675	2 500	35 295	74 130
Wet Fir (MP)		498	41 299	16 247	7 845	54 762	120 651
Cedar/Hem (GMP) < 140 YRS		194	10 575	3 467	875	26 517	41 628
Cedar/Hem (GMP) >140 YRS		930	9 507	3 340	1 616	28 800	44 193
Bal/Spruce (G)		531	3 737	888	4 108	13 501	22 765
Bal/Spruce (MP)		2 023	26 427	5 215	26 112	111 308	171 085
Balsam (GMP) >140YRS		4 383	11 693	1 873	8 165	46 966	73 080
Lodgepole Pine (G)		35	9 269	3 644	13 617	24 791	51 356
Lodgepole Pine (MP)		498	48 549	10 674	74 664	110 636	245 021
Total Ha	111 864	9 281	185 527	57 023	139 502	452 576	955 773

Note: The table above describes the timber harvesting land base, before additions to the land base for NSR, timber licence reversions, and rehabilitation of problem forest types.

A.2 Definition of the Timber Harvesting Land Base

The timber harvesting land base was determined by first deducting from the total TSA area, all areas considered to be currently unavailable for timber harvesting. Additions to the land base such as NSR areas which will be rehabilitated to productive forest, timber licence reversions and rehabilitation of problem forest types, were then added back in to establish the current timber harvesting land base. Harvesting operations will subsequently result in the removal of some land base because of long-term productivity losses associated with future roads, trails and landings. All these categories are summarized below in Table A-3 and Table 1 of the main report.

Table A-3. Timber harvesting land base, Okanagan TSA 1992

Classification	Area (ha)	Area (ha)	% of total area	% of productive forest area
Total Land base		2 173 271	100.00	
Non-Crown land		414 755	19.08	
Non-forest land		355 206	16.34	
Total productive forest		1 403 309	64.57	100.00
Reductions to productive forest:				
Inoperable	115 112		5.30	8.20
Low quality site	11 797		0.54	0.84
Environmentally sensitive	43 298		1.99	3.09
Deciduous types	33 669		1.55	2.40
Problem forest types	120 013		5.52	8.55
Non-commercial cover	5 196		0.24	0.37
Riparian areas	15 003		0.69	1.07
Roads, landings, and trails	38 138		1.75	2.72
Not satisfactorily restocked	65 310		3.01	4.65
Total current reductions	447 536	447 536	20.59	31.89
Current productive land base		955 773		
Additions to productive forest:				
Not satisfactorily restocked	65 310			
Timber Licence reversions	17 096			
Rehabilitation	900			
Total additions	83 306	83 306	3.83	5.94
Total productive land base		1 039 079	47.81	74.04
Future roads, landings, and	67 461	67 461	3.10	4.81
Long-term productive land base		971 618	44.71	69.24

A.2 Definition of the Timber Harvesting Land Base

This section provides the information used to define the timber harvesting land base in the order shown in Table A-3.

A.2.1 Inventory file status

Inventory surveys were carried by Public Sustained Yield Units (PSYU) as follows:

PSYU	Date of inventory survey
Adams	1968
Ashnola	1969
Barton Hill	1970
Eagle	1971
Spallumcheen	1972
Okanagan	1975
Kamloops	1977
Kettle	1977
Salmon Arm	1978
Shuswap	1979

These PSYUs, in whole or in part, were combined to form the Okanagan TSA. Forest Cover polygon information (age, age class, height, height class, stocking class and identity code) is projected to 1993.

A.2.2 Non-Crown, non-forest areas

All areas not designated as being ownership 62C (Crown forest management unit available for long-term integrated resource management), 69C (Miscellaneous reserves available for long-term integrated resource management) were excluded from the timber harvesting land base.

A.2 Definition of the Timber Harvesting Land Base

In addition, any area with a type identity of 8 (no typing available) was excluded. Non-forested and non-commercial (brush) areas, designated on the inventory file as type identity 6 and 5, respectively were also excluded from the timber harvesting land base. Table A-4 shows the distribution of the land base by ownership.

Table A-4. Distribution of total area by ownership

Ownership Code	Description	Area ha	Reduction due to Alienated Area ha	Area Remaining after all Reductions ha
40	Crown Grant	297806.5	297806.4	0.0
50	Federal Lands	865.6	865.6	0.0
52	Indian Reserve	65161.7	65161.6	0.0
60	Ecological Reserve	898.6	898.6	0.0
61	Use, Recreation and Enjoyment of the Public	5410.7	5410.7	0.0
62	Crown Forest Management Unit	1694954.3	169.3	924395.7
63	Provincial Park Class 'A'	2431.0	2431.0	0.0
65	Provincial Park Class 'C'	41.0	41.0	0.0
67	Provincial Park Special or Reserve	68.8	68.8	0.0
69	Government Reserves	73699.7	9969.5	31377.5
70	Crown Timber Alienated	20962.1	20962.1	0.0
75	Christmas Tree Permit Area	147.5	147.5	0.0
76	TFL - Crown & TFL Owners and Unreported	1665.1	1665.1	0.0
77	Woodlots - Crown Portion	8878.8	8878.8	0.0
99	Miscellaneous Leases	279.2	279.2	0.0
Totals:		**2173270.6**	**414755.3**	**955773.2**

A.2 Definition of the Timber Harvesting Land Base

A.2.3 Reductions to the productive forest

A.2.3.1 Inoperable areas

The operable land base is defined as the area where current conventional and cable harvesting methods could be implemented without detriment to the site. The area must also be capable of supporting a productive forest.

Operability lines were established in the Okanagan TSA according to the following process:

1. TRIM data (contour information) was processed onto forest cover maps;
2. Areas with soil instability (ES), avalanche concerns (Ea) and swamps were identified;
3. TRIM data, was used to develop slope classifications:

0%	---	30%
31%	---	50%
51%	---	70%
71%	---	+

4. Using the above information and aerial photographs, preliminary operability lines were established; and
5. Operability lines were reviewed by Forest Service and forest industry staff and adjustments were made where necessary.

A.2.3.2 Environmentally sensitive areas

Table A-3 summarizes the area reductions prescribed for environmentally sensitive areas (ESAs).

Table A-5. Per cent area reductions for ESAs

ESA Code	ESA Description	Per cent area Reduction
Ep	Regeneration Problems	90%

The ESA value Ep is used to describe those areas which have regeneration problems. In most cases, these areas are high elevation stands where the establishment of new stands is hindered by the unpredictable and severe climate. Due to this factor, it is assumed that only 10% of these areas can be considered as areas contributing volume to the AAC. As improved silviculture techniques develop, and re-establishment of these stands becomes more assured, this per cent area reduction will decrease.

ESAs for severe soil and steepness problems (Es) and severe snow chute and avalanche problems (Ea), have been replaced in this analysis by the exclusion of inoperable areas (see Section A.2.3.1). This approach has been taken since the operability survey of the Okanagan TSA removes (from the available land base) those areas no longer considered suitable for harvesting, due to soil conditions, steep slopes and avalanche chutes.

ESAs for areas where recreational values are exceptionally high (Er), areas of critical importance to wildlife (Ew), and areas where water values are exceptionally high (Eh) have been replaced with forest cover constraints on analysis units within the landscape, ungulate winter range and community watershed zones. These changes allow for more realistic modelling of environmental concerns.

A.2.3.3 Deciduous, non-merchantable and non-commercial cover

Some stands are not currently utilized because they either cannot be harvested economically or they contain mostly non-commercial tree species. Examples include older stands that contain low net timber volumes or poor quality trees and stands dominated by deciduous species. Areas of low site quality and where lodgepole pine stands fail to reach a specified height at a certain age are also excluded. Table A-6 lists the problem forest types for the Okanagan TSA.

Table A-6. Reductions for Deciduous, Non-Merchantable and Non-Commercial Cover

Type Group or Species	Criteria					% Area Excluded
	Site Class	Stocking Class	Age Class	Height Class	Height (m)	
35-42 All deciduous						100%
1-34 All coniferous	Low					100%
1-34	Poor	R				95%
12-17 Hemlock leading (He vol. ≥60% of total vol.)			8 and 9			100%
1-27, 32-34 All species except Lodgepole pine 28-31			≥6	1 and 2		100%
Lodgepole pine leading		4				100%
28-31			≥5		≤18.5	100%
28-31			4		≤12.7	100%
28-31			3		≤9.5	100%
28-31			2		≤5.0	100%

A.2.3.4 Exclusion for riparian areas

A total of 15 003 ha (1.5% of the operable land base) was excluded to account for management practices in Riparian areas (as documented in the Okanagan TSA Integrated Resources Management Guidelines for Timber Harvesting).

This percentage was based on a sample of 18 map sheets in the TSA. GIS was used to establish a buffer around all streams and swamps and then the following assumptions were used to determine the riparian area reduction:

1. The riparian management subzone is 20 metres wide on either side of the stream or swamp.
2. All land base reductions (as per data package) were applied to the 20-meter buffer to avoid double counting of land base reductions such as problem forest types.
3. 50% of the area can be selection harvested (i.e. maintain 50% crown closure).
4. 10% of the streams on the 1:20 000 forest cover maps are over 0.6 metres in width and serve a catchment basin >1,500 hectares.
5. Swamp complexes are greater than 2 hectares.
6. No harvesting is permitted within the riparian management subzone on those streams listed in Appendix 4 of the *Okanagan TSA Integrated Resource Management Timber Harvesting Guidelines.*

A.2.3.5 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 too small to meet inventory typing criteria and therefore are not accounted for in the inventory file. To account for this loss in the area available for timber harvesting a 12% reduction was applied to all areas younger than 40 years (the areas assumed to have a timber harvesting history). A reduction of 1.5% is applied to all areas greater than 40 years to account for roads established in these areas to access the currently harvested sites.

A.2.3.6 Identification of not satisfactorily restocked areas

All areas designated as NSR as derived from the History Records System (HRS) and the Major Licence Silviculture Information System were mutually excluded from the land base (the additions are described in Section A.2.4.1).

A.2.4 Addition to the productive forest

A.2.4.1 Restocking of not satisfactorily restocked areas

All NSR both current and backlog, is assumed to be restocked within 10 years, therefore these areas are added back into the timber harvesting land base. Table A-7 summarizes the total area of current and backlog NSR existing in the timber harvesting land base for the Okanagan TSA. NSR areas were distributed between management zones and analysis units in the same proportions as exist for the timber harvesting land base.

Table A-7. Not Satisfactorily Restocked (NSR) Areas

Analysis unit by species type and site class:

	Wet Fir	Wet Fir	Cedar/He	Bal/Spruce	Bal/Spruce	Pine	Pine	Total
Backlog NSR								
Landscape	167	453	622	130	1 337	415	1 884	5 008
Ungulate	51	138	190	40	408	126	574	1 527
Watershed	125	337	463	97	995	309	1 402	3 728
Timber	407	1 102	1 515	318	3 255	1 010	4 587	12 195
Total Backlog	750	2 030	2 790	585	5 995	1 860	8 448	22 458
Current NSR								
Landscape	217	589	806	168	1 732	536	2 440	6 488
Ungulate	66	180	246	51	528	164	744	1 979
Watershed	162	438	600	125	1 289	399	1 816	4 830
Timber	529	1 434	1 963	410	4 216	1 306	5 940	15 799
Total Current	975	2 640	3 616	755	7 765	2 405	10 940	29 096
TOTAL ALL	1 725	4 670	6 406	1 340	13 760	4 265	19 388	51 554

A.2 Definition of the Timber Harvesting Land Base

Since the silviculture HRS and MLSIS provides a more accurate estimate of NSR areas than the Forest Inventory Planning (FIP) file the difference between the two (12 229 ha) was added back into the FIP file on a prorated basis according to Table A-8.

Table A-8. Additions of Backlog and Current NSR to the FIP File

Analysis unit by species type and site class:

	Wet Fir (G)	Wet Fir (MP)	Cedar/Hem (GMP)	Bal/Spruce (G)	Bal/Spruce (MP)	Pine (G)	Pine (MP)	Total ha
Current and Backlog NSR								
Landscape	112	202	341	96	711	222	1,044	2,727
Ungulate	34	62	104	29	217	68	318	832
Watershed	83	150	254	71	529	165	777	2,030
Timber	272	492	830	233	1 732	540	2,541	6,640
TOTAL ha	**501**	**906**	**1 529**	**430**	**3 189**	**994**	**4 680**	**12 229**

A.2.4.2 Timber licence reversions

Table A.9 summarizes the area of timber licences reverting to the Crown for the Okanagan TSA. These lands are added to the operable land base as they are harvested on a decade by decade basis until all lands are reverted in 50 years time. Until the time of reversion, the land and its associated volumes are not included in the TSA analysis.

Table A-9. Timber licence reversions

Species Type	Area of TLs reverting (ha)					Total Area (ha)
	Years until reversion					
	0-10	10-20	20-30	30-40	40-50	
Wet Fir (G)	217	148	348	119	77	909
Wet Fir (M,P)	486	330	776	265	172	2 029
C/H (G,M,P)	2 320	522	3 446	1 706	1 740	9 734
S/B (G)	67	10	130	30	73	310
S/B (M,P))	856	127	1 651	385	932	3 951
Pl (G)	26					26
Pl (M,P)	150					150
Total Area	**4 122**	**1 137**	**6 351**	**2 505**	**2 994**	**17 109**

A.2 Definition of the Timber Harvesting Land Base

The procedure for determining Timber licence (TL) reversions is as follows:

1. Areas in TLs is determined from Forest Inventory Planning (FIP) files.
2. Land base reductions are performed for non-productive areas, deciduous, non-commercial, future roads, and Not Satisfactorily Stocked (NSR) areas.
3. NSR areas are then re-introduced into the 0-10 years until reversion category on the assumption that these areas will be satisfactorily restocked by the year 2000.

The total timber licence reversions were divided up into the landscape zone (22.3%), ungulate winter range zone (6.8%), community watershed zone (16.6%), and the timber production zone (54.3%).

A.2.4.3 Rehabilitation of non-commercial areas

Table A-10 identifies the area of non-commercial brush cover (Alder) that will be rehabilitated back to productive land and therefore added back to the timber harvesting land base.

Table A.-10. Rehabilitation of Non-Commercial Brush Cover

Species type	PFTs OR NC Brush	
	Area (ha)	Rate of Restocking (ha/decade)
Spruce/Balsam	900	900

It was assumed that the rehabilitation would occur on good sites only.

A.2.5 Future Roads, trails and landings

As future harvesting occurs there will be associated losses in productive area due to roads, trails and landings. All existing stands currently over 40 years old will be subject to an 8.1% loss. The total deduction of 8.1% is based on the *Soil Conservation Guidelines for Timber Harvesting - Interior B.C.* and is comprised of the following:

1. roads and landings - 7%
2. skid roads and trails - 2.6%
3. a 1.5% reduction was made on areas age classes 3 and above to account for existing roads and landings. (see Table C-4).

The area that will eventually be lost is not mutually excluded from the land base. The B.C. Forest Service timber supply model simply reduces the areas by 8.1% the first time all stands over 40 years old are harvested.

A.3 Volume Exclusions

A.3.1 Volume exclusions for mixed species types

Table A-11 summarizes the per cent volume exclusion of less desirable or unmerchantable species to be excluded from mixed species types.

Table A-11. Volume Exclusions for Mixed Species Types

Inventory Type Group	Volume excluded from type group	% Volume exclusion for This species
27 Pw or Pa	Pa volume component	100%
1-34	deciduous volume component	100%
12-17 hemlock leading	H vol. component of age class 8 and 9 where the H vol. < 60% of total vol.	100%
9-11 and 19-20 all non-H leading except deciduous	H volume in age class 8 and 9	100%
18-20 balsam leading	age class 8 and 9	25%

Since the balsam leading stands are not made up of 100% balsam volume but include other species as well the weighted average contribution of balsam volume to balsam leading stands was used to determine the volume exclusion. It was found that balsam leading stands contain, on average 69% balsam volume. Therefore, (69 x .25 = 17) the actual volume exclusion was 17%.

A.3 Volume Exclusions

A.3.2 Unsalvaged volume losses

Unsalvaged losses are timber volumes destroyed or damaged by natural causes such as fire and disease. Estimated annual losses are deducted from the gross timber supply to determine the projected net volumes that will be harvested over time. Table A-12 shows the estimated average annual loss for the Okanagan TSA.

Table A-12. Unsalvaged volume losses

Cause of loss	Annual unsalvaged loss in cubic metres/years
Insects	99 480
Wind Damage	22 000
Fire	3 430
Other	1 700
TOTAL	**126 610**

Mountain pine beetle attack accounts for 83% of the unsalvaged losses due to insects with the majority of the loss in the southern portion of the TSA. Balsam bark beetle and Spruce bark beetle accounted for the remainder. Losses due to wind damage occurred primarily in small scattered patches and along the edges of existing cutblocks and were based on discussions with forest district protection and timber staff. Fire losses were based on 10 year averages. Unsalvaged seed tree losses accounted for other losses.

A.4 Forest Management Assumptions

A.4.1 Utilization Levels

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

The utilization level currently practised in the Okanagan TSA is 12.5 cm minimum diameter at breast height for lodgepole pine and 17.5 cm minimum diameter at breast height for all other species.

A.4.2 Minimum harvest ages for each analysis unit

Table A-13 lists the minimum harvest age for each analysis unit. Minimum harvest ages are based on Forest District cutting priorities weighted by area for each species type in each district and do not necessarily reflect biological culmination ages. Impacts of different harvest age assumptions on timber supply were evaluated using sensitivity analysis in Section 5.2.

Table A-13. Minimum Harvest Area for Each Analysis Unit

Species type	Minimum harvest age (years)
Wet Belt Fir	**110**
Cedar/Hemlock	**102**
Balsam/Spruce	**113**
Lodgepole Pine	**80**

A.4.3 Harvest profile

Table A-14 lists the current harvest profile for the Okanagan TSA. This profile is compared with the modelled harvest profile in Section 4.0 of the report.

Table A-14. Harvest Profile

Species type	Per cent of total harvest
Dry Belt Fir and Py	1.0%
Wet Belt Fir	11.4%
Cedar/Hemlock	12.4%
Spruce/Balsam	29.3%
Lodgepole Pine	45.9%
	100%

A.4 Forest Management Assumptions

A.4.4 Forest cover requirements

Table A-15 specifies the forest cover requirements needed to achieve the forest management objectives for each zone. There are two types of forest cover guidelines:

1. The first is a green-up forest cover guideline. The guideline is stated in terms of a maximum area that can be less than a green-up age.

2. The second is an old growth guideline. This guideline is stated in terms of a minimum amount of area that must be over a prescribed age. The term old growth is used for labelling purposes.

Table A.15 also shows the present status of each management zone relative to the forest cover guidelines prior to any harvesting. All the forest management zones mutually meet the forest cover requirements.

Selection harvesting satisfies all forest cover requirements. In the deferral zone, once the deferral period is over the forest cover requirements will be as per the timber zone.

Table A-15. Forest Cover Guidelines by Management Zone

	Green-up forest cover guideline					Old-growth forest cover guideline				
Zone	% Gross area	% ECA Net operable area	Minimum Height (m)	Tree Age (yrs)	Current Per cent	% Gross Area	Net Operable Area	Minimum Height (m)	Tree Age (yrs)	Current per cent
Landscape	11.4%	15%	6	25	13.1		5%		141	30.6
Ungulate Winter Range		20%	3	16	7.9	40%	27%	20	75	75.3
Community Watersheds	20%	26%	6	26	16.3		5%		141	29.2
Timber Production	30%	35%	6	28	16.5		5%		141	41.6
Deferrals		35%	6	33	0.6		5%		141	79.3

ECA = Equivalent Clear-cut Area

A.4.4.1 Forest cover guideline for green-up

The green-up requirements in the Okanagan TSA Integrated Resource Management Guidelines for Timber Harvesting (OkTHG) stipulate a Maximum Equivalent Clear-cut Area (ECA) percentage for community watershed (20%), fisheries sensitive watershed (25%) and timber emphasis watersheds (30%). ECA refers to the amount of harvested forest land within a watershed which hydrologically acts like a clear-cut. The guideline is intended to minimize the risk of damaging changes to the hydrograph.

The process for determining the maximum per cent ECA for the green-up forest cover guideline is as follows:

1. Assign initial ECA percentages as stipulated above, to each zone;
2. Since ECA in the OkTHG is based on the gross land area, adjust the percentage for each zone by the ratio of total gross area (not including private land) to operable area. Where guidelines apply directly to the net operable area (i.e. ungulate winter range), this adjustment is not required;
3. Based on average clear-cut size and reserve width for each zone, determine the maximum achievable ECA;
4. The maximum per cent ECA younger than tree height, will be the lower of (2.) or (3.) above (i.e. for the timber harvest zone, the gross to net area adjustment resulted in an ECA of 41%. However, since the maximum achievable ECA given an average 30 hectare block and 400-meter reserve width, is 35%, this is the figure used in Table A.15).

The maximum ECA of 25% for fisheries sensitive watershed, when adjusted to the net operable land base, exceeded that of the timber zone. This is due to the fact that, on average, over 50% of the fisheries sensitive watersheds are inoperable. This has the effect of buffering the watershed and therefore allows for a higher percentage ECA on the remaining operable land base. For this reason, the fisheries zone was combined with the timber harvest emphasis zone and weighted by area.

ECA is based on the hydrological recovery of the stand which, in turn, is determined by an equivalent tree height. The age to reach minimum tree height was determined using regenerated stand yield curves.

Based on work completed by the Southern Interior Watershed Assessment Committee, 8 metres is interpreted as the tree height necessary for a stand to reach hydrological recovery. Hydrological recovery (8 metres), is only a concern on the snow pack portion of a watershed which, in the Okanagan, constitutes, on average, 60% of the watershed areas. On the remaining 40% of the watershed (non-snow pack), a green-up criteria of 3 metres is required before adjacent clear-cut areas can be harvested. For the purposes of modelling, a weighted average of 6 metres [(0.6 x 8m) + (0.4 x 3m)] will be used as the tree height that represents both adjacency and hydrological recovery on all watersheds.

The ungulate winter range is primarily below the snow pack, therefore a 3-meter minimum tree height is designated for this zone. An ECA of 20% (applied to the operable land base) is necessary in order to meet the clear-cut harvesting guidelines (i.e. a maximum of 5 hectares with 300-metre reserves).

Based on the OkTHG and a study entitled Visually Effective Green-up (Silvatech, 1992), 6 metres is the tree height recovery that will be used to model visual green-up in the landscape zone. For the purposes of modelling visual green-up, ECA will represent the visible portion of cutblocks. The maximum percentage ECA in the landscape zone is 15%. This was determined by:

1. Estimating the area of each visual quality objective (VQO) in the landscape zone;
2. Using the midpoint ECA for each VQO, calculating an area weighted average ECA for the entire zone (11.4%); and
3. Adjusting the percentage by the ratio of total to operable forested area (non-productive types do not contribute to visual green-up).

A 15% ECA is within the range of a partial retention VQO.

A.4.4.2 Old-growth forest cover guideline

The OkTHG states that 10% of forest producing sites should be maintained as old growth at any one time. It further states that distribution should be such that at least 10% of each 4000 hectare unit is managed as old growth where it exists, with the minimum old growth unit being greater than 50 hectares. For the purposes of this timber supply analysis, this number has been adjusted to 5% of the operable land base, to account for the old growth that is in parks, ecological reserves, inoperable areas, and other reductions to the forested land base.

The minimum age of old growth is considered to be 141 years. This is consistent with the *Old Growth Strategy for British Columbia*. The old-growth criteria will be applied to all zones, except the wildlife ungulate winter range. For this zone, 40% of the winter range will be retained in stands of a 20-meter minimum height. The mature cover height constraint is then adjusted by the ratio of gross to net operable area to account for inoperable forested areas that meet this requirement.

A.4 Forest Management Assumptions

A.4.5 Basic Silviculture and Regeneration Assumptions

Table A-16 shows what species are regenerated once existing areas are harvested and basic silviculture activities take place and specifies the expected regeneration delay following harvesting.

Table A-16. Regeneration Assumptions

Species Type	Regenerated Species Type	Regen Delay(s) (years)
Dry Belt Fir	75% Dry Belt Fir 25% Pl	N/A
Wet Belt Fir	50% Wet Belt Fir 30% Pl 10% Sx/Bl 10% Cw/Hw	4
Cedar/Hemlock	50% Wet Belt Fir 20%Sx/Bl 20%Pl 10%Cw/Hw	4
Spruce/Balsam	90% Sx/Bl 10%Pl	4
Lodgepole Pine	90% Pl 10% Wet Belt Fir	5

Four years was used as a regeneration delay for all types, except lodgepole pine. It was felt that these regeneration delays would adequately allow for normal reforestation practices as well as flexibility for plantation failures and difficulties in obtaining the proper planting stock.

A.4 Forest Management Assumptions

A.4.6 Yield Estimates for Existing Stands

A batch version of the Variable Density Yield Prediction (VDYP, version 4.2b) model, developed by the Inventory Branch of the B.C. Forest Service, was used to project volume yields for existing stands. The batch VDYP model provides a complete volume curve for every forest stand in the timber harvesting land base, based on the species composition, height, age, stocking and geographic location of the stand. These curves are then aggregated into the analysis unit curves in Table A-17, by averaging the individual curves, weighted by the area of each stand that makes up the analysis unit.
The regenerated stand yield volumes generated from TIPSY are listed in Table A.20.

Table A-17. Yield Estimates for Existing Stands - VDYP

	Dry Fir GMP	Wet Fir - Good	Wet Fir - Med/Poor	Cedar Hemlock - GMP<141	Cedar Hemlock - GMP>140
Age					
0	0	0	0	0	0
10	0	0	0	0	0
20	0	0	0	0.01	0
30	0.54	6.41	0.83	2.67	0.57
40	7.60	35.93	15.38	27.37	14.59
50	23.37	72.74	41.08	61.11	40.68
60	43.26	109.80	68.91	95.26	67.23
70	63.91	145.97	96.70	126.32	91.69
80	84.06	180.72	123.66	154.82	114.48
90	103.45	212.5	148.95	176.19	131.18
100	122.05	241.27	172.78	193.64	144.59
110	139.80	266.93	194.97	208.01	155.38
120	155.55	289.16	214.34	219.22	163.46
130	170.48	311.53	233.19	236.17	177.20
140	183.77	332.02	250.01	252.22	190.74
150	195.42	349.26	264.20	267.00	203.37
160	205.67	364.32	276.47	280.61	215.17
170	214.61	377.31	286.95	293.05	226.12
180	223.19	389.08	296.58	304.88	236.74
190	231.15	400.22	305.56	316.00	246.92
200	238.94	411.04	314.38	326.94	256.91
210	246.34	421.35	322.79	337.41	266.55
220	253.35	431.19	330.80	348.54	277.05
230	259.99	440.59	338.45	359.38	287.39
240	266.29	449.59	345.76	369.87	297.48
250	272.29	458.23	352.76	380.02	307.33
260	272.56	458.74	353.32	382.33	308.56
270	272.80	459.20	353.83	384.49	309.69
280	273.00	459.60	354.3	386.51	310.75
290	273.16	459.97	354.73	388.35	311.73
300	273.29	460.31	355.12	390.05	312.64
310	273.39	460.62	355.46	391.64	313.50
320	273.45	460.90	355.77	393.11	314.31
330	273.48	461.16	356.03	394.49	315.07
340	273.48	461.39	356.26	395.79	315.80
350	273.45	461.60	356.45	397.01	316.48

Table A-17. Yield Estimates for Existing Stands - VDYP (cont'd)

	Spruce Balsam - Good	Spruce Balsam - Med/Poor	Balsam GMP >140	Lodgepole Pine - Good	Lodgepole Pine - Med/Poor
Age					
0	0	0	0	0	0
10	0	0	0	0	0
20	0	0	0	0.33	0.13
30	1.82	0.25	0.07	29.85	4.31
40	21.54	2.87	2.84	83.95	33.43
50	73.73	11.88	14.30	131.67	71.48
60	123.98	28.61	31.69	173.53	106.77
70	169.25	50.71	54.32	210.16	138.58
80	209.45	75.77	72.81	242.45	167.22
90	243.57	99.94	89.03	271.87	193.96
100	272.98	122.73	103.64	298.59	218.70
110	298.47	144.09	116.90	323.07	241.68
120	320.40	163.86	128.91	345.69	263.16
130	341.78	183.33	141.95	367.16	283.59
140	360.17	201.06	154.52	381.52	297.51
150	376.36	217.82	166.47	392.48	308.40
160	390.63	233.25	177.84	400.25	316.33
170	403.16	247.37	188.69	404.84	321.31
180	414.26	260.29	199.05	405.12	322.65
190	424.05	272.11	208.95	406.43	323.40
200	433.46	293.35	218.49	407.54	325.21
210	442.16	293.86	227.65	410.28	328.01
220	450.20	303.71	236.48	413.13	330.84
230	457.67	312.96	244.97	415.96	333.6
240	464.61	321.63	253.14	418.73	336.25
250	471.05	329.78	261.02	421.39	338.76
260	473.92	334.36	262.57	423.35	340.80
270	476.50	338.59	264.01	425.20	342.68
280	478.83	342.50	265.38	426.93	344.41
290	480.90	346.10	266.65	428.52	345.97
300	482.76	349.43	267.83	429.99	347.37
310	484.41	352.49	268.95	431.33	348.62
320	485.89	355.32	270.01	432.54	349.71
330	487.20	357.93	271.00	433.62	350.64
340	488.37	360.31	271.92	434.58	351.43
350	489.39	362.50	272.80	435.41	352.08

A.4 Forest Management Assumptions

A.4.7 Yield Estimates for Regenerated Stands

The weighted average VDYP curves for existing stands were reviewed to determine if they adequately reflected the yield projections of managed stands in the Okanagan TSA. It was agreed that, with the exception of Analysis Unit 1, Dry Belt Douglas-fir, the yield curves generated by the Table Interpolation Program for Stand Yields (TIPSY) better reflected the yield expected from our managed stands. The use of TIPSY is not appropriate for use in stands that are harvested with selection methods and hence is not recommended for use in Analysis Unit 1, which is managed predominantly by selection harvesting methods.

Table A-18 identifies the area of existing immature forest that has a history of management (i.e. harvesting and regeneration) that should be assigned to a regenerated stand yield curve (TIPSY).

Table A-18. Immature Plantation History

Species Type	Area to be allocated to regenerated stand yield tables (ha)				Total ha
	Landscape Zone	Ungulate Zone	Community Watershed Zone	Timber Zone	
Wet Fir (G)	549	164	67	1 135	**1 915**
Wet Fir (M,P)	2 571	598	437	3 573	**7 179**
Ce/He (G,M,P)	1 306	354	95	3,938	**5 693**
Sp/Ba (G)	259	46	130	802	**1 237**
Sp/Ba (M,P)	2 055	471	1 511	3 178	**7 215**
Pl (G)	614	318	920	2 829	**4 681**
Pl (M,P)	5 148	919	9 407	11 558	**27 032**
					54 952

A.4 Forest Management Assumptions

Table A-19 outlines the Operational Adjustment Factors applied to the TIPSY yield curves.

Table A-19. Operational Adjustment Factors (OAF)

Species Type	Site Index	OAF 1 (%)	OAF 2 (%)	Regen. delay (yrs)
Wet Fir (G)	21	32.5	17.1	4
Wet Fir (M,P)	17	11.6	22.7	4
Ce/He (G,M,P)	16	36.5	26.8	4
Sp/Ba (G)	19	20	0	4
Sp/Ba (M,P)	11	15	5	4
Pl (G)	20	15	5	5
Pl (M,P)	16	15	5	5

Note: All species planted to 1 400 stems/hectare.

A.4 Forest Management Assumptions

Table A-20. Yield Estimates for Regenerated Stands - TIPSY

	Dry Fir GMP	Wet Fir - Good	Wet Fir - Med/Poor	Cedar Hemlock - GMP	Spruce Balsam - Good	Spruce Balsam - Med/Poor	Lodgepole Pine - Good	Lodgepole Pine - Med/Poor
Age								
0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
20	0.03	1.2	0	0	0.1	0	1.8	0
30	1.48	20.5	6.9	4.2	4.2	0	45.9	8.1
40	14.06	64.2	24.4	17.9	28.3	0.4	114.5	43.3
50	35.4	126.1	59.2	48	102.2	2.3	170.7	89.3
60	59.14	185	102.4	87.3	183.6	6.4	234	126.2
70	82.58	234.2	148.9	129.5	255	28.7	279.3	160.3
80	104.85	277.7	188.1	172.3	328.9	64.8	317.1	195.6
90	126.08	311.6	221.2	206.9	381.4	107.3	346.5	228
100	146.21	341.5	249.4	237.2	418.8	150.4	370.1	251.9
110	165.27	366.1	273.6	262.2	445.9	187.1	389.8	271.8
120	182.45	385	291.9	282.8	468.2	220.9	405.4	289.9
130	198.76	400.7	307.2	299.5	486.6	253.6	418.8	304
140	212.21	409.3	320.3	312.5	500.2	289.4	430	316.8
150	223.67	415.4	331.2	323.2	512	319.5	439.3	326.7
160	233.34	419.2	338.9	332.4	515.5	343.2	447.5	335.6
170	241.29	421.1	344.8	339.3	517.9	362.2	448	342.4
180	248.06	421.7	348	344.1	520.3	376.5	448.4	348.1
190	254.21	421.6	349.4	347.8	521.2	389.8	448.5	353.7
200	260.51	420.7	348.5	349.7	521.2	399.4	448.5	357.2
210	266.76	420.8	349.6	351.3	521.2	408.9	448.5	360.8
220	272.72	420.8	350.6	352.4	521.2	416.6	448.5	363.5
230	278.39	420.8	351.5	353.4	521.2	422.4	448.5	366.2
240	283.78	420.8	352.2	354.2	522.1	428.2	448.5	368.9
250	288.91	420.8	352.5	354.8	522.1	433	448.5	369.8
260	289.62	420.8	352.8	355.6	523	436.9	448.5	371.6
270	290.27	420.8	353.1	355.9	523	439.9	448.5	372.5
280	290.85	420.8	353.4	356.2	523	441.9	448.5	373.4
290	291.36	420.8	353.4	356.2	523.9	443.9	448.5	374.3
300	291.81	420.8	353.5	356.5	523.9	445	448.5	374.3
310	292.2	420.8	353.5	356.5	523.9	445	448.5	374.3
320	292.52	420.8	353.5	356.5	523.9	445	448.5	374.3
330	292.77	420.8	353.5	356.5	523.9	445	448.5	374.3
340	292.97	420.8	353.5	356.5	523.9	445	448.5	374.3
350	293.11	420.8	353.5	356.5	523.9	445	448.5	374.3