

Cranbrook TSA Timber Supply Analysis

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Preface

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

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

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

Assessing the implications of only current practices rather than looking at a number of different

management schemes will expedite the analysis process, allowing analysis of all TSAs in the province to be completed by early 1995. An important part of these analyses, however, is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on timber supply will form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

This timber supply analysis for the Cranbrook TSA began in June 1994. The information it contains is independent of the October 1994 East Kootenay Land Use Plan by the Commission on Resources and Environment (C.O.R.E.). Any land-use decisions by cabinet, or changes to management practices arising from the C.O.R.E. report will be included in the current management practices defined for the next Cranbrook TSA timber supply analysis, scheduled to be completed within 5 years.

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

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Cranbrook Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short (next 20 years) and long (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Cranbrook TSA covers a total area of 1.48 million hectares, including 45 000 hectares of park land not accounted for in the inventory file (i.e. Purcell Wilderness Conservancy, Elk Lakes Provincial Park, Elk Lakes Recreation Area, Top of the World Park and Akamina Kishinena Recreation Area). About 423 445 hectares of the Cranbrook TSA are available for timber harvesting under current management practices. Total current volume of operable standing timber in the area is about 54 million cubic metres, of which 44 million cubic metres are of harvestable age. The area is dominated by lodgepole pine and spruce stands with lesser amounts of Douglas-fir, larch, balsam, cedar, and hemlock stands.

For the purpose of this analysis, the AAC is assumed to be 896 136 cubic metres per year. This assumption is required as the land base from the former Tree Farm Licence (TFL) 13 is now included in the Cranbrook TSA. The former TFL 13 AAC of 27 200 cubic metres has, therefore, been added to the approved Cranbrook TSA AAC of 873 810 cubic metres for analysis purposes. The assumed AAC of 896 136 cubic metres does not include 4874 cubic metres that is apportioned to woodlots.

Current forest management of the Cranbrook TSA includes recognizing areas with significant forest resource values such as aesthetics,

wildlife, community water supply, and old growth. Range values are also accounted for in the analysis. Resource values have been accounted for by excluding some sensitive areas and applying forest cover requirements to the land base that is assumed to be available for timber harvesting and range.

Given current management assumptions, the analysis shows the assumed AAC of 896 136 cubic metres per year cannot be maintained without causing significant reductions in future harvest levels below the long-term level. The report projects that the harvest rate may have to decline by 10% immediately, then by a further 31% over the next 5 decades to 559 000 cubic metres annually. After a further 7 decades, the harvest could then rise to the long-term harvest level of about 633 000 cubic metres per year. The long-term harvest level is sustainable over the long term given current management assumptions.

Many of the data and assumptions used in the analysis are subject to varying degrees of uncertainty. As an example, the extent of the land base assumed available for timber harvesting is particularly uncertain due to potential changes in management guidelines, or through technical innovations.

Sensitivity analysis was used to examine how uncertainty about data and assumptions affect the results of the timber supply analysis.

Over the first 8 to 10 decades harvest levels are most sensitive to changes in requirements for the maintenance of old growth, more stringent forest cover requirements to account for non-timber values and changes to volume estimates for existing timber. Short-term harvest levels are also moderately sensitive to changes in minimum harvestable ages but are relatively insensitive to changes in yield estimates of future regenerated stands. The long-term harvest level is sensitive to uncertainty of regenerated stand yields and the land base assumed available for harvesting. In general, the long-term harvest level is not sensitive to uncertainty about other data and assumptions.

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Introduction

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

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

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

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

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and

socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

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

Timber supply projections made for TSAs look far into the future — 200 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* now requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply area (TSA)

An integrated resource management unit established in accordance with Section 6 of the Forest Act.

Allowable annual cut (AAC)

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

Introduction

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

The following sections outline the timber supply analysis for the Cranbrook TSA. Following a brief

description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. The report ends with a summary and conclusions.

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

Forest inventory

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

1 Description of the Cranbrook Timber Supply Area

The Cranbrook TSA covers approximately 1 470 000 hectares and is located in the southeast corner of British Columbia. It is one of seven TSAs in the Nelson Forest Region (Figure 1) and is administered from the Cranbrook Forest District office in Cranbrook. The boundaries of the Cranbrook TSA coincide with those of the Cranbrook Forest District. The TSA is bounded by the Skookumchuck Valley to the north, the United States of America to the south, the Alberta border to the east, and the Southern Purcell height of land to the west. The TSA boundary encompasses the cities of Cranbrook, Kimberley, and Fernie; the municipalities of Sparwood and Elkford; several settlement areas; a number of provincial and regional parks; and scattered parcels of private land (including managed forests 27 and 36).

The topography of the Cranbrook TSA is varied and is characterized by three major physiographic regions: the Rocky Mountains, the Rocky Mountain Trench, and the Purcell Mountains. The Rocky Mountain Trench divides the Cranbrook TSA in half with the Purcell Mountains to the west and the Rocky Mountains to the east. The trench varies in width from 5 kilometres in the north to 27 kilometres near Cranbrook. The valley floor offers high quality ungulate habitat due to its limited snowfall and low elevation (800 metres above sea level). The western side of the trench features irregular, comparatively

low foothills which gradually gain height until they merge with the extremely rugged backbone of the Purcell Mountains. In contrast, the eastern side of the trench is characterized by an abrupt rise and continuous wall broken only by tributary valleys.

The major drainage in the Cranbrook TSA is the Kootenay River which flows southward through the Rocky Mountain Trench. Its main tributaries are the Moyie River, St. Mary River, the Wildhorse River, the Bull River, and the Elk River. The Kootenay River flows across the international border near Newgate. Moyie Lake is the largest natural lake followed by St. Mary and Wasa Lakes. Lake Koocanusa forms the upper reaches of the reservoir created by the Libby Dam in the United States and at times during the late summer provides a large lake suitable for water based recreation. The Flathead River, another large drainage, flows south across the United States border in the southeast section of the Cranbrook TSA.

The Cranbrook TSA experiences a predominantly continental and semi-arid type of climate. Precipitation in the Rocky Mountain Trench is light, generally less than 40 centimetres annually. In higher elevations, however, precipitation is heavy with greater than 500 centimetres of snow annually. Prevailing winds are from the south and southwest in the summer while north winds periodically flow down the Rocky Mountain Trench in the winter.

1 Description of the Cranbrook Timber Supply Area

Figure 1. Map showing the location of the Cranbrook TSA within the Nelson Forest Region.

2 Information Preparation

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

2.1 Land base inventory

Land base inventory information used in this analysis comes in the form of a computer file prepared by the B.C. Forest Service Inventory Branch in 1994. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

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

The reduced data file is derived through a computer process that identifies information for non-contributing areas and removes it from the file. When these reductions are made, care is taken to ensure that only a single reduction is made where

categories overlap (for example, where a park area also has unstable soils).

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

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

It is important to note that the timber harvesting land base recommendations of the Commission on Resources and the Environment (C.O.R.E.) have not been included in this analysis. All study areas identified under the Protected Areas Strategy are assumed to be available for timber harvesting.

Timber harvesting land base

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

2 Information Preparation

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

- areas not managed directly by the B.C. Forest Service — this includes non-Crown land, areas managed by other agencies (for example, parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licenses);
- non-forest areas — areas not occupied by productive forest cover (for example rock, swamp and alpine areas);
- non-commercial cover areas — areas occupied by non-commercial tree or brush species;
- inoperable areas* — areas defined as unharvestable for terrain-related and economic reasons. Characteristics used in defining inoperability include steepness of slope and topography;
- environmentally sensitive areas* — a proportion of the areas considered to be sensitive were deducted;
- some sites with low timber growing potential (low site class);
- deciduous stands;
- non-merchantable forest types — stands of non-merchantable coniferous species, low quality timber or low volume;
- existing forest roads, skid trails and landings — to account for the loss of productive forest land that has occurred during past timber harvesting and development, 4.5% of the area is removed;
- not satisfactorily restocked* (NSR) areas — these areas are initially removed, but are considered available for timber production when restocked and are added back into the timber harvesting land base at that time;
- visual quality preservation — timber harvesting has not occurred in this area and in order to maintain their special values, is not expected to occur in the future;
- future forest roads, skid trails and landings — to account for future losses of productive land to development. These areas are initially included in the timber harvesting land base, but are removed after the first harvest. A maximum reduction of 4.5% of the area will be taken out (after harvest) to account for future roads, trails and landings;
- biogeoclimatic types ESSF dk-p and ESSF wm-p;
- specific areas as identified in Table A-3. in the appendix.

Table 1 summarizes the areas represented by each of the above criteria. A more detailed description of these categories and the rationale for the removals and additions are provided in Appendix A, "Description of Data Inputs and Assumptions."

Inoperable areas

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

Environmentally sensitive areas

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

Not satisfactorily restocked (NSR)

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

2 Information Preparation

Table 1. Timber harvesting land base, Cranbrook TSA

Classification	Area (hectares)	Per cent of total area	Per cent of Crown forest area
Total land base	1 427 853 ^a		
Not administered as part of timber harvesting land base ^b	255 323	17.88	
Non-forest land	387 715	27.15	
Total productive forest managed by Forest Service (Crown forest)	784 814	54.96	
Reductions to Crown forest:			
Non-commercial cover	3 495	0.24	0.45
Inoperable	208 832	14.63	26.61
Environmentally sensitive areas (ESA)	40 360	2.83	5.14
Sites with low timber growing potential	11 438	0.80	1.46
Deciduous types	6 676	0.47	0.85
Non-merchantable forest types	65 378	4.58	8.33
Existing roads, trails, landings	20 123	1.41	2.56
Not satisfactorily restocked (NSR)	44 009	3.08	5.61
ESSF park land types	4 198	0.29	0.53
Area specific reductions	869	0.06	0.11
Total reduction	405 378	28.39	51.65
Initial timber harvesting land base (less NSR)	379 436	26.57	48.35
Additions:			
Not satisfactorily restocked	44 009	3.08	5.61
Current timber harvesting land base	423 445	29.66	53.95
Future reductions:			
Future roads, trails, landings (estimate)	20 000	1.40	2.55
Future timber harvesting land base	403 445	28.26	51.41

(a) Purcell Wilderness Conservancy, Elk Lakes Provincial Park, Elk Lakes Recreation Area, Top of the World Park and Akamina Kishinena Recreation Area not included in TSA file, total TSA area is 1.48 million hectares.

(b) This category includes private land, areas under federal government jurisdiction, some provincial parks, ecological reserves, the Height-of-the-Rockies wilderness area, Christmas tree permits, and woodlot licences.

2 Information Preparation

Figure 2 shows the total Cranbrook TSA land base summarized by three major categories. The

amount of forested land managed by the B.C. Forest Service is 55% of the TSA or 784 814 hectares.

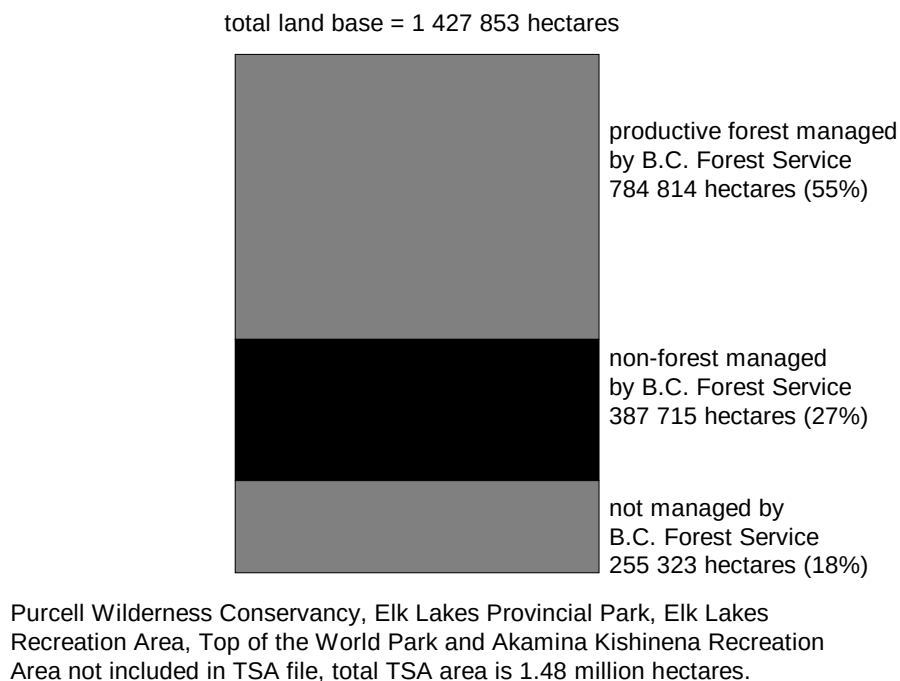


Figure 2. Total land base by major land categories, Cranbrook TSA.

2 Information Preparation

Not all of the productive forest is considered available for timber harvesting. Figure 3 shows that only 54% of the productive forest is available for timber harvesting (current timber harvesting land base plus the NSR area). This land base, referred to

as the timber harvesting land base, accounts for about 30% of the total area in the Cranbrook TSA. The largest single reduction to the productive forest land base is for inoperable areas.

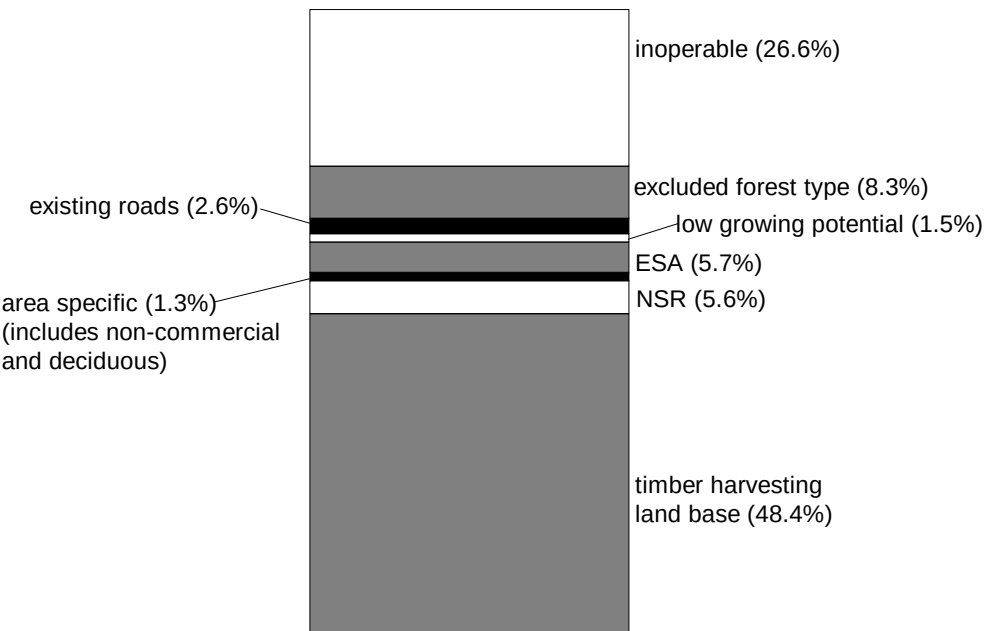


Figure 3. Classification of the productive Crown forest land base, Cranbrook TSA.

2 Information Preparation

The current timber harvesting land base of 423 455 hectares including NSR, contains significant biological, visual, and economic richness and is the focus of this analysis. Forest management activities conducted on the timber harvesting land base include: timber harvesting, silvicultural practices, maintenance of visual quality.

The timber harvesting land base contains many stands of trees of varying ages. Figure 4 shows the age distribution of these stands by 10 year classes. The

figure illustrates the limited supply of older stands. This initial age structure would tend not to allow higher harvest levels over the short term (as is the case in many other TSAs), because a relatively smaller part of the forest is now at or close to merchantable age* and a relatively large portion is currently below green-up* criteria.

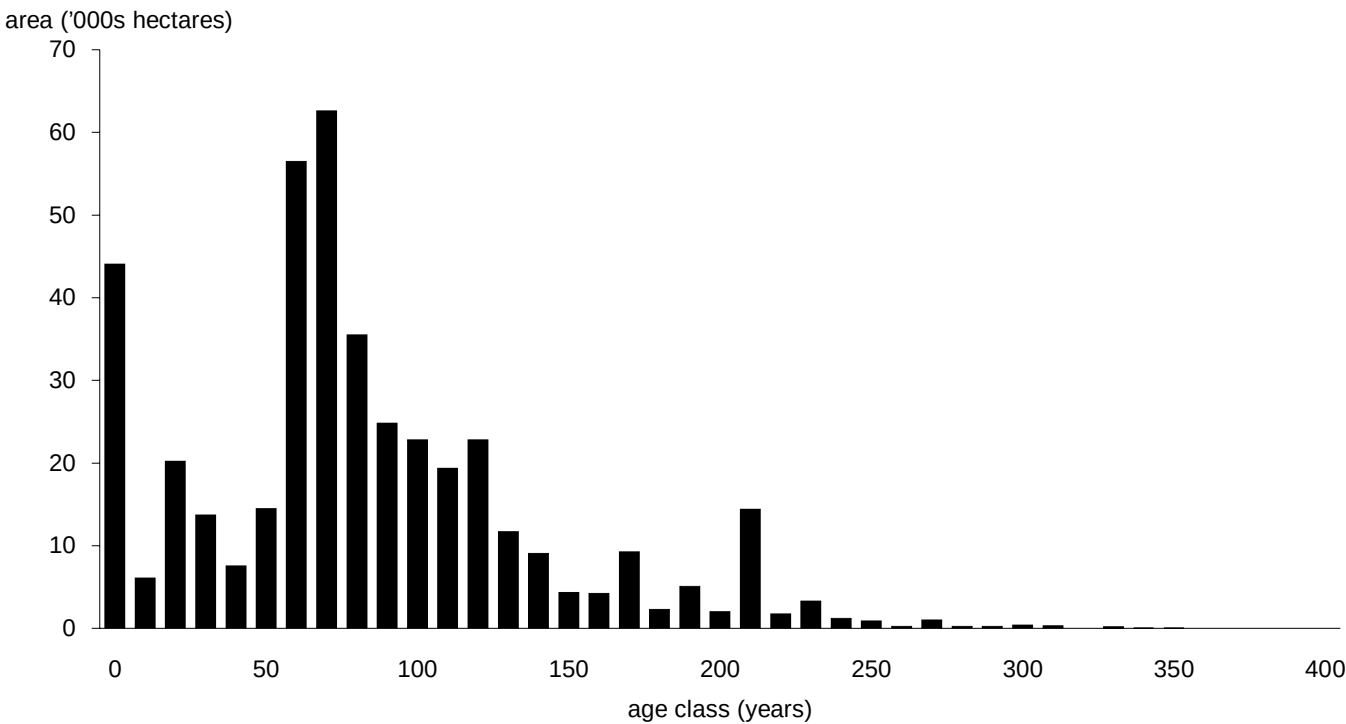


Figure 4. Current age class distribution, timber harvesting land base, Cranbrook TSA.

Merchantable age

The age at which a stand attains a minimum acceptable size, quality and/or volume to make it suitable for harvesting.

Green-up

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

2 Information Preparation

Figure 5 shows the composition of the timber harvesting land base by species and maturity. Currently, over 70% of the stands in the timber harvesting land base are less than 100 years of age.

Lodgepole pine stands under 100 years account for more than 33% of the current timber harvesting land base.

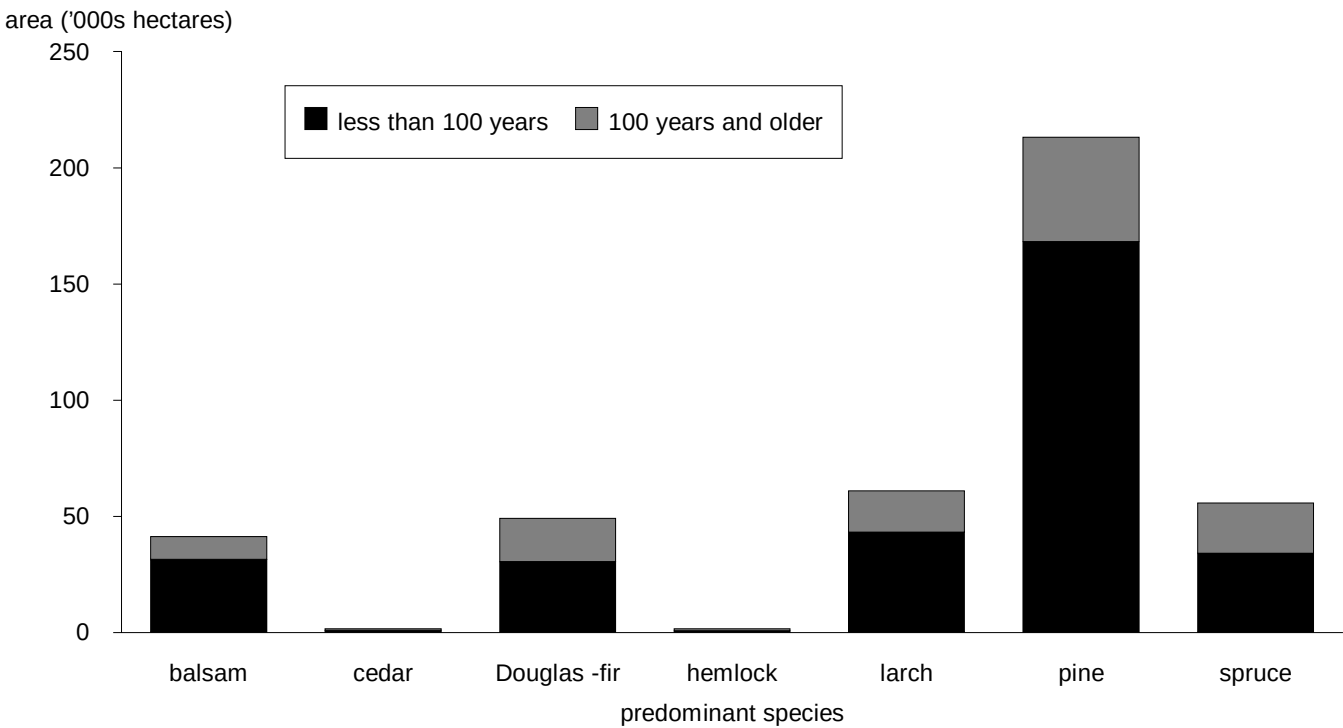


Figure 5. Current species composition, timber harvesting land base, Cranbrook TSA.

2 Information Preparation

Figure 6 shows the timber harvesting land base by site quality class. The site quality of the area is skewed towards the medium rating with almost 54%

of the area classified as medium and only 19% classified as good.

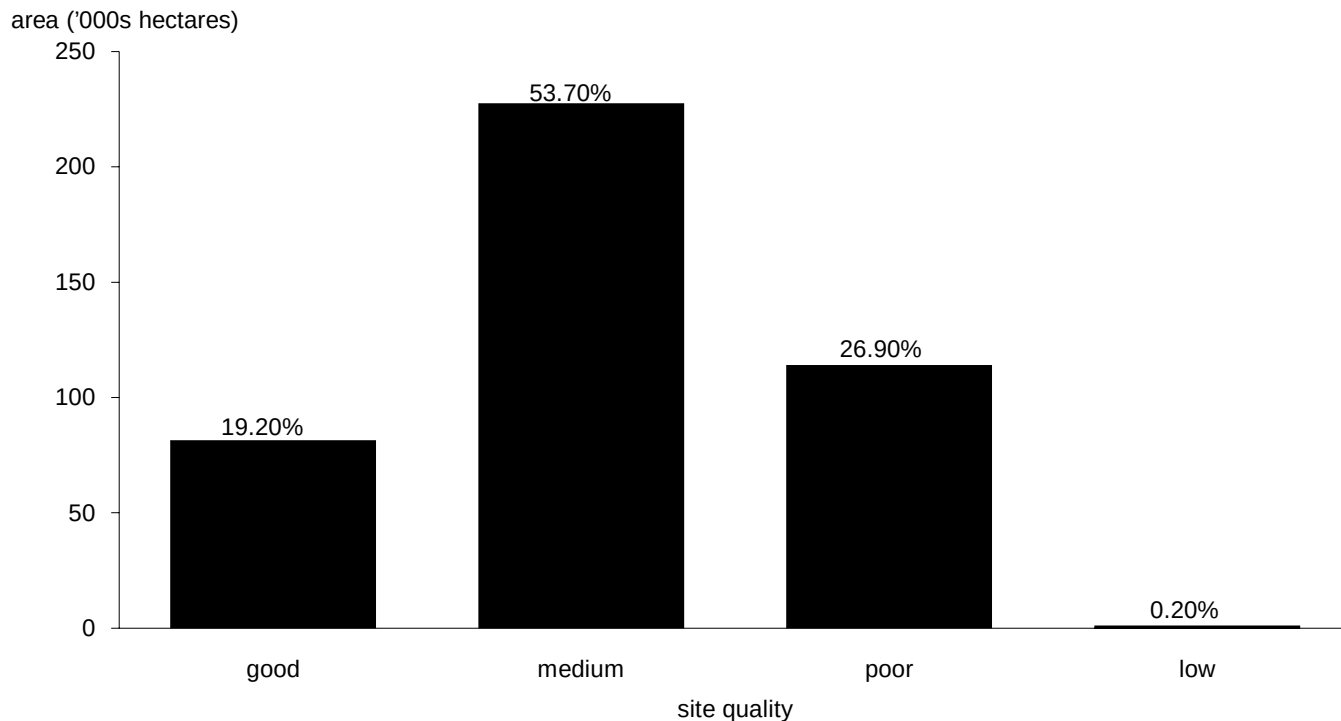


Figure 6. Area by site quality class, timber harvesting land base, Cranbrook TSA.

2 Information Preparation

2.2 Timber growth and yield

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

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

2.3 Management practices

Timber supply is directly connected to forest management activity. The focus of the Timber Supply Review is to describe the timber supply based on current management practices, as implemented in plans for the area. Staff in the Cranbrook Forest District (with regional and branch assistance) defined these practices in the following management assumptions*:

Management assumptions

Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Free-growing

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

- Basic silviculture levels — reforestation activities required to establish free-growing* stands of acceptable species. In the Cranbrook TSA, it is assumed that 15% of the total volume of a mixed pine or fir stand is reserved from harvesting. The trees reserved from harvesting not only provide seed for regeneration purposes, they also provide valuable habitat for forest dwelling animals;
- Forest health and non-recoverable losses — expected timber losses due to fire, wind damage, and pest (insect, disease and animals). For the Cranbrook TSA, non-recoverable losses are estimated to be 139 000 cubic metres per year;
- Forest cover objectives* — specify the desired distribution of areas by age class groupings. These objectives are used to specify general cutblock adjacency* guidelines as well as desired conditions for wildlife habitat, old growth, and aesthetics. There are two types of forest cover objectives:
 - old-growth forest cover guidelines — specify a minimum percentage of the forest that must be older than a prescribed age; and
 - green-up and adjacency forest cover guidelines — allow no more than a specified percentage of the forest to be younger than the green-up age. The green-up age represents the number of growing years it takes a tree to reach certain desired conditions before adjacent mature timber may be harvested. These desired conditions can be to ensure the maintenance of water quality, wildlife habitat, soil stability or aesthetics.

Forest cover objectives

Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.

Cutblock adjacency

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

2 Information Preparation

- Utilization levels — tree and log size limits describing what timber must be harvested and removed from the site. The utilization levels are presented in Appendix A, "Description of Data Inputs and Assumptions";
- Minimum harvestable ages — the time it takes for stands to grow to harvestable size. The minimum harvestable age defines the lower age 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;
- Rate of restocking of current and backlog not satisfactorily restocked (NSR) areas.

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

2.4 Management zones

This analysis recognizes the importance of forest values such as visual quality, wildlife habitat, old growth and water quality to the Cranbrook TSA by defining separate management zones for these values. Also, two zones have been defined for areas where a portion of the currently forested land is scheduled for conversion to range land.

- Landscape partial retention* zone
This zone includes visually sensitive areas along the Rocky Mountain Trench and other areas where alterations to the landscape may be visible but are not conspicuous. Effective management of partial retention areas allows a maximum of 10% of the landscape to be under cover of stands that have not reached green-up conditions. Trees 6 metres tall are considered to have met visual green-up conditions. The *Cranbrook Forest*

District Interim Old Growth Strategy require that at least 10% of the area within this zone be covered by stands older than 140 years.

- Community watershed zone

There are several licensed community watersheds in the Cranbrook TSA. These include: Mark Creek, Upper Gold Creek, Joseph Creek, Matthew Creek, Fairy Creek, Boivin Creek, Silver Spring Lake, Glencairn Creek, Cummings Creek, Reserve Creek, Blavatsky Creek, and Kimberley Creek. Management guidelines for community watershed areas allows a maximum of 25% of the area to be under cover of stands that have not reached green-up conditions. Hydrologic green-up height for community watershed areas is assumed to be 9 metres. In addition, the *Cranbrook Forest District Interim Old Growth Strategy* requires that at least 10% of the area within this zone be covered by stands older than 140 years.

- Riparian management zone

The riparian zone was defined as being 23% of the total land base, (although with subsequent reductions to Crown forest, the riparian zone accounts for about 20% of the current timber harvesting land base), based on application of the *Cranbrook Forest District Riparian Management Zone Guidelines*. Within this zone, a maximum of 35% can be less than the green-up height of 9 metres. A further requirement, to ensure mature forest cover exists, requires 25% of the zone be greater than 120 years of age at all times.

Partial retention VQO

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

2 Information Preparation

- Landscape modification* zone

This zone includes moderately visually sensitive areas along the Rocky Mountain Trench and some areas visible from Highways 3, 93 and 95. Management constraints allow a maximum of 20% of the landscape to be under cover of stands that have not reached green-up conditions. Trees 6 metres tall are considered to have met visual green-up conditions. Furthermore, the *Cranbrook Forest District Interim Old Growth Strategy* requires that 10% of this zone be maintained in trees over 140 years.

- Caribou habitat zone

This zone contains an area identified by the Ministry of Environment, Lands and Parks that is critical to the well being of caribou in the area. Current management requirements allow a maximum of 35% of the area to be under cover of stands that have not reached green-up conditions. Green-up height is assumed to be 3 metres. An additional requirement to maintain at least 12% greater than 140 years also exists.

- Forage zones

Two forage zones were identified in the analysis, a forage predominant and a forage significant zone. These zones includes areas in the East Kootenay Rocky Mountain Trench that have been prioritized for significant forage production by the *Trench Integrated Renewable Resource Management Plan* plus a portion of the Wigwam River drainage that has been targeted for increased forage production for wildlife habitat needs. Within these zones, there are no green-up requirements as these areas are scheduled for predominantly range management after harvest. The *Cranbrook Forest District Interim Old Growth Strategy*, however, requires that 6% of the forage significant zone and 3% of the forage predominant zone be maintained in trees over 140 years old.

- The timber emphasis zone (or integrated resource management zone) was subdivided by biogeoclimatic classification and geographic area into 10 areas to allow for modelling the *Cranbrook Forest District Interim Old Growth Strategy*. The 10 areas identified, based on

requirements for the maintenance of old growth, include:

- Timber Emphasis - PPdh2
3164 hectares;
- Timber Emphasis - IDFdm2
32 057 hectares;
- Timber Emphasis -- ICHmk1
86 951 hectares;
- Timber Emphasis - ICHmw2
12 442 hectares;
- Timber Emphasis - MSdk
26 754 hectares;
- Timber Emphasis - ESSFdk-S
16 745 hectares;
- Timber Emphasis - ESSFdk-E
39 450 hectares;
- Timber Emphasis - ESSFdk-W
5171 hectares;
- Timber Emphasis - ESSFwm-S
5392 hectares;
- Timber Emphasis - ESSFwm-E
4991 hectares;
- Timber Emphasis - ESSFwm-W
18 419 hectares.

At any time, 35% of each of these areas are allowed to be under cover of stands that have not reached the 3 metre green-up condition. The *Cranbrook Forest District Interim Old Growth Strategy* requires 6% old growth in ponderosa pine and interior Douglas-fir types and 10% in MS, ICH and ESSF types. These requirements, however, were revised as area reductions to the Crown forest (Table 1) will account for some of the old-growth requirement. See Appendix A, "Description of Data Inputs and Assumptions" for more detail on the old-growth adjustment.

Modification VQO

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

2 Information Preparation

Figure 7 shows the area of each zone in the Cranbrook TSA.

See Table A-2. in the appendix for more detail.

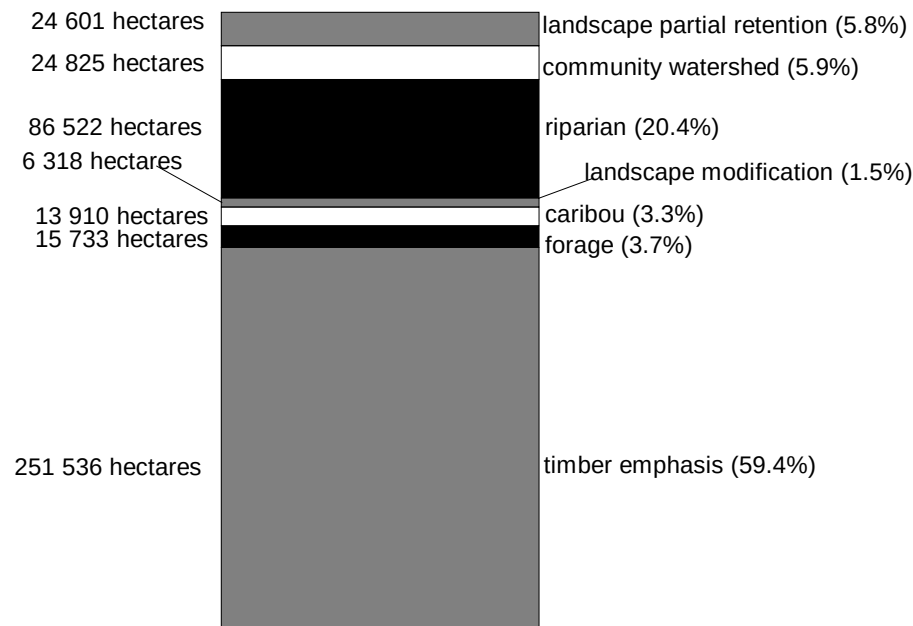


Figure 7. Breakdown of the timber harvesting land base by zone, Cranbrook TSA.

3 Analysis Methods

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

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

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

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

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

4 Results

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

4.1 Base harvest forecast

The harvest forecast*, based on current management assumptions for the Cranbrook TSA, is shown in Figure 8. This forecast is referred to as the base harvest forecast and is used as the basis for comparison for all other harvest forecasts in this report.

The harvest forecasts in this report assume an AAC of 896 136 cubic metres, this figure is based on adding the former TFL 13 AAC of 27 200 cubic metres to the approved Cranbrook TSA AAC of 873 810 cubic metres and subtracting the AAC allocation for woodlots of 4 874 cubic metres. The base harvest forecast shows an initial harvest rate of 806 000 cubic metres per year, which is about 10% lower than the assumed AAC. From this initial rate of harvest, the harvest forecast declines 10% per decade for the next 4 decades to 559 000 cubic metres per year — a level which is about 12% below the long-term level. The projected rate of harvest remains below the long-term level for 7 decades before rising to the long-term harvest level of 633 000 cubic metres per year. Overall, there is about

a 22% decline from the initial harvest level to the long-term level attained in decade 13, this also represents a 29% decrease from the assumed AAC.

The estimated unsalvaged losses to fire, wind and pest damage of 139 000 cubic metres per year have been subtracted from all harvest forecasts in this report.

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

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

As shown in Figure 8, the harvest level goes below the long-term level and remains there for several decades. This is due to the fact that volumes from regenerated stands exhibit higher volumes than existing stands. This shortfall cannot be avoided; therefore, the base harvest forecast represents a balance between the amount of time below the long-term harvest level and the harvest levels in the short-, intermediate-, and long-term.

Harvest forecast

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

4 Results

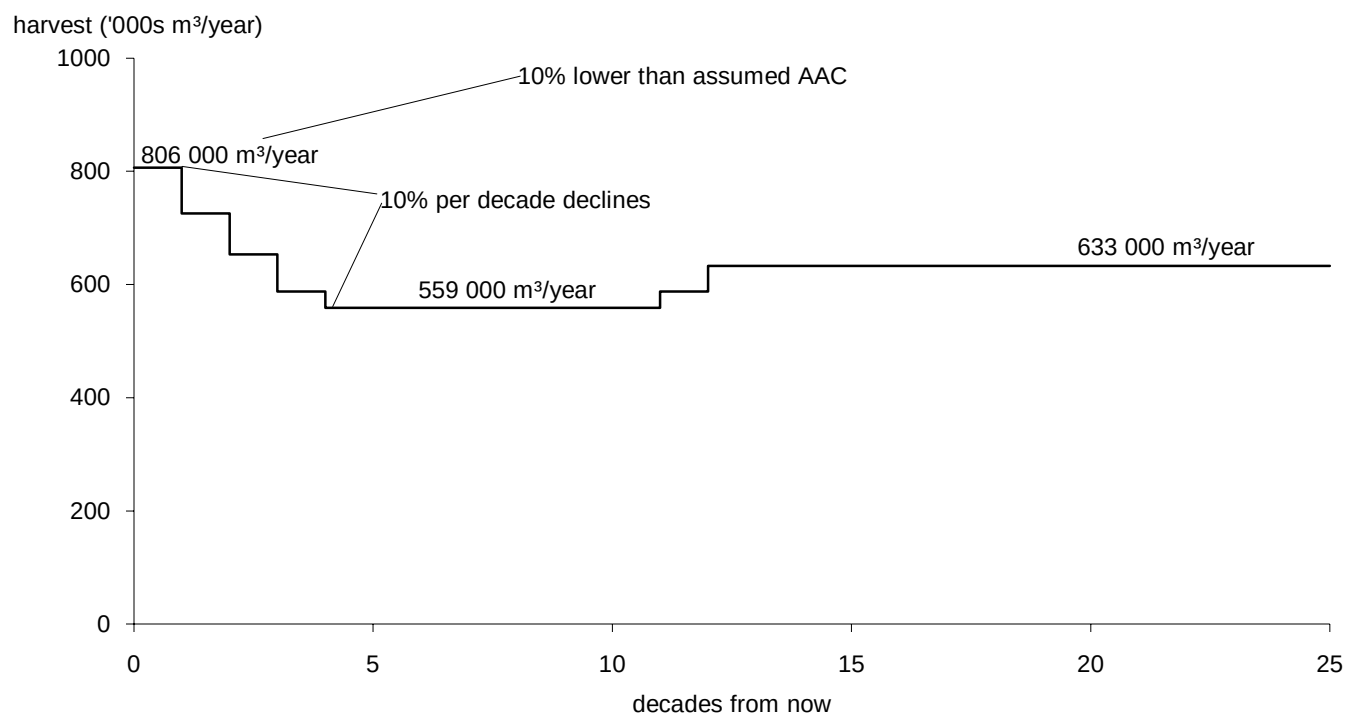


Figure 8. Base harvest forecast for the Cranbrook TSA.

It is important that the long-term harvest level not be interpreted as being the same as a theoretical maximum sustainable harvest level based on maximum mean annual increment (MAI)*. The long-term harvest level in this forecast is about 200 000 cubic metres less than the theoretical maximum long-term level of 832 000 cubic metres annually. There are several reasons why the theoretical long-term level cannot be attained. The estimate of the theoretical long term does not take into consideration the volume left standing in seed-tree silviculture systems. Secondly, forest cover requirements for values such as wildlife, visual quality, and old growth result in areas being temporarily unavailable for harvest. This has the effect of not allowing harvest at culmination and consequently lowering long-term harvest levels. Minimum harvestable ages were established at ages which are less than the age of maximum MAI. A theoretical maximum long-term level based on

minimum harvestable ages is about 94 000 cubic metres greater than the base harvest forecast long term or 727 000 cubic metres.

The base harvest forecast was defined by attempting to maintain the current harvest level for the Cranbrook TSA (896 136 cubic metres per year) for at least the next 10 years, declining around 10% in each of the following decades, and avoiding harvest shortfalls below the long-term level. As illustrated in Figure 8, this course was not possible, and adjustments were made to produce the base harvest forecast. The long-term level was defined as the harvest level that will maintain timber growing stock at an even level over the long term so that harvesting can continue at that rate in perpetuity (Figure 9). A continually declining growing stock* would signify that timber is being harvested above the productive capability of the land. Other possible harvest flows are examined in Section 5.1, "Alternative initial harvest levels and harvest flows over time."

Mean annual increment (MAI)

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

Growing stock

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

4 Results

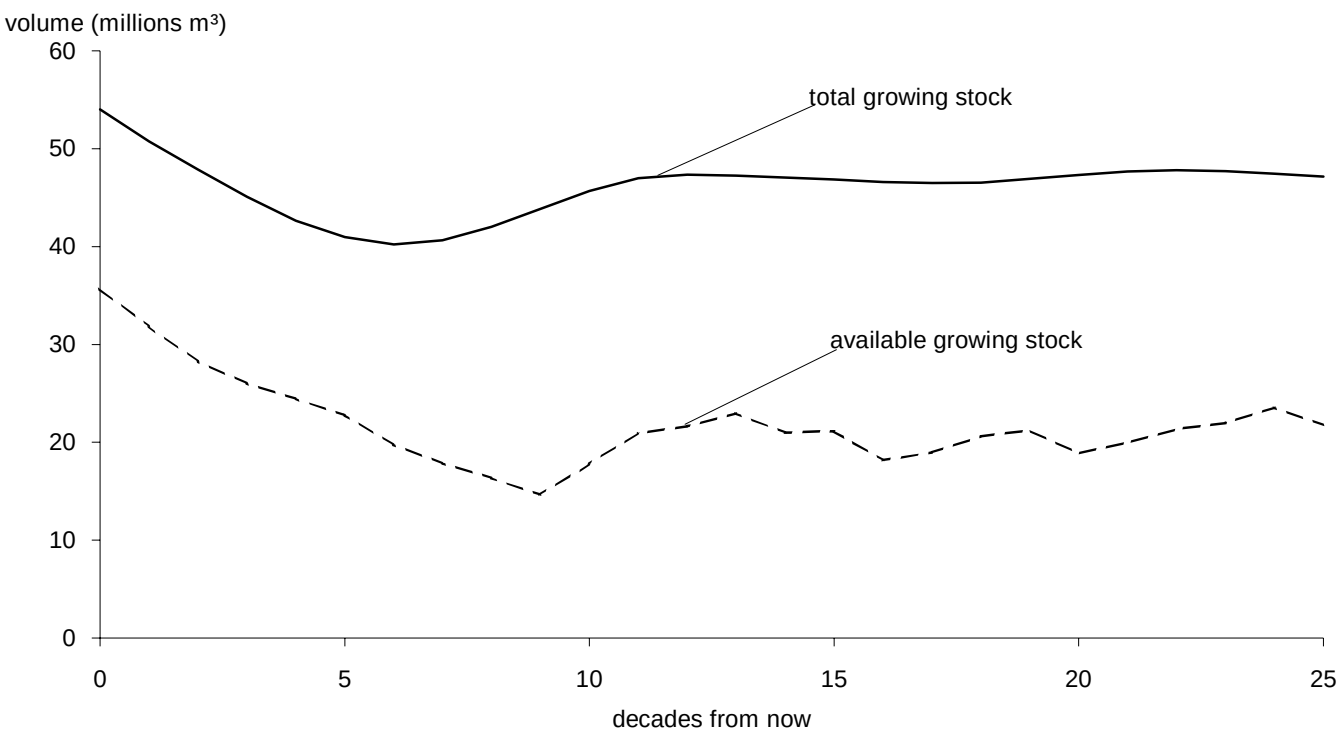


Figure 9. Total and available growing stock over time, Cranbrook TSA.

The timber harvesting land base currently contains a total of about 54 million cubic metres of standing timber (Figure 9). The dashed line indicates that about 35 million cubic metres of timber is older than the minimum harvestable ages set for each tree species. Similar to the trend seen for the base harvest forecast (Figure 8), both the total growing stock and

that above minimum harvestable age are projected to decline over the next 100 years or so before stabilizing. The trend in growing stock over time is a result of the initial harvest level being higher than the long-term level and the transition from an old forest to a younger forest.

4 Results

4.2 Area, average volume, and average age harvested

The relationship between annual volume per hectare harvested and the annual area harvested are shown in Figures 10 and 11 respectively. Figure 10 illustrates that the annual average volume per hectare harvested is initially about 270 cubic metres per hectare and oscillates several times during the next 250 years. While the trend is quite level, a high of about 270 cubic metres per hectare occurs in decade 1 while

a low of about 205 cubic metres per hectare occurs in decade 10. The oscillations are caused by older forests being unavailable for harvest due to forest cover requirements in combination with the cycling of good, medium and poor quality growing sites. The older forests are maintained until such time as younger stands have aged sufficiently to meet cover requirements. The older stands with higher volumes per hectare, would then cycle back into the available forest, thus causing the oscillations.

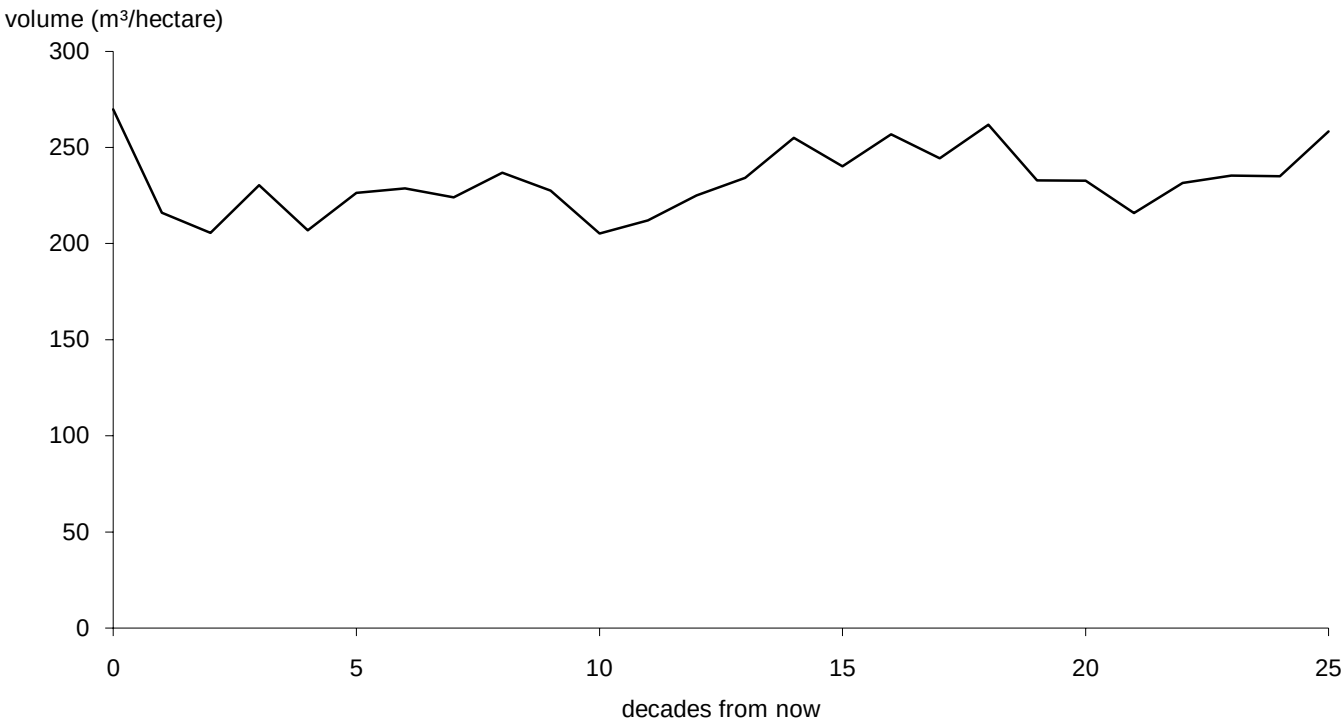


Figure 10. Average volume of timber harvested per hectare over time, Cranbrook TSA.

4 Results

Figure 11 shows that the pattern for the annual area harvested is almost the reverse of the pattern of volume per hectare harvested. Average volume per hectare harvested is high when area harvested is low, and low when area harvested is high. This relationship is expected since the timber harvest is constant at 633 000 cubic metres per year for most of the analysis horizon. The annual area harvested is initially about 3500 hectares climbing to

4000 hectares in the second decade. A low of about 2900 hectares per year comes in decade 8, when the average volume per hectare is high. When the average volume per hectare decreases, more area must be harvested to attain a given volume. It should be noted that the non-recoverable loss of 139 000 cubic metres is included in the calculation of annual area harvested.

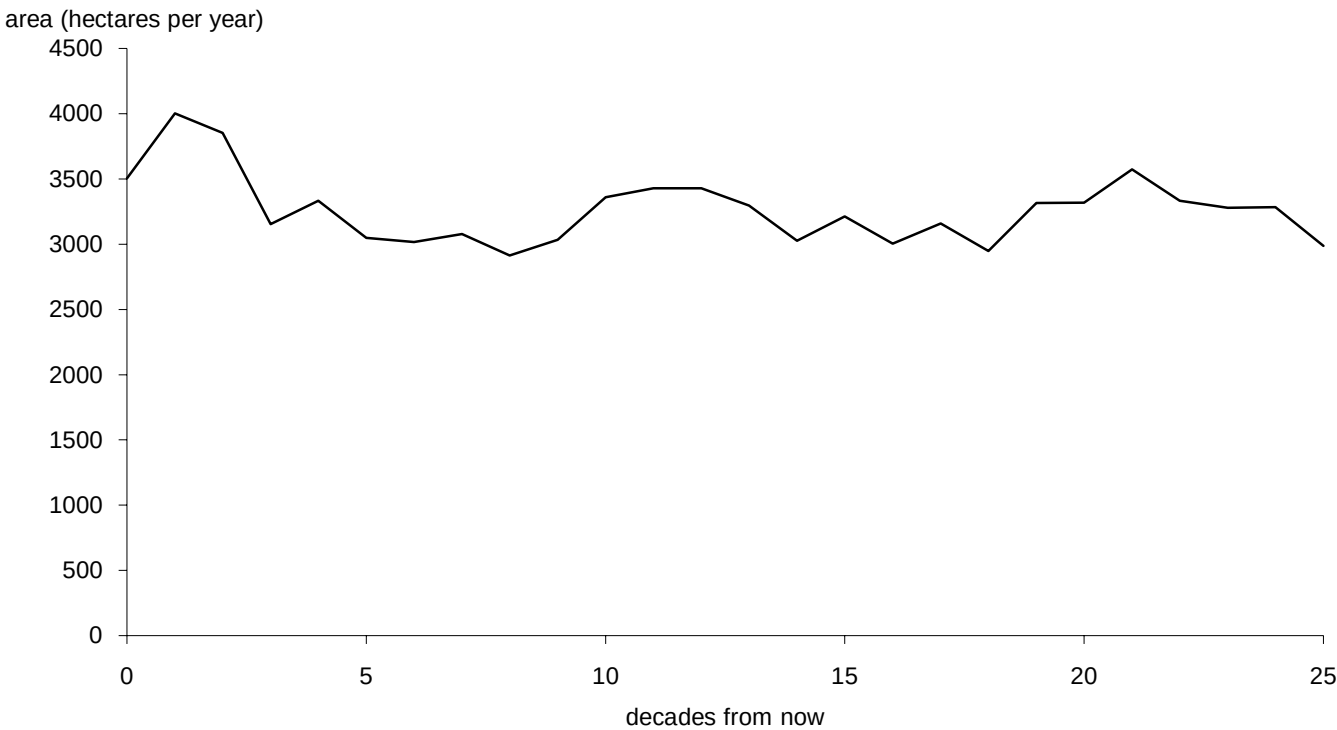


Figure 11. Average annual area harvested over time, Cranbrook TSA.

4 Results

Figure 12 illustrates the average harvest age over time in the Cranbrook TSA. Decade 1 has the highest average age at about 170 years followed by a drop in decade 2 to about 125 years as an average age. Again oscillations are evident as older wood that was required to meet forest cover requirements for old growth becomes available. The oldest wood, not

required to meet old-growth objectives, is harvested in the first decade. In decade 2, the average harvest age dropped considerably. Decades 6 and 18 show surges in average age harvested which is due to old-growth requirements being met or exceeded, leaving older timber available for harvest.

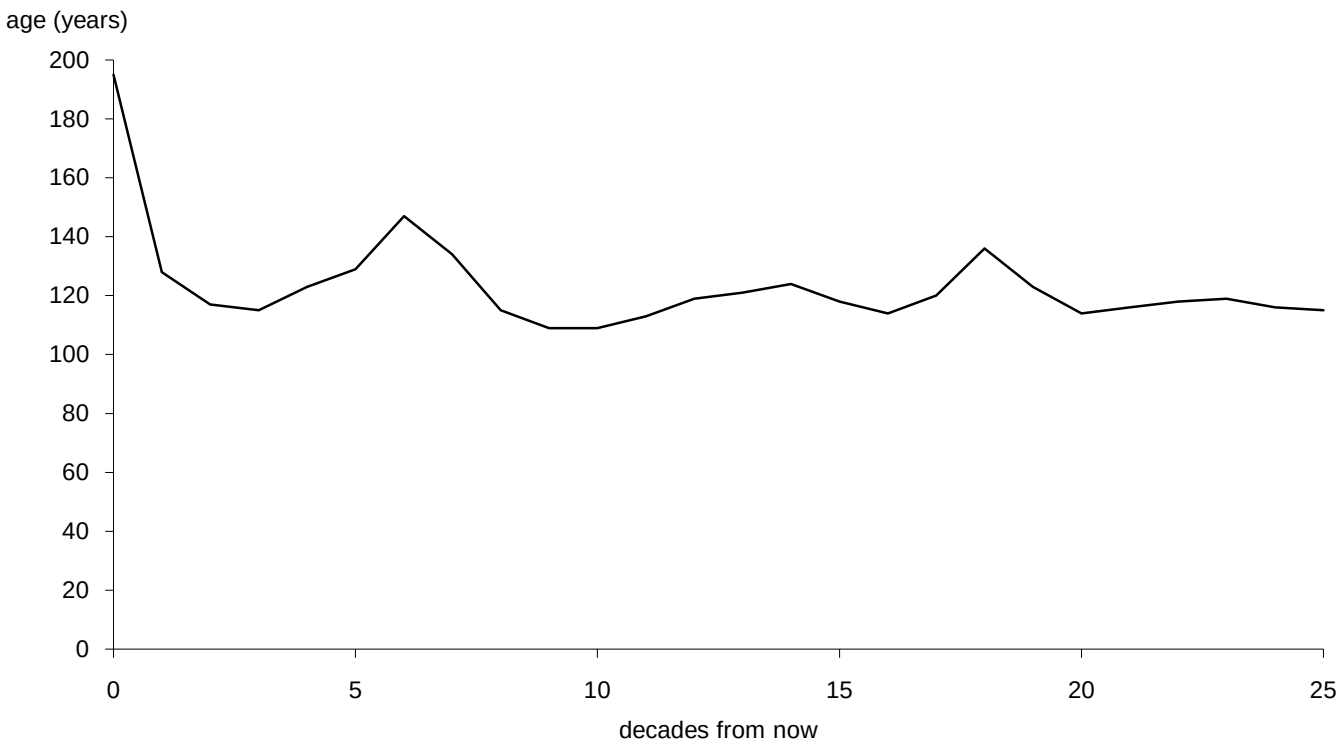


Figure 12. Average harvest age over time, base harvest forecast, Cranbrook TSA.

4 Results

4.3 Age class composition over time

Given the assumptions in the base harvest forecast for the land base and its management, the following figure illustrates how the age composition of the forest changes over time. As indicated in the Figure 13 series, the area covered by stands under 100 years old becomes more evenly distributed over time. Requirements for visual quality, wildlife

habitat, and old growth result in some timber being retained in the older age classes. Through time, forest cover requirements ensure that about 15% of the forest remains in an old-growth state. The charts do not include environmentally sensitive areas, non-merchantable stands, or inoperable areas that also contain a variety of age classes including old growth.

4 Results

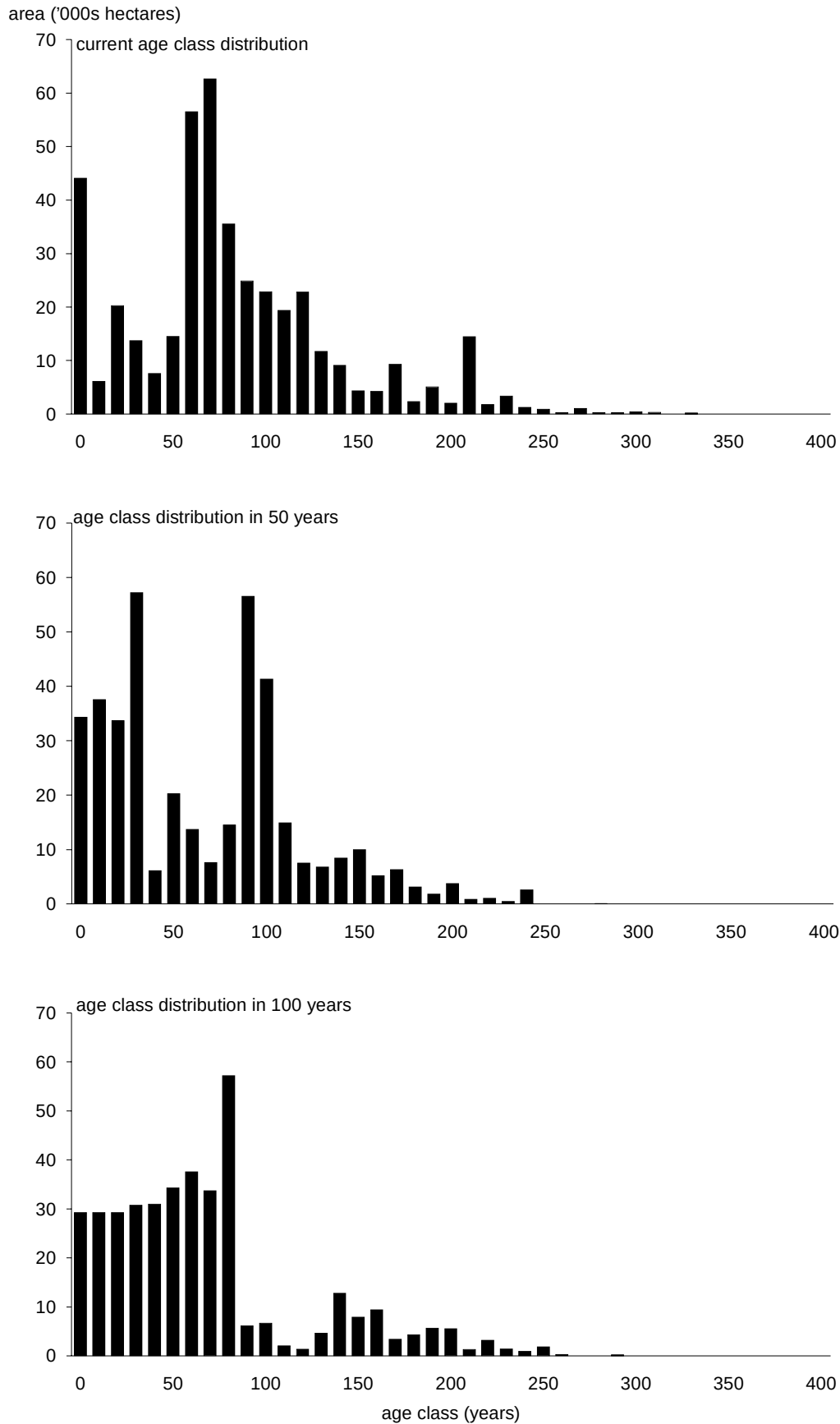


Figure 13. Stand age distribution over time, Cranbrook TSA (continued).

4 Results

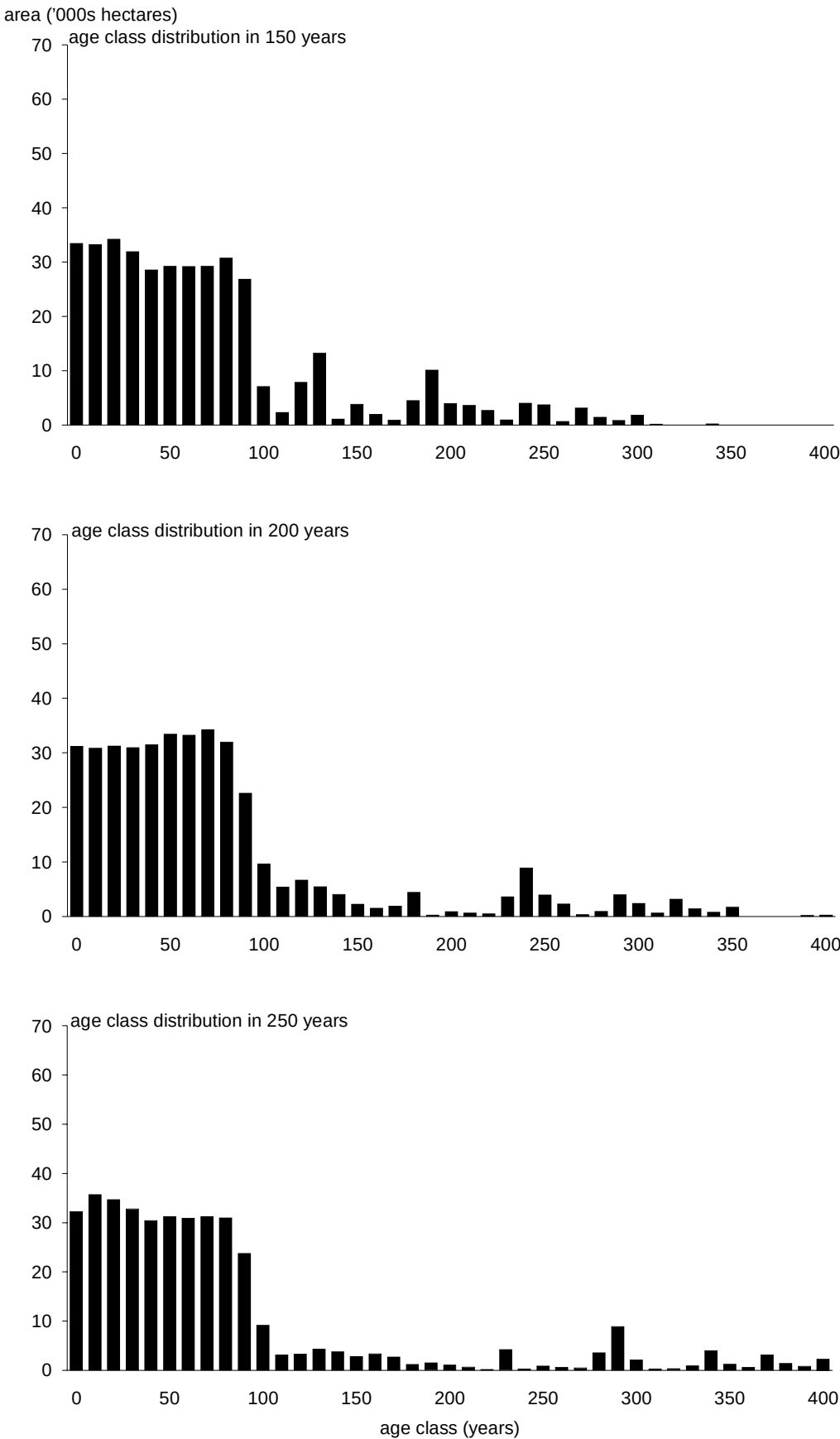


Figure 13. Stand age distribution over time, Cranbrook TSA (concluded).

5 Timber Supply Sensitivity Analyses

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

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

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. One purpose of sensitivity analysis is to highlight which variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

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

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

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions (shown in Figures 8-13) are referred to as the base case.

5.1 Alternative initial harvest levels and harvest flows over time

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

5 Timber Supply Sensitivity Analyses

The base harvest forecast, as shown in Figure 8 and discussed in Section 4, "Results," begins at a level that is 10% below the current AAC and declines for 4 decades at 10% per decade to an interim level which is about 30% below the initial level. After 7 decades at this level, the forecast climbs to the long-term level of 633 000 cubic metres. The base harvest forecast is shown (by means of a dotted line) in all graphs in this section for comparison.

Two harvest flow patterns are shown in Figure 14. The current harvest level can be maintained for 1 decade, however, a shortfall from decades 5 to 12 in excess of 27% below the long-term harvest level would be experienced. As shown in

Figures 4 and 13 and discussed in Section 4, "Results," there is just enough older forest to support a higher initial rate while forest cover requirements are in place. A longer shortfall is evident due to harvesting more in the short term. Mature inventory is reduced and cover requirements are just being met; therefore, the shortfall is greater. The dashed line in Figure 14 shows that in order to achieve a harvest forecast that does not decline, the initial rate must be reduced to about 603 000 cubic metres, 32% below the initial base harvest level. This non-declining harvest flow is about 4% below the long-term level for the first 12 decades. It is not possible to have a harvest flow that does not drop below the long-term level.

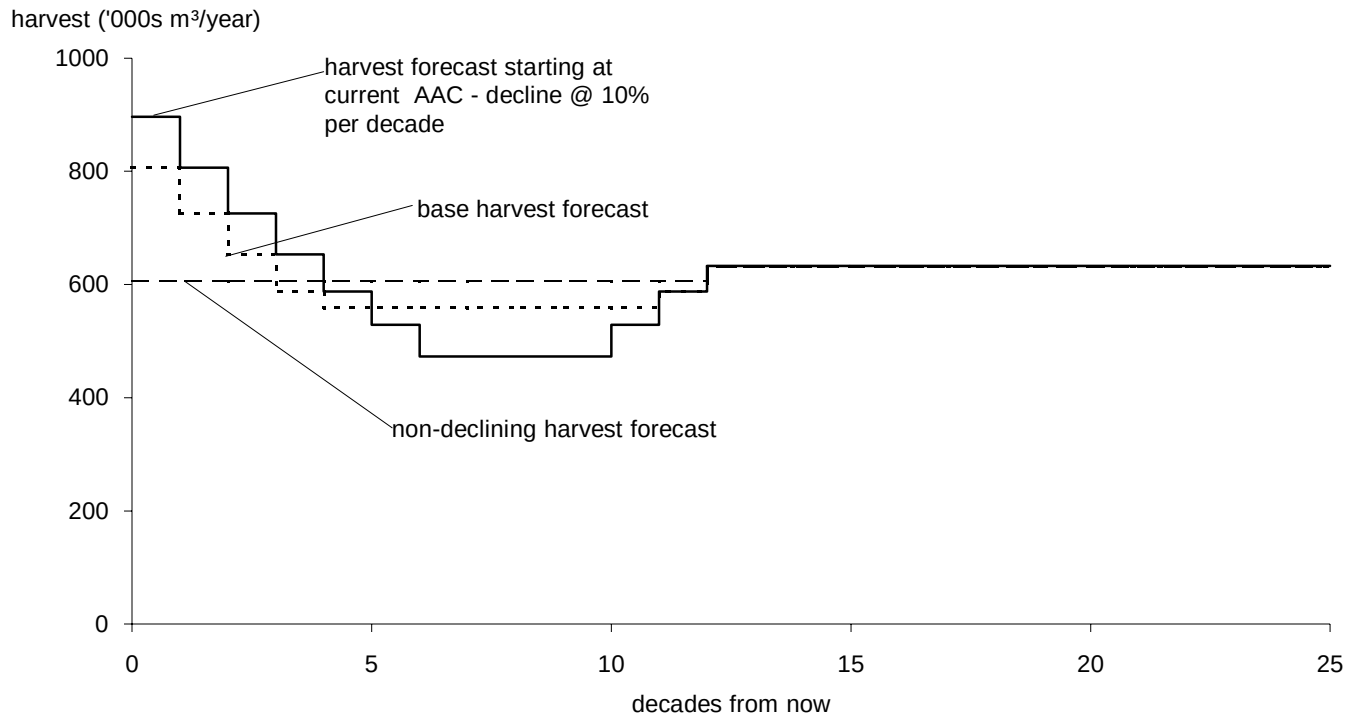


Figure 14. Alternative harvest forecasts, non-declining and current AAC, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

Two further flow patterns are shown in Figure 15, one starting at the current AAC harvest level, the other starting at a level 15% below the base harvest forecast initial level. The harvest forecast that starts at the current AAC level declines 12% per decade in an attempt to lessen the interim shortfall in decades 6 through 12. In this case, however, the forecast declines for 5 decades to 525 000 cubic metres, 17% below the long-term level. This harvest

forecast illustrates the trade-offs in wood supply in short- and intermediate-terms. The dashed line in Figure 15 represents an immediate 15% decrease from the base harvest initial level (23% reduction from current AAC level) to 687 000 cubic metres annually. This forecast then declines over the next 2 decades reaching a level 6% below the long-term level. In both cases, the long-term level of 633 000 cubic metres is reached in decade 13.

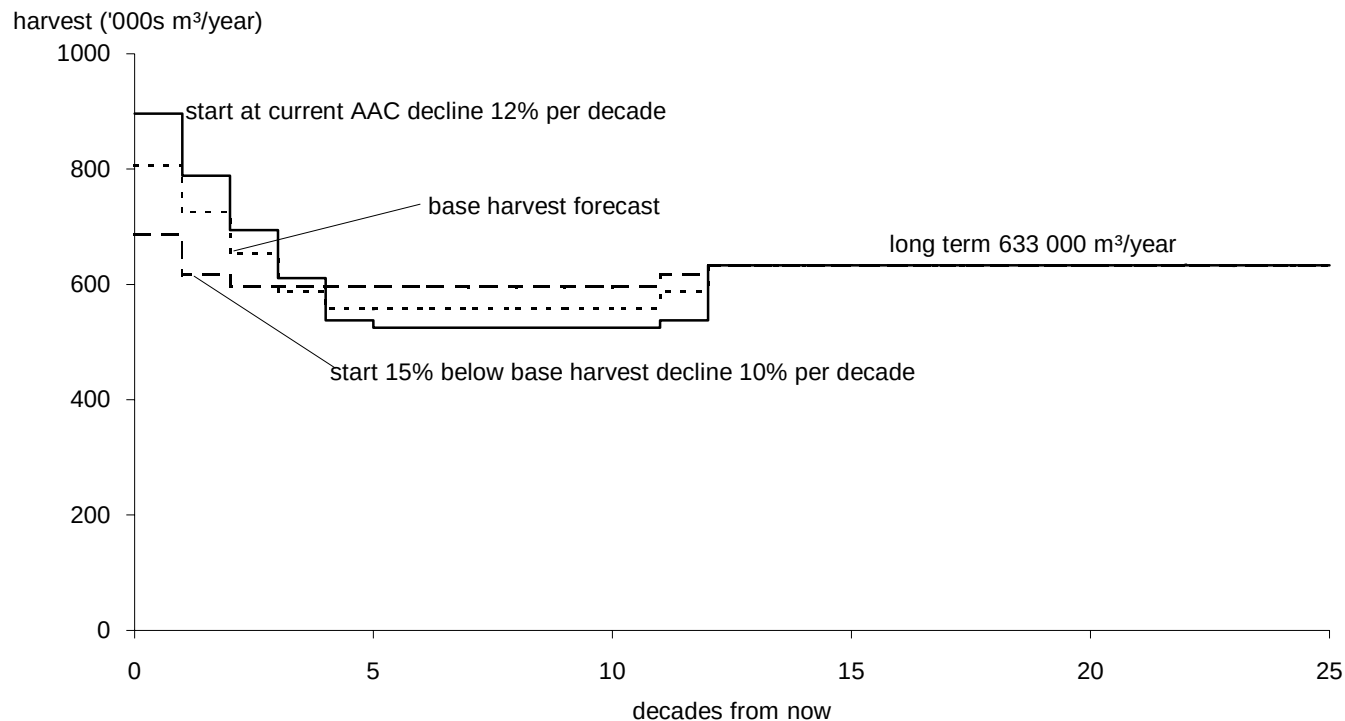


Figure 15. Alternative harvest forecasts, current AAC with 12% per decade decline and initial level 15% below base initial level, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.2 Sensitivity to minimum harvestable ages

The minimum harvestable ages of the base harvest forecast were set with the objective of meeting certain tree size and volume area criteria. The minimum harvestable ages used in the base case ranged from 50 to 200 years. This section examines the sensitivity of the harvest forecast to changes in minimum harvestable ages for all species. There was a minimal effect when minimum harvestable ages were adjusted by 10 years, therefore adjustments of 20 years were chosen.

Figure 16 illustrates how the harvest forecast would change if minimum harvestable ages for all forest types were 20 years different, both older and younger, than the base case ages. The thick solid line and the dashed line represent the effect of increasing the minimum harvestable ages by 20 years. The starting level, in the case of the dotted line, is 806 522 cubic metres annually (identical to the base case initial level); then, it declines at 10% per decade to a level that is about 29% below the long-term level now at 685 000 cubic metres. The higher long-term level is established in decade 13 due to the fact that older, and thus higher volume per hectare, stands are

being harvested and which are closer to culmination MAI as well. An alternative forecast (thick solid line) illustrates the non-declining harvest rate when minimum harvestable ages are increased by 20 years. It commences at a rate 30% lower than that of the base harvest rate. The higher long-term level, about 7% higher than that of the base case, is attained again, in decade 13. The higher long-term level is possible because increased minimum harvest ages bring stands closer to culmination age*. In the short term, however, fewer stands meet the minimum harvestable age criteria and less timber is available for harvest.

The thin solid line illustrates the effect of decreasing all minimum harvestable ages by 20 years. In this case, the base level is followed until decade 5. Reducing minimum harvestable ages decreases the amount of shortfall in decades 5 to 11 (i.e. the harvest forecast at this point is 7% below the long term). It should be noted that the long-term level is about 3% lower than that of the base harvest forecast. In the long term, stands would be harvested at younger ages with less volume per hectare. In the short term, more stands would have reached minimum harvestable age and, therefore, would be available for harvest.

Culmination age

The age at which a timber stand reaches its highest mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.

5 Timber Supply Sensitivity Analyses

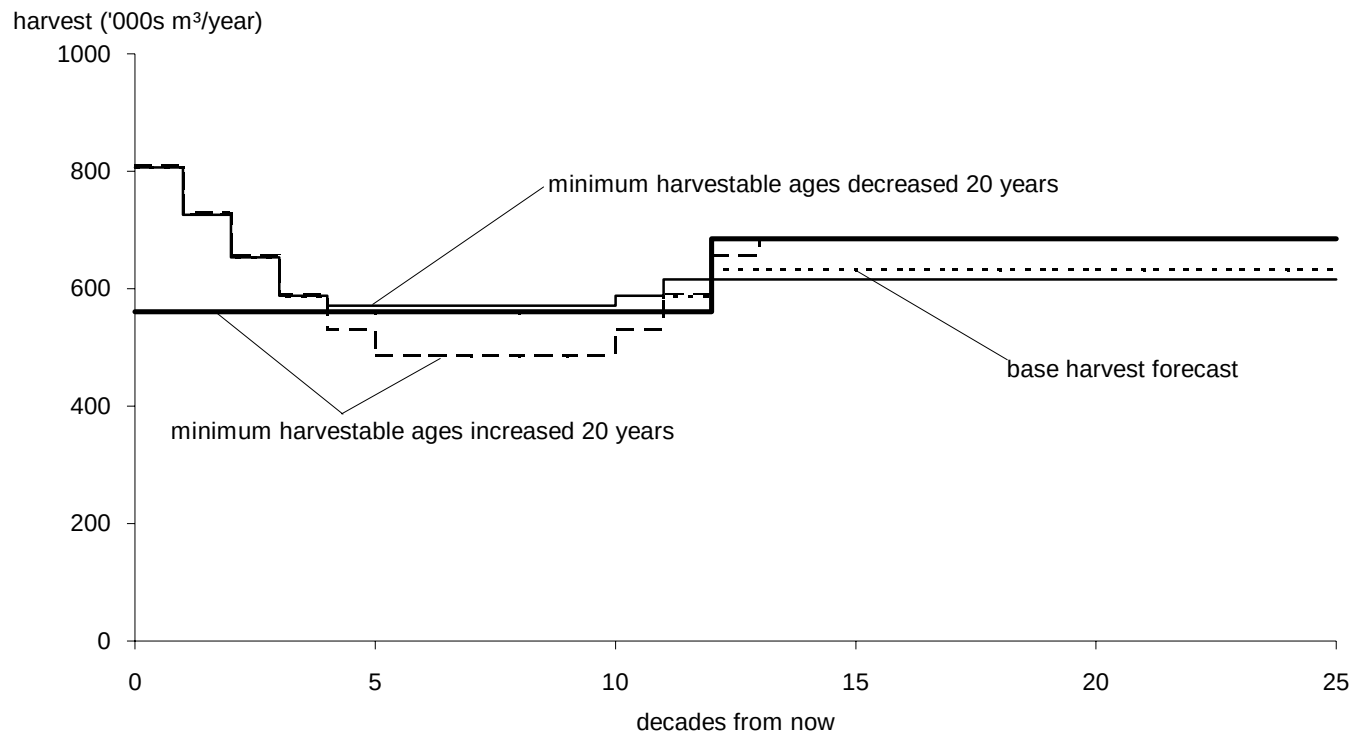


Figure 16. Harvest forecasts with minimum harvestable ages changed by 20 years, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.3 Sensitivity to existing timber volumes

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

The thin solid line in Figure 17 illustrates the effect on the harvest forecast if the estimated timber volume from existing stands is 10% greater. An initial harvest level of 896 136 cubic metres per year (equivalent to the current AAC) can be maintained for 1 decade after which a decline of 10% per decade occurs. The interim shortfall is almost eliminated. Adding 10% more to the timber volume per hectare, therefore, has a large effect on timber volume available for harvest. The long-term level is the same as that of the base harvest forecast because regenerated yield estimates remained unchanged.

The thick solid line and the dashed line show two alternative harvest forecasts if the estimated

timber volume from existing stands are 10% lower than predicted. This change has a direct effect on the short-term harvest forecasts because of the reduction in the existing mature inventory of timber that is ready for harvest. Reducing the volume of timber harvested per hectare also requires more forest area be harvested in order to achieve the same harvest level.

As indicated by the dashed line, in order to have a non-declining forecast without causing future significant interruptions in harvest flow, it is necessary to start at a level 33% lower than that of the base case (39% lower than the current AAC). It is possible, as shown by the thick solid line, to start at 700 000 cubic metres, a 13% decrease from the initial level in the base forecast; however, this causes an interim shortfall of 21% in decades 5 to 11. The long term, reached in decade 13, is the same as in the base harvest forecast.

With timber volumes reduced, more area must be harvested to obtain the volume requested. In doing so, cover requirements become the limiting factor.

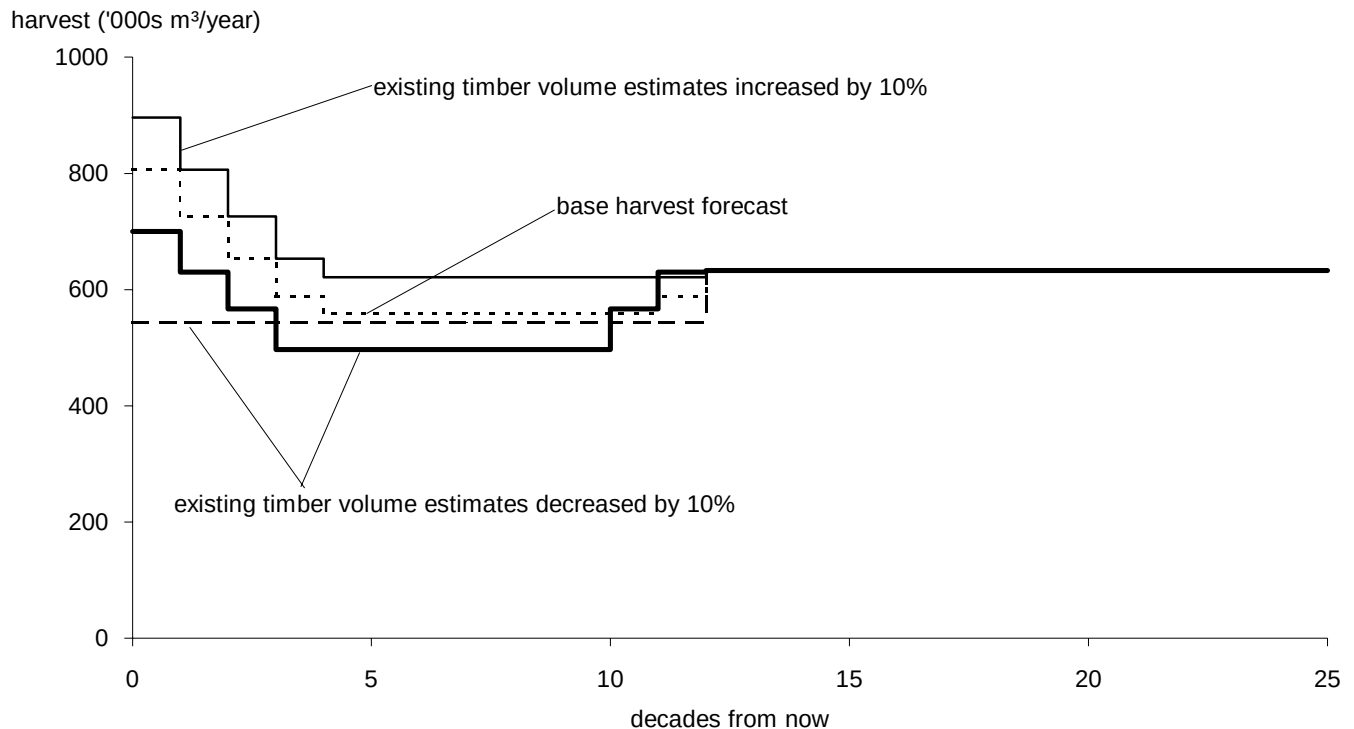


Figure 17. Harvest forecasts with existing timber volume estimates changed by 10%, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.4 Sensitivity to regenerated timber volume estimates

Uncertainty in regenerated timber volume estimates is due to factors such as the use of inventory data from existing mature forests to predict the growth and yield of future regenerated stands, the effect of replacing existing forests with different species after harvesting, and the estimates of future productivity. The following sensitivity analyses examine the effect that uncertainty in the estimated timber volumes from regenerated stands have on the harvest forecast.

The solid line in Figure 18 shows the effect on the harvest forecast of increasing the estimated timber volumes from all regenerated stands by 10%. Increasing the volume from regenerated stands has no effect on short-term harvest levels because the majority of the timber harvested in the short term is from existing older stands. However, a new

long-term harvest level is established at decade 13 which is about 11% higher than the base long-term level. Interim harvest levels (decades 5 to 11) now appear to fall significantly below the long-term level. In order to reduce the amount of shortfall, a lower initial harvest level than the base forecast would be necessary.

The dashed line shows the effect of decreasing all regenerated stand yield estimates by 10%. This change only affects the steady long-term harvest level, which is reduced by just over 10% from the base harvest forecast. It should be noted, however, that the harvest level does not have to fall below the new long-term harvest level. Given reduced regeneration timber volume estimates, it is possible to start at a higher initial level, decline to a level below the long-term and rise to it at some point.

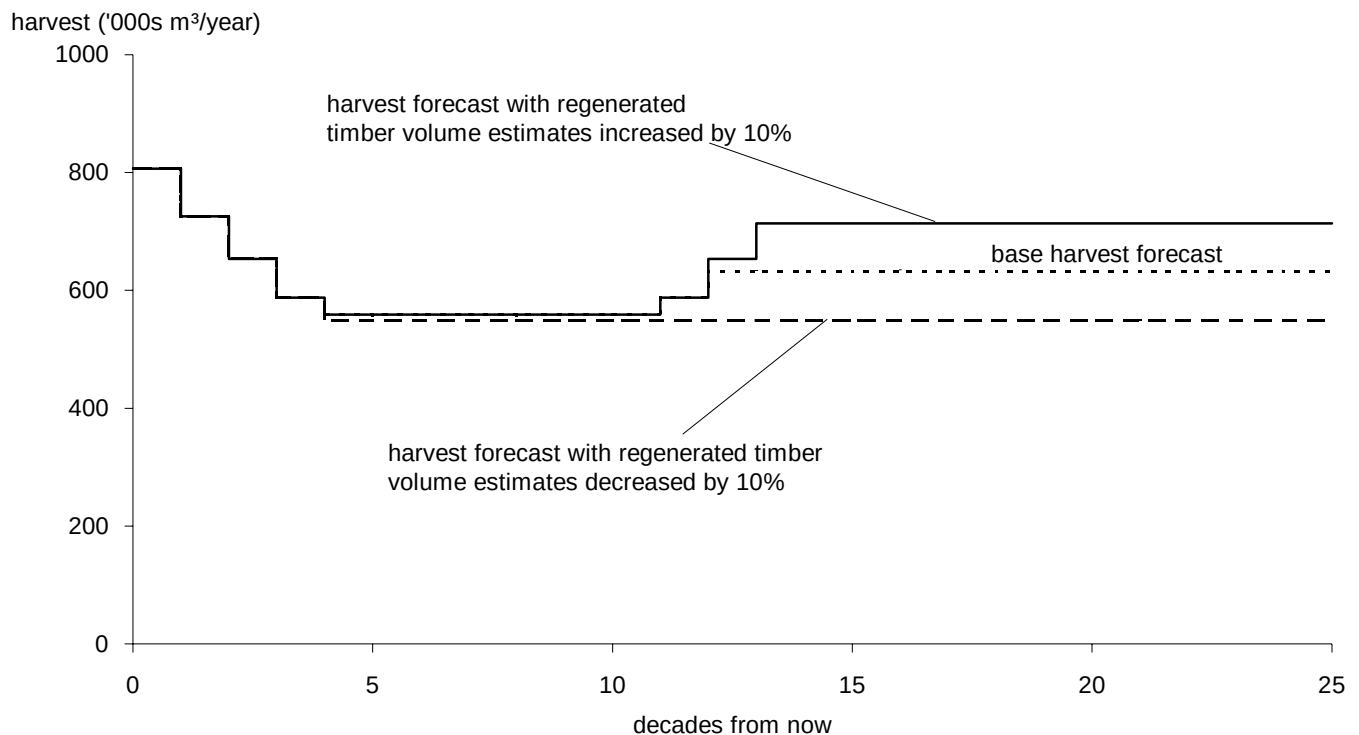


Figure 18. Harvest forecasts with regenerated timber volume estimates changed by 10%, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.5 Sensitivity to the size of the timber harvesting land base

The area that is assumed to be available for timber harvesting is one of the primary inputs for timber supply analysis. In the Cranbrook TSA, the timber harvesting land base could be larger or smaller than expected if any of the areas listed in Table 1 were different. There are a number of reasons that these areas could be different from what is expected. The timber harvesting land base could be larger than expected due to improved timber harvesting techniques and equipment, which reduce the cost of harvesting operations or which prevent damage from occurring on sensitive sites. It could also be larger as a result of an increase in the value of currently unmerchantable forest types.

Conversely, the timber harvesting land base could be smaller than expected if, for example:

- harvesting costs increased, reducing the economic feasibility of harvesting;
- new guidelines to further protect resources other than timber are imposed; or
- decisions to protect additional areas, such as those considered through the Protected Areas Strategy are made. (It should be noted that the base harvest forecast assumes these areas are

available for timber harvesting now and in the future.)

The following sensitivity analyses examine the effect on the harvest forecast of uncertainty associated with the size of the timber harvesting land base. In the following analyses, the timber harvesting land base was increased and decreased by 10% across all stands regardless of age, species or management regime.

The solid line in Figure 19 illustrates the effect of increasing the area of the forest operations land base by 10%. It is possible to maintain the current AAC for 1 decade before a 10% per decade decline is necessary. A new interim shortfall level (about 9% below the long-term level) is established in decade 5, and long-term level of 706 000 cubic metres is established in decade 13. The long-term level is about 11% higher than that of the base harvest forecast.

The dashed line represents the effect of reducing the area within the timber harvesting land base by 10%. The initial harvest level must drop immediately by about 8% and continue to decline at 10% per decade for 5 decades to a new interim level of 457 000 cubic metres annually. The long-term level, set in decade 13, of 557 000 cubic metres annually is almost 11% lower than that of the base harvest forecast.

5 Timber Supply Sensitivity Analyses

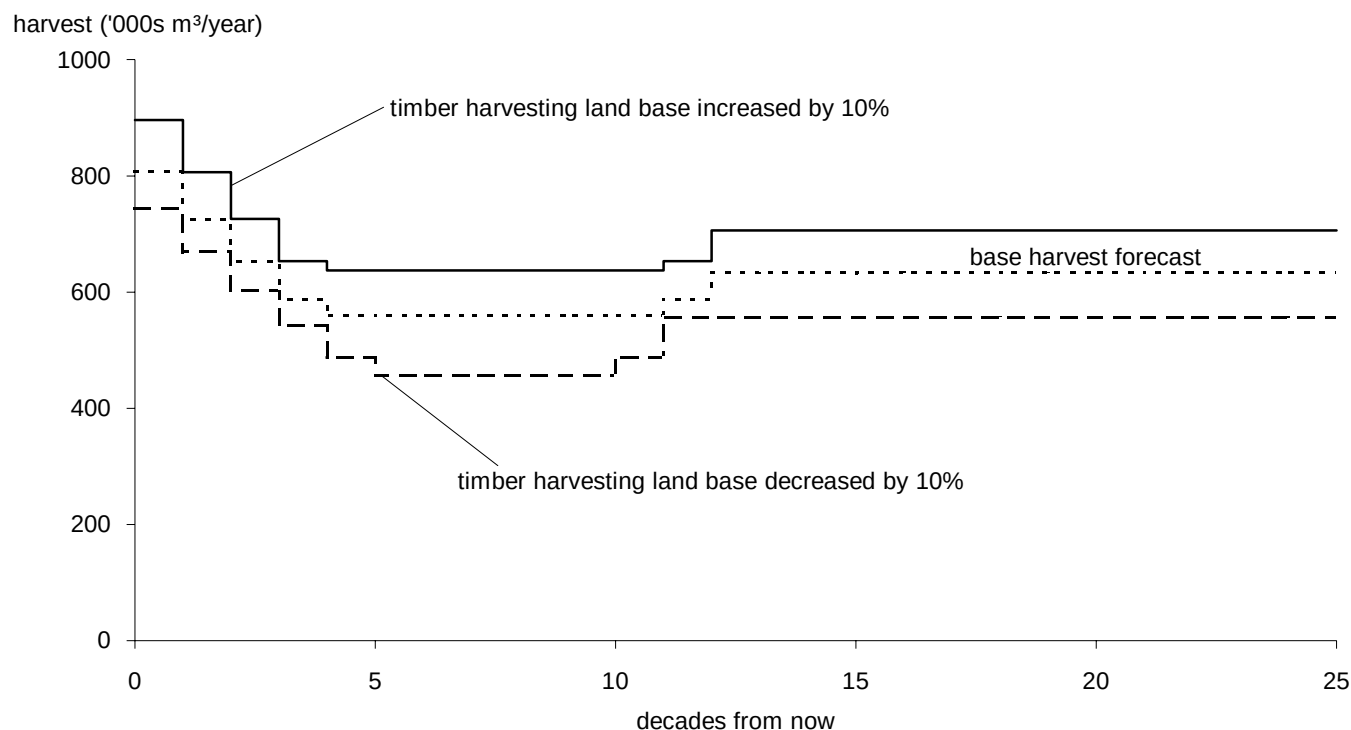


Figure 19. Harvest forecasts with the area of the timber harvesting land base increased and decreased by 10%, Cranbrook TSA.

5.6 Sensitivity to green-up ages

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

Uncertainty about green-up age arises because the desired green-up conditions may not accurately reflect actual needs, and because uncertainties about growth and yield may mean that stands will reach the desired condition sooner or later than estimated.

As discussed in Section 2.3, "Management practices" and Section 2.4, "Management zones" the required green-up ages used in the base forecast are the estimated number of years it takes for trees on a harvested area to grow to a required height.

Uncertainty in the required green-up age stems from both uncertainty in stand height growth rates as well as the subjectivity of the height requirement. The following sensitivity analysis examines the effect that

uncertainty in the required green-up age has on the harvest forecast.

The thin solid line and the thick solid line in Figure 20 show two alternative harvest forecasts if all green-up ages are reduced by 10 years. More timber is available in both the short- and long-term when the required time for stands to reach green-up conditions is reduced. When the time required for stands to reach green-up conditions is reduced, more timber is available because adjacent timber can be harvested sooner. In the case of the dashed line, the initial harvest level is the same as that of the base, however, the shortfall in decades 5 to 11 is reduced. The thin solid line illustrates the effect of starting at the current AAC level (with green-up requirements reduced by 10 years). In this case, there is an interim shortfall of about 18% below the long-term level. The long-term level for both these cases is about 2% higher than that of the base forecast.

The thick line in Figure 20 shows the effect of green-up ages being 10 years older. Less volume is available over time when green-up ages are greater because it takes longer for areas adjacent to recently

5 Timber Supply Sensitivity Analyses

harvested areas to become available for harvest. The initial harvest level is about 26% lower and the long-term level is about 2% lower than those of the base case. The initial harvest level is affected due to

the age class distribution of the forest. By adding 10 years to the green-up periods, less timber is available for harvest, as it is required to meet cover requirements.

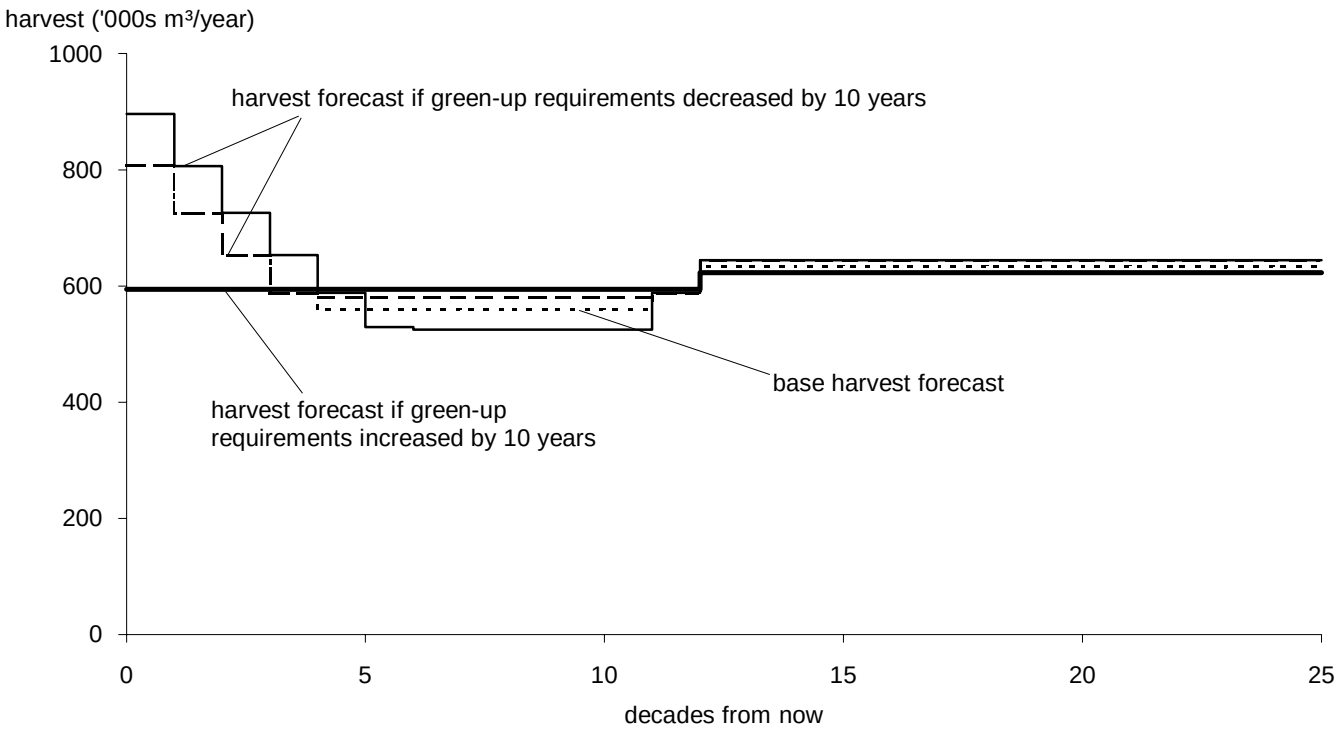


Figure 20. Harvest forecast with all green-up ages changed by 10 years, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.7 Sensitivity to changes in all forest cover requirements

The following sensitivity analysis examines the effect of altering the forest cover requirements by 10 percentage points. Changing cover requirements by 5 percentage points illustrated a small change in harvest; therefore, 10 percentage points were used. The forest cover requirements for cutblock adjacency, old growth, visually sensitive areas, and wildlife habitat were varied as were the requirements for old growth.

The solid line in Figure 21 shows the harvest forecast with the forest cover requirements relaxed by 10 percentage points. Relaxing forest cover requirements involves increasing the maximum allowable proportion of the area that does not meet green-up conditions. In the riparian management zone, for example, the cover requirement percentage goes from 35% to 45%. The mature area forest cover requirements are relaxed by decreasing the amount of forest required to be older than the mature age. Thus, in the riparian management zone, the old-growth cover requirement percentage goes from 25% to 15%. In this case, the current AAC (896 136 cubic metres annually) can be held for

1 decade. The forecast then declines by 10% per decade to a interim level slightly above the base case. It then rises to a long-term level of 652 000 cubic metres annually, 3% higher than the base long-term harvest level. Forest cover requirements still play a role in limiting the amount available for harvest, albeit to a lesser extent than in the base forecast.

The dashed line in Figure 21 shows the base harvest forecast with the forest cover requirements tightened by 10 percentage points. To tighten the requirements for forest cover, it is necessary to decrease the amount of area allowed to be in a non-greened up state and increase the amount of forest required to be older than the green-up age. In the riparian management zone, for example, the cover requirement goes from 35% to 25% and the requirement to maintain old growth goes from 25% to 35%. Under this condition, the highest initial harvest level (without causing long-term shortfalls), is 533 000 cubic metres, a 34% decrease from the base case. This rate continues for 13 decades until the long-term level, equivalent to that of the base forecast, is reached.

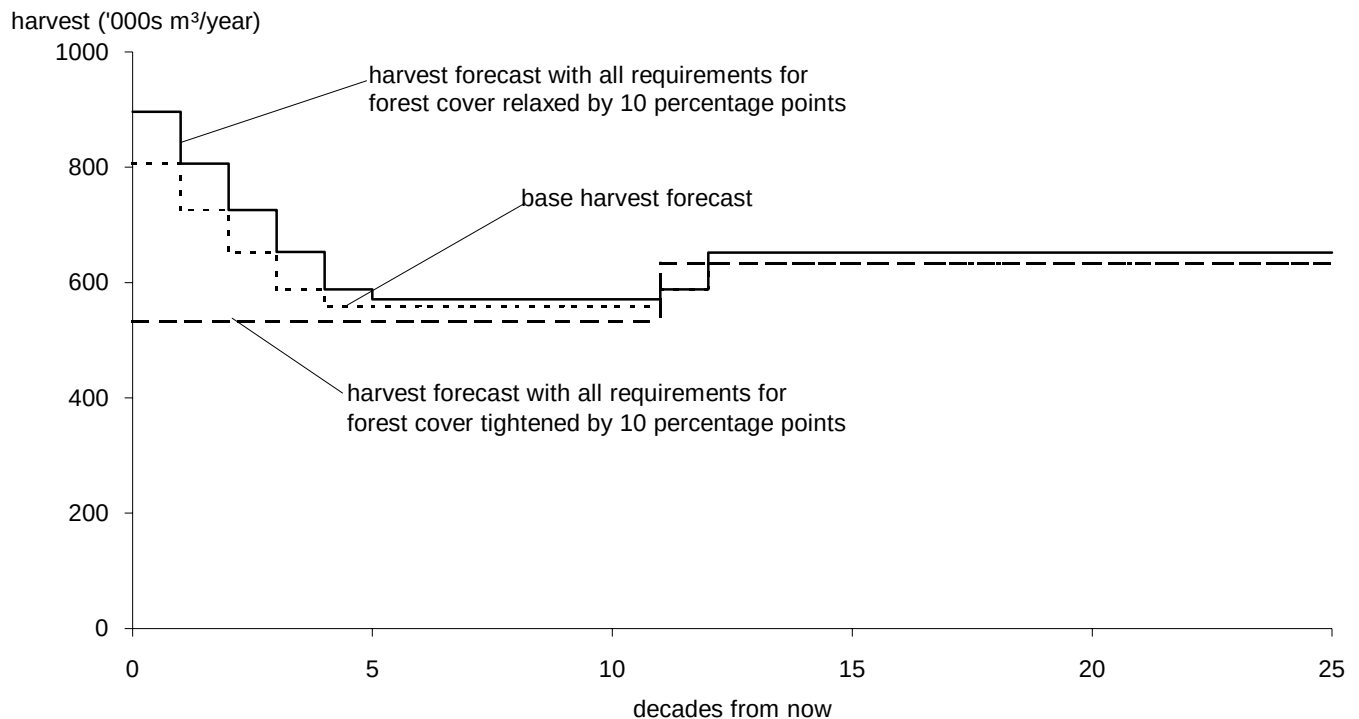


Figure 21. Harvest forecast when forest cover requirements are changed by 10%, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.8 Sensitivity to cutblock adjacency requirements

In the base case, forest cover requirements used to model cutblock adjacency and green-up guidelines were based on the assumption that, at any time, a maximum of 35% of the timber emphasis, caribou and riparian zones, may be covered by stands less than 3 metres tall. This requirement may also be referred to as a 3-pass harvesting system as it allows 100% of the forest to be harvested over 3-entries (passes) into the area. Site specific forest cover requirements will vary from this average requirement. Uncertainty in the average forest cover requirement used to model cutblock adjacency and green-up in this analysis stems from these site specific variations from the average, and uncertainty in how accurately a cover requirement reflects the adjacency guidelines.

Since the forest cover requirement for adjacency was not a limiting factor in the base case, relaxing the forest cover requirement to allow more area to be less than 3 metres tall (e.g. changing to a 2-pass harvesting system), does not alter the harvest forecast. Because there is no change from the base case, this harvest forecast is not shown graphically.

The effect of making forest cover requirements for cutblock adjacency more stringent so that only

25% (4-pass) or 20% (5-pass) of the area may be forested with stands less than 3 metres tall are shown in Figure 22. The forecast illustrating a 4-pass system is indicated by the solid line. The initial level is about 26% lower than that of the base, and is mainly a function of cover requirements in decade 2. Higher harvests in the first decade would cause a greater decline to the second decade level. As noted, the current age class structure has about 14% in stands under 20 years of age. Higher harvests exacerbate the age class imbalance and limit further harvests in decade 2.

The long-term level, however, is about 3% higher than that of the base forecast, due to the adjacency requirements causing harvest ages to increase. These increased harvest ages are closer to the age of MAI culmination.

The effect of making forest cover requirements for cutblock adjacency similar to a 5-pass system is shown by the dashed line in Figure 22. Again, it is evident that the preponderance of stands under 20 years of age has a great effect in the short term. The initial harvest level is about 50% of the base case initial harvest level. The long term is about 1.5% greater than that of the base harvest forecast due again to increased harvest ages caused by the adjacency requirements.

5 Timber Supply Sensitivity Analyses

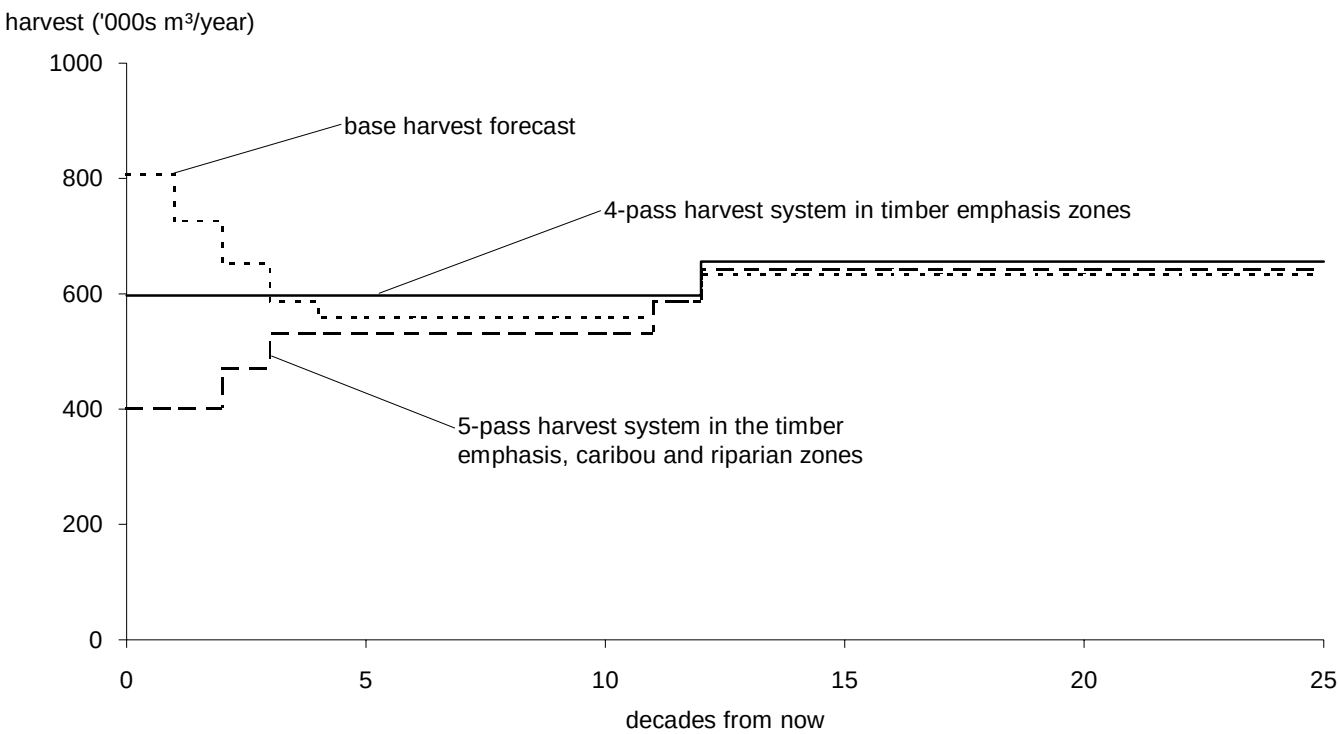


Figure 22. Harvest forecast with more stringent cutblock adjacency requirements, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.9 Sensitivity to visual quality requirements

In the base case, forest cover requirements for visually sensitive areas were shown in Section 2.4, "Management zones," and provide two levels of protection for visual quality. In visually sensitive areas, recently harvested areas must be covered by trees at least 6 metres tall before adjacent areas can be harvested. As illustrated in Figure 7, visually sensitive areas account for about 7% of the timber harvesting land base; therefore, changes to forest cover requirements in the visual quality objectives* (VQO) do not have as large an impact as changes that affect the timber emphasis areas (which account for about 60% of the net operable land base).

The thin solid line in Figure 23 illustrates the effect of allowing 5% more of each visually sensitive area to be covered by stands younger than the

green-up age. For example, forest cover requirements for the retention/partial retention areas were relaxed from 10% to 15%. In this case, the interim shortfall can be reduced, and the long-term level increased. The long-term level of 648 000 cubic metres is about 2% greater than that of the base forecast.

The dashed line indicates the effect of tightening the forest cover constraint by reducing the area allowed to be under the green-up age in visually sensitive areas by 5%. The harvest forecast starts, again, at the same level as that of the base harvest, however, the interim shortfall in decades 5 to 11 is about 16% lower than that of the base case. The long-term level is also about 2% lower than the base forecast.

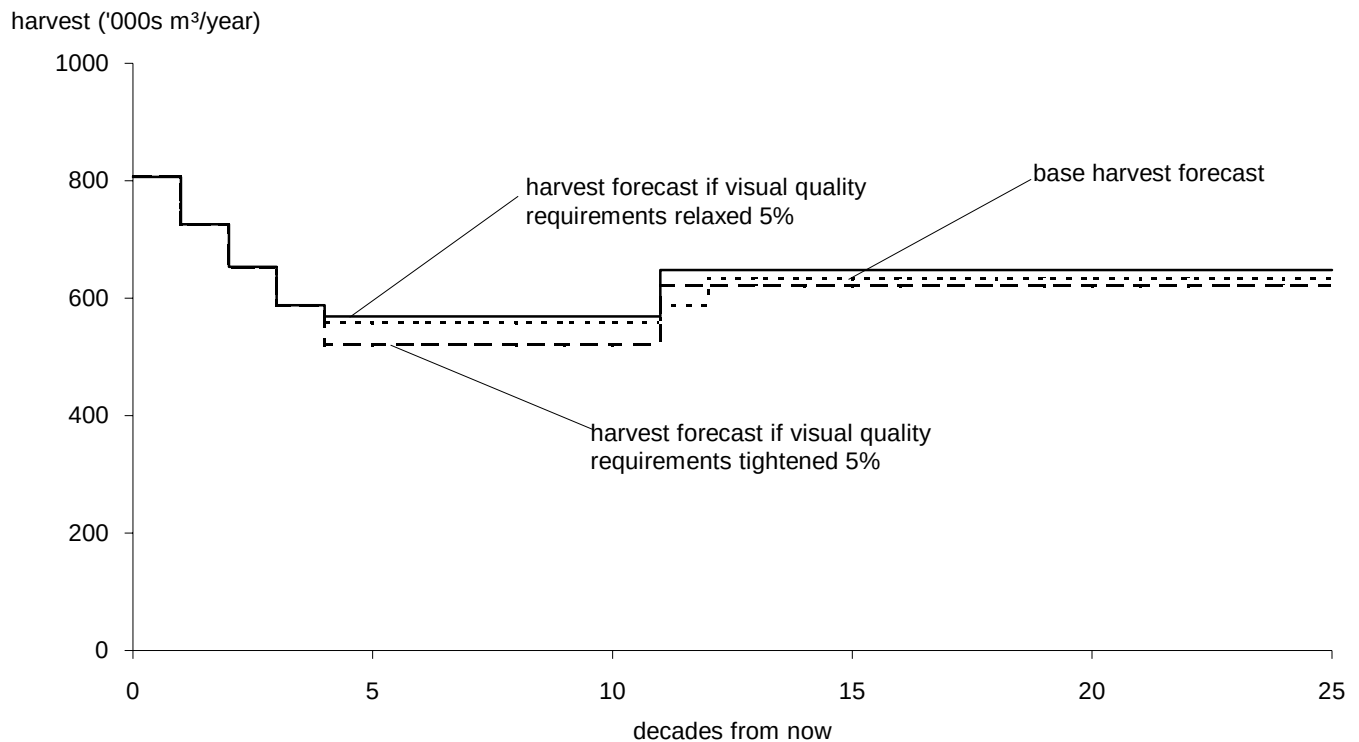


Figure 23. Harvest forecast with increased and decreased forest cover requirements for visual quality, Cranbrook TSA.

Visual Quality Objective (VQO)

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

5 Timber Supply Sensitivity Analyses

5.10 Sensitivity to changes in old-growth cover requirements

The following sensitivity analysis examines the effect of altering the forest cover requirements for old growth by 5 percentage points. As illustrated in Section 2, "Information Preparation," Figure 4, there are not a lot of older stands in the timber harvesting land base; therefore, small changes to old-growth requirements have large impacts on available timber supply.

The dashed and solid lines in Figure 24 show the harvest forecast with the forest cover requirement for old growth relaxed by 5 percentage points. The mature area forest cover requirements are relaxed by decreasing the amount of forest required to be older than the mature age. Thus, in the riparian management zone, the mature area forest cover requirement percentage goes from maintaining 25% to 20%. In this case, the current AAC (896 136 cubic metres annually) can be held for 1 decade (as indicated by the dashed line); or, if the initial level is

that of the base forecast, the interim shortfall can be lessened (solid line). The forecasts then decline by 10% per decade to new interim levels and both rise to a long-term level of 653 000 cubic metres annually, 3% higher than the base long-term harvest level.

The dashed and solid lines in Figure 25 show the harvest forecast with the forest cover requirements for old growth tightened by 5 percentage points. The mature area forest cover requirements are tightened by increasing the amount of forest required to be older than the mature age. Thus, in the riparian management zone the mature area forest cover requirement percentage goes from maintaining at least 25% to 30%. The base case initial harvest level causes a significant interim shortfall, as indicated by the dashed line in Figure 25. The highest non-declining forecast is shown by the solid line which starts at 564 000 cubic metres, a 30% decrease from the base case. This rate continues for 13 decades until the long-term level of 606 000 cubic metres is reached.

5 Timber Supply Sensitivity Analyses

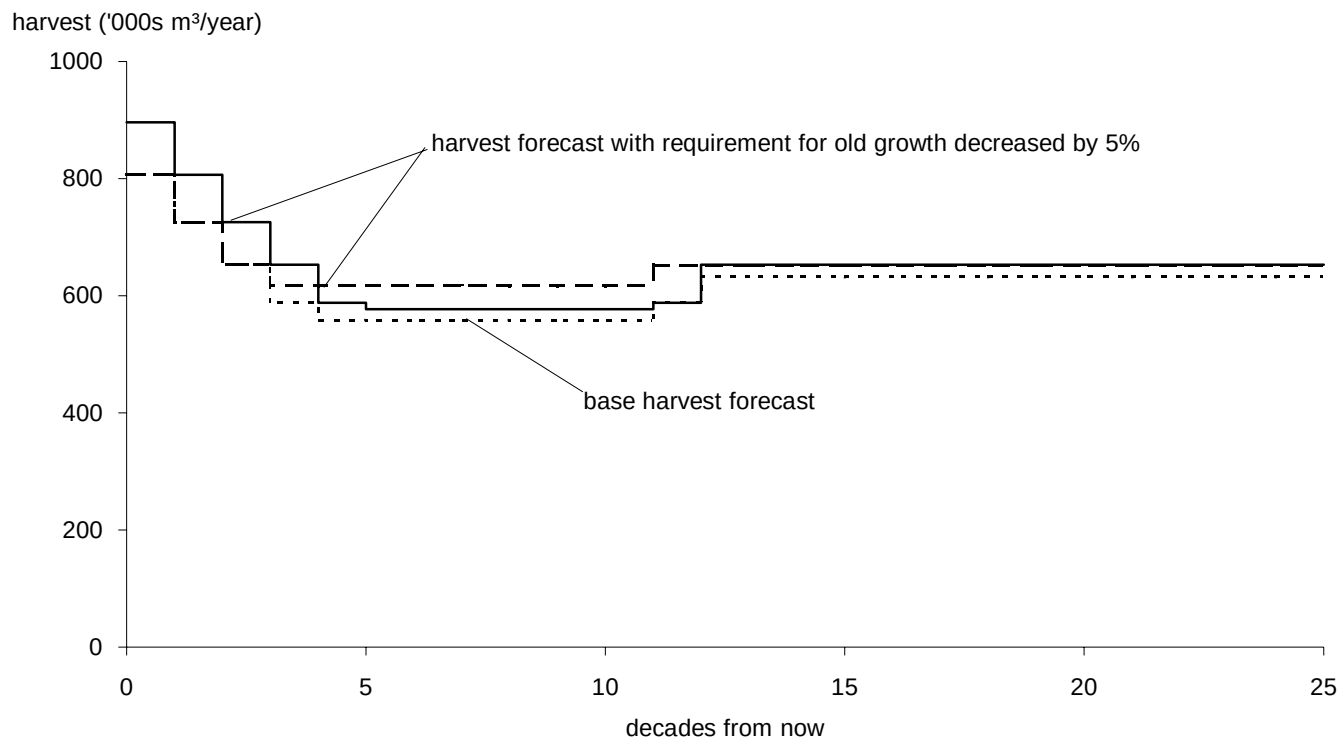


Figure 24. Harvest forecast when forest cover requirements for old growth are relaxed, Cranbrook TSA.

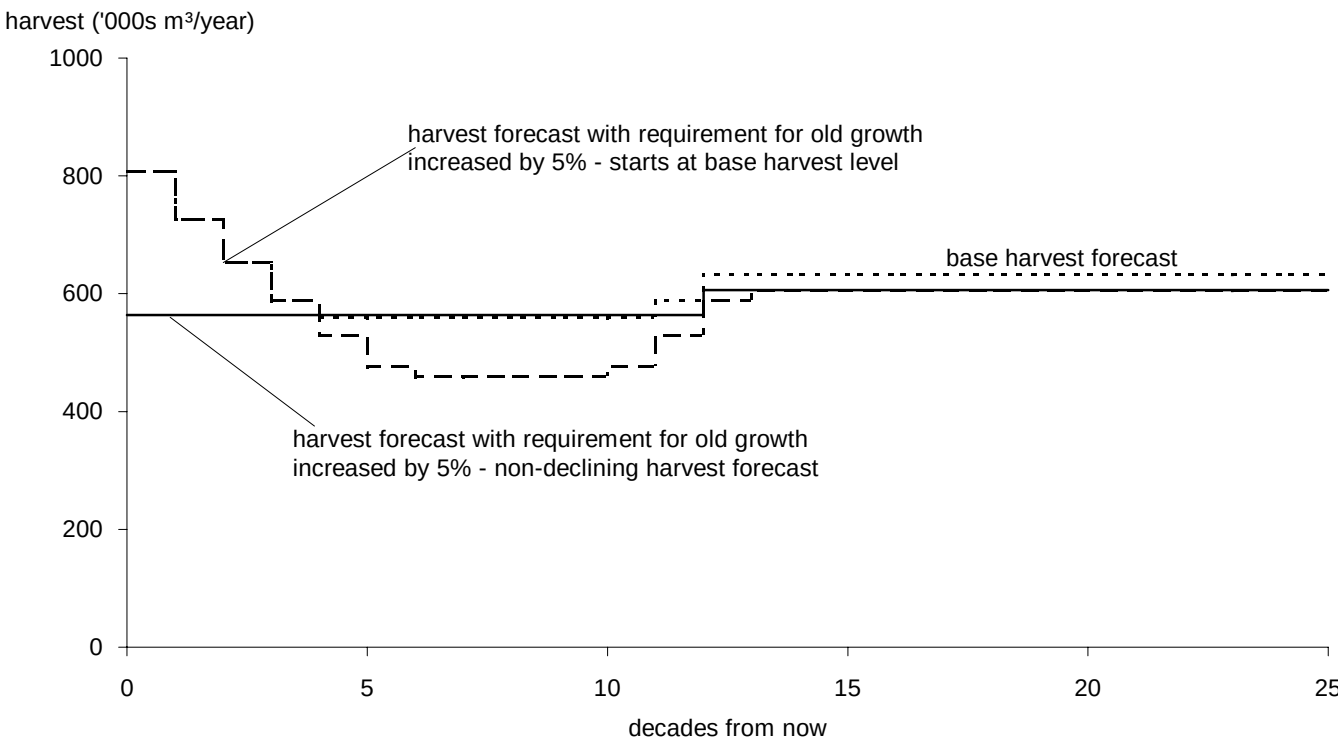


Figure 25. Harvest forecast when forest cover requirements for old growth are tightened, Cranbrook TSA.

5 Timber Supply Sensitivity Analyses

5.11 Sensitivity to changing several assumptions concurrently

The sensitivity analyses discussed in Sections 5.2 to 5.9 examine the effect on the harvest forecast of altering a single forest management assumption at a time. The following sensitivity analyses examine the effect of changing a number of assumptions concurrently. This sensitivity serves to place bounds on harvest flow over time.

The solid line in Figure 26 shows the harvest forecast when the following changes are applied:

- all green-up ages reduced by 5 years;
- 5% more visually sensitive area is allowed to be under cover of stands younger than green-up age;
- both existing and regenerated stand yield estimates increased by 10%;
- all minimum harvestable ages reduced by 10 years;
- land base increased by 10%.

Using all of the assumptions above concurrently has a large effect on the harvest forecast. The initial harvest level of 896 136 cubic metres annually (i.e.

current AAC level) can be held for 7 decades before a decline of 10% is necessary. The long-term level of 825 000 cubic metres is 23% higher than that of the base harvest forecast.

The dark solid line in Figure 26 shows the harvest forecast when the following changes to yield and forest management are applied:

- all green-up ages increased by 5 years;
- 5% less visually sensitive area is allowed to be under cover of stands younger than green-up age;
- existing and regenerated stand yield estimates decreased by 10%;
- all minimum harvestable ages increased by 10 years;
- land base decreased by 10%.

Applying these changes concurrently, an initial harvest level 50% less than the base initial harvest level is necessary to avoid major future disruptions in timber supply. This forecast inclines by 12% at decade 13 to a long-term level of 456 000 cubic metres annually, 28% less than that of the base harvest forecast.

5 Timber Supply Sensitivity Analyses

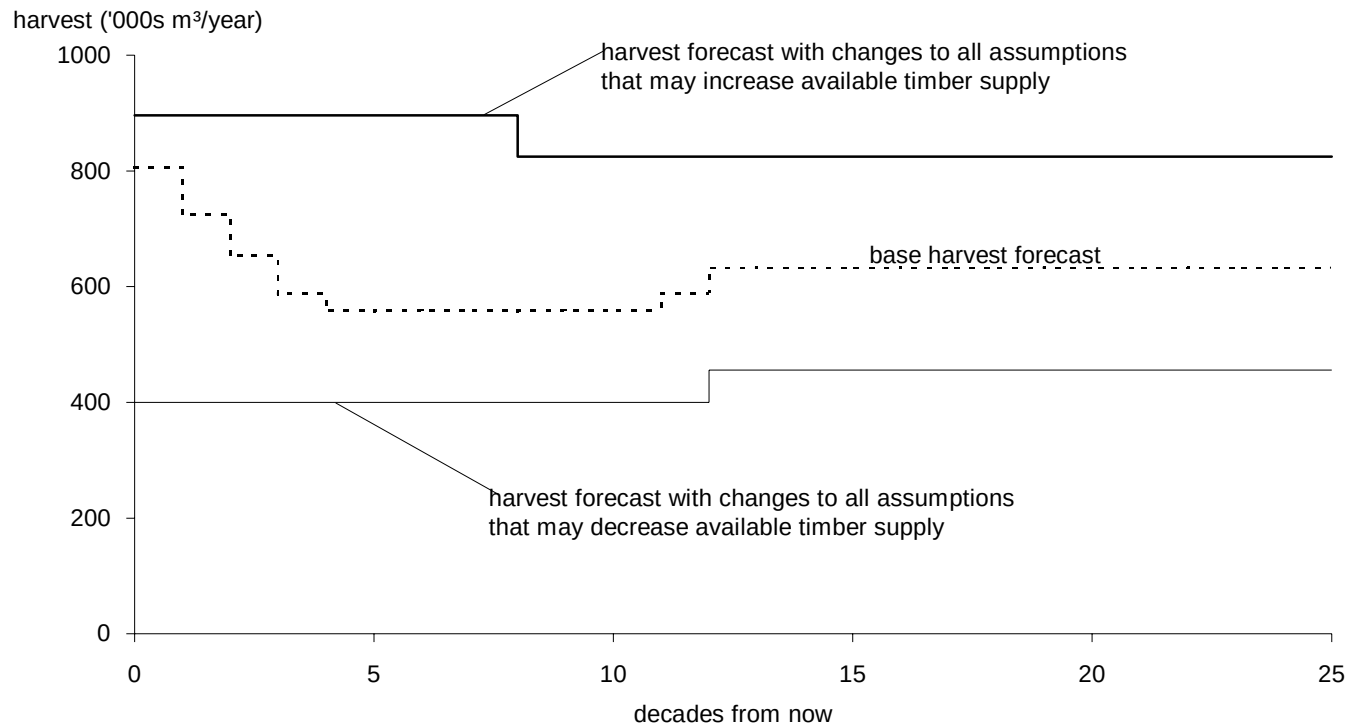


Figure 26. Harvest forecast with changes to several forest growth and management assumptions concurrently, Cranbrook TSA.

6 Summary and Conclusions

The base harvest forecast in this analysis indicates that the current harvest level of 896 136 cubic metres in the Cranbrook TSA cannot be maintained without causing significant future shortfalls in timber supply. As illustrated in the base harvest forecast (Figure 8), the harvest rate has to decline by 10% immediately, then by 31% over the next 5 decades to 559 000 cubic metres to avoid a significant shortfall. After a further 7 decades, the harvest could then rise to the long-term sustainable timber supply level of 633 000 cubic metres per year. The base harvest forecast was chosen as a means to distribute the inevitable decline to the long-term level, and minimize the interim shortfall in decades 5 to 11. As illustrated in the alternative harvest forecasts, the initial harvest rate can be increased to the current AAC by either allowing greater declines per decade or allowing a greater interim shortfall to occur thereby accepting significant timber supply shortfalls in the future. Conversely, the highest non-declining rate of harvest has an initial level 25% below the base initial harvest level, which is 32% below the current AAC level.

Several important factors affect the timber supply forecast. The most important factor is the current distribution of different stand ages in the timber harvesting land base. Only 0.71% of the land base is over 250 years old. Only 12% currently is over 140 years of age, while over 16 % is under the age of 20 years. Given this age class profile, it is evident that

current timber harvest levels must start to decline in the short term to the long-term sustainable level.

Also contributing to the decline in timber supply are forest cover requirements for other resources such as wildlife habitat, visual quality and especially old growth. Sensitivity analyses show that the decline would not be as pronounced if forest cover requirements were reduced. Conversely, the decline would be significantly greater if forest cover requirements were increased.

Sensitivity analyses indicate that uncertainty in the assumptions and data used in this analysis may be significant in both the short- and long-term. The short-term timber supply is especially sensitive to changes in the forest cover requirements for adjacency, old-growth and green-up requirements, and volume estimates for existing stands. Uncertainty in the estimates of existing stand volumes is particularly important because even moderate changes in these assumptions result in initial harvests more than 50% lower than the base case or conversely, the initial harvest level could be equal to the current AAC and be maintained for 1 decade.

Uncertainty about minimum harvestable ages, land base, and visual quality objectives have moderate impacts on short-term harvest levels. Changes in regenerated yields have no impact on short-term harvest rates although the long-term harvest level is moderately affected.

7 References

- B.C. Ministry of Environment. May 1986. Biophysical Resources of the East Kootenay Area Wildlife. Ministry of Environment Technical Report 22. Denis Demarchi, Wildlife Branch. Victoria, B.C.
- B.C. Ministry of Forests, Cranbrook Forest District, 1990. Synopsis of the Cranbrook Forest District Portion Trench Integrated Renewable Resource Management Plan. Cranbrook, B.C.
- B.C. Ministry of Forests 1981. Cranbrook TSA - Yield Analysis Technical Report. Victoria, B.C.
- B.C. Ministry of Forests, Nelson Forest Region. September 1985. Timber Supply Area Plan for the Cranbrook TSA. Nelson, B.C.

8 Glossary

Allowable annual cut (AAC)	The allowable rate of timber harvest from a specified area of land. The Chief Forester sets AACs for timber supply areas (TSAs) and tree farm licences (TFLs) in accordance with <i>Section 7</i> of the <i>Forest Act</i> .
Culmination age	The age at which a timber stand reaches its highest mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.
Cutblock adjacency	The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.
Forest inventory	Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

8 Glossary

Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Merchantable age	The age at which a stand attains a minimum acceptable size, quality and/or volume to make it suitable for harvesting.
Modification VQO	Alterations may dominate the visual landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service, Silviculture Branch. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective)
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with <i>Section 6</i> of the <i>Forest Act</i> .
Visual Quality Objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

APPENDIX A

Description of Data Inputs and Assumptions

Introduction

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

A.1 Zone and Analysis Unit Definition

A.1.1 Definition of management zones

The timber harvesting land base was divided into 9 zones on the basis of differing forest management practices. Management practices vary between zones because of the emphasis on non-timber resources, the use of different harvesting methods or harvesting history.

Management zones were defined through the use of planning cells and polygons.

A brief description of the zones and the forest cover requirements used in the 1994 timber supply review analysis is as follows:

Management Zone 1: Landscape Visual Quality - Retention or Partial Retention

All those areas with an assigned VQO (Visual Quality Objective) in the Timber Supply Review (TSR) inventory file of retention or partial retention.

Management Zone 2: Community Watersheds

All those areas that the Ministry of Environment, Lands, and Parks has identified as being licensed community watersheds.

Planning Cells - Cranbrook Watershed:

C005, C008, C010, C080, G185, G187, G190, G195, G200, G205, G210

Planning Cells - Mark Creek (Kimberley):

K015, K020, K025, K030, K035, K040

Planning Cells - Matthew Creek (Kimberley, Marysville):

S685, S690, S695, S700, S705, S710, S715, S720, S725

Planning Cells - Fairy Creek (Ferne):

E030

Planning Cells - Boivin Creek (Elkford):

E160, E165, E170

Planning Cells - Silver Spring Lake (Elko):

T555

Planning Cells - Glencairn Creek (Moyie):

M220

Planning Cells - Cummins Creek (Sparwood):

E065, E070, E075, E080, E085, E090

Planning Cells - Reserve Creek (Tobacco Plains I.R.):

T660

Planning Cells - Blavatsky Creek (MacDonald Ranch and Lumber):

T695

Forest Cover Polygons - Kimberley Creek (Meadowbrook):

Map Sheet 082G071:

entire polygons:

0659, 0660, 0605, 0606, 0604, 0589, 0792, 0614, 0617, 0619, 0791, 0620, 0352, 0793, 0621, 0618, 0370, 0351, 0371, 0349, 0372, 0369, 0353, 0385, 0384, 0367, 0368, and 0354.

A.1 Zone and Analysis Unit Definition

partial polygons:

.74 of 0655, .81 of 0662, .19 of 0663, .65 of 0661, .49 of 0607, .4 of 0664, .04 of 0608.46 of 0658, .48 of 0608, .21 of 0590, .5 of 0580, .17 of 0592, .65 of 0613, .39 of 0794, .74 of 0615, .34 of 0623, .43 of 0622, .33 of 0630, .60 of 0616, .37 of 0588, .88 of 0373, .96 of 0350, .02 of 0348, .06 of 0346, .28 of 0304, .89 of 0366, .20 of 0345, .06 of 0340, .5 of 0356, .15 of 0383, .82 of 0362, .2 of 0361, .53 of 0364, .51 of 0775, .41 of 0342, .12 of 0103.

Map Sheet 082G061:

entire polygons: 0015, 0014.

partial polygons: .01 of 0012, .83 of 0013, .79 of 0011, .45 of 0016, .12 of 0213.

Management Zone 3: Riparian

This zone was defined as 23% of the remaining net operable land base after zones 1 and 2 had been established. This is based on Geographic Information System (GIS) analysis of Moyie LRUP area and Mark Creek Watershed. The approved *Cranbrook Forest District Riparian Management Zone Guidelines* identify specific forest cover constraints for riparian management zones.

Management Zone 4: Landscape Visual Quality - Modification

All those remaining areas with an assigned VQO in the TSR inventory file of modification.

Management Zone 5: Caribou Habitat

The area identified by the Ministry of Environment Lands and Parks as being critical core caribou habitat in the Cranbrook Forest District. They indicate that the caribou herd in this area is threatened with potential extirpation.

The remaining area in planning cells:

M105, M100, M095, M090, M080, M075, M085, P035, P030, P025, S075, S080, S070, P040, P020, S085, S090, S035, S030, S100.

The remaining area in that portion of the following planning cells above elevation 1800 metres:

M065, M070, M035, M040, M045, M060, M065, M050, M125, M135, P005, M110, M115, M120, P010, P015, P045, S095, S065, S060, S055, P050, P055, S025, S020, S040, S050, S045, S105, S110, S115, S120, S125.

Management Zone 6: Forage Predominant

Areas in the East Kootenay Rocky Mountain Trench that have been prioritized for forage production by the *Trench Integrated Renewable Resource Management Plan* plus a portion of the Wigwam River drainage that has been targeted for prescribed fire and forage production for wildlife habitat needs.

The remaining area in planning cells:

T040, T140, T160, T165, T185, T200, T225, T265, T370, T375, T450, T482, T495, T600, T630, T635, T675, W145.

A.1 Zone and Analysis Unit Definition

Management Zone 7: Forage Significant

Areas in the East Kootenay Rocky Mountain Trench that have been prioritized for significant forage production in conjunction with timber production by the *Trench Integrated Renewable Resource Management Plan* plus a portion of the Wigwam River drainage that has been targeted for increased forage production for wildlife habitat needs.

The remaining area in planning cells:

T050, T075, T085, T205, T260, T380, T385, T405, T470, T480, W150, W155.

The following timber emphasis zones are subdivided by biogeoclimatic classification and geographic area to allow for modelling the *Cranbrook Forest District Interim Old Growth Strategy*.

Management Zone 8: Timber Emphasis - PPdh2

The remaining area that has an assigned biogeoclimatic classification of PPdh2 in the TSR inventory file.

Management Zone 9: Timber Emphasis - IDFdm2

The remaining area that has an assigned biogeoclimatic classification of IDFdm2 in the TSR inventory file.

Management Zone 10: Timber Emphasis - ICHmk1

The remaining area that has an assigned biogeoclimatic classification of ICHmk1 in the TSR inventory file.

Management Zone 11: Timber Emphasis - ICHmw2

The remaining area that has an assigned biogeoclimatic classification of ICHmw2 in the TSR inventory file.

Management Zone 12: Timber Emphasis - MSdk

The remaining area that has an assigned biogeoclimatic classification of MSdk in the TSR inventory file.

Management Zone 13: Timber Emphasis - ESSFdk South

The remaining area that has an assigned biogeoclimatic classification of ESSFdk in the TSR inventory file within those planning cells that start with a "C", "G", "P", or "M" (except for M005-020, M171, and M205-260).

Management Zone 14: Timber Emphasis - ESSFdk East

The remaining area that has an assigned biogeoclimatic classification of ESSFdk in the TSR inventory file within those planning cells that start with a "B", "E", "F", "T", or "W".

Management Zone 15: Timber Emphasis - ESSFdk West

The remaining area that has an assigned biogeoclimatic classification of ESSFdk in the TSR inventory file within those planning cells that start with a "K", "P", "S", "Y", and selected "M" (includes M005-020, M171, and M205-260).

Management Zone 16: Timber Emphasis - ESSFwm South

The remaining area that has an assigned biogeoclimatic classification of ESSFwm in the TSR inventory file within those planning cells that start with a "C", "G", "P", or "M" (except for M005-020, M171, and M205-260).

A.1 Zone and Analysis Unit Definition

Management Zone 17: Timber Emphasis - ESSFwm East

The remaining area that has an assigned biogeoclimatic classification of ESSFwm in the TSR inventory file within those planning cells that start with a "B", "E", "F", "T", or "W".

Management Zone 18: Timber Emphasis - ESSFwm West

The remaining area that has an assigned biogeoclimatic classification of ESSFwm in the TSR inventory file within those planning cells that start with a "K", "P", "S", "Y", and selected "M" (includes M005-020, M171, and M205-260).

A.1.2 Analysis unit definition

An analysis unit represents a group of similar stands. Generally, an analysis unit contains stands that possess similar tree species composition and similar timber growing capabilities. In the inventory file, the major combinations of species are called type groups and timber growing capability, or site quality, is indicated by a site index or site class. For the Cranbrook TSA analysis, site groups were assigned using new site class (NSITE) and (if present) special site class (SSITE). Analysis units and the inventory file variables used to define them, are shown in Table A-1.

A.1 Zone and Analysis Unit Definition

Table A-1. Analysis unit definition

Analysis unit	Species description	Site class	Inventory type groups	Comments
1	PI (pure)	G,M	28	
2	PI (pure)	P	28	
3	PI (leading)	G,M	29-31	
4	PI (leading)	P	29-31	
5	PI (age class 3)	G,M,P	28-31	
6	SB types, Pw, Pa, FS	G,M	4, 18-27	
7	SB types, Pw, Pa, FS	P	4, 18-27	
8 ^a	CH types, FC, FH	G,M,P	2, 3, 9-17	
10	FPy,Py	G,M	6, 32	
11	FPy,Py	P	6, 32	
12	FPy,Py,F,FPI	L	1, 5, 6, 32	trench low sites
13	FL types, FPI	G,M	1, 5, 7, 8, 33, 34	
14	FL types, FPI	P	1, 5, 7, 8, 33, 34	
15	High elevation sites	G,M,P	all	elevation >1800 m
20	Forage area	all	1-34	
21	Forage area	all	1-34	0 volume

(a) Initially, two analysis units were defined for CH types, FC, and FH: one, comprising good and medium sites, the other, poor sites. These units were subsequently combined. Some tables listed later in this appendix show the separated analysis units, numbered 8 and 9.

The area within each zone and analysis unit is given in Table A-2. The areas shown include the adjustments to not satisfactorily restocked (NSR) areas described later in this appendix. Note that all analysis units are not represented in every zone.

In the Cranbrook TSA, pure pine, spruce, cedar, hemlock and high elevation forest types are harvested using a clearcut harvesting system and are restocked by planting or natural regeneration while mixed pine, and mixed fir types are harvested using a seed-tree harvest system which are also restocked by natural regeneration, or in some cases planting to assist the natural regeneration. The intent of the seed-tree systems is to aid regeneration by leaving enough trees standing to provide seed to regenerate surrounding areas.

A.1 Zone and Analysis Unit Definition

Table A-2. Area by zone and analysis unit

Analysis unit	Area (hectares) by zone									
	1	2	3	4	5	6	7	8	9	10
1	3 006	7 280	10 583	1 032	468				1 283	16 550
2	570	1 284	2 012	138	103				341	2 562
3	3 852	3 160	10 416	1 099	570			53	3 312	15 443
4	352	290	1 636	134					337	2 318
5	1 527	1 010	8 561	341	860				1 012	11 680
6	703	1 764	9 009	230	2 854			47	658	5 307
7	274	1 184	4 448	184	1 358				82	1 968
8	177		815		85					347
10	225		1 696					499	1 374	
11	449		1 586					923	884	
12	82		203					144	141	79
13	5 972	1 295	12 694	1 243	44			247	9 923	16 375
14	4 031	569	6 503	466				1 012	7 242	6 528
15	460	4 654	6 916	719	6 392					
20						1 637	1 364			
21						6 162	5 135			
Total	21 680	22 491	77 080	5 587	12 735	7 798	6 499	2 925	26 588	79 159

Analysis unit	Area (hectares) by zone								
	11	12	13	14	15	16	17	18	Total
1	1 330	1 835	3 193	4 766	1 342	502	134	2 789	56 095
2	89	165	1 080	1 329	425	135		369	10 602
3	2 314	3 769	1 948	2 594	668	400	273	1 860	51 732
4	124	288	688	1 106	90	71	36	163	7 634
5	2 333	2 958	2 132	3 895	295	673	103	2 032	39 412
6	1 159	3 906	1 492	7 330	165	1 033	1 864	3 830	41 353
7	278	1 460	862	4 688	250	833	788	2 133	20 790
8	390	1 204		47		44	174	383	3 667
10									3 795
11									3 844
12							31		681
13	2 351	7 561	368	917	257	74	131	1 044	60 498
14	1 002	1 260	222	430	78	33	124	294	29 795
15			1 708	8 609	1 114	1 078	804	2 744	35 198
20									3 001
21									11 297
Total	11 369	24 406	13 692	35 710	4 684	4 878	4 461	17 641	379 383 ^a

(a) NSR not included in these summaries.

Note: Totals may not sum correctly due to rounding.

A.2 Definition of the Timber Harvesting Land Base

The final timber harvesting land base was determined by first deducting all areas considered to be currently unavailable for timber production from the total TSA area. All NSR area on the inventory file was also removed at this stage as a first step in updating the NSR figure. The NSR area, updated to 1993, was then added back to establish the current timber harvesting land base. Harvesting operations will subsequently result in the removal of some of that initial area because of long-term productivity losses. All these categories are summarized in Table 1 of the main report.

A.2.1 Non-Crown land

Non-Crown land is all land that is not administered or managed by the B.C. Forest Service and includes such categories as provincial parks, private land and areas under federal jurisdiction. This area, which is identified on the inventory file as ownership code not equal to 61C, 62C, 69C, or 76C, is excluded from the land base. In some cases 69C areas were converted to 69N so that they would not be considered in the forestry land base. These areas are as follows:

Table A-3. Exclusion of specific, geographically defined areas

Identifying inventory variables	Excluded area (hectares)	Reason for exclusion
Mapsheet 082G002 Forest cover polygons: 543-547, 558 Mapsheet 082G003 Forest cover polygons: 67, 68, 72, 76-79, 89--95	119.8	Ward Creek Ecological Reserve - map reserve
Mapsheet 082G008 Forest cover polygons 609, 622, 623, 631-633, 637-646, 650-652, 654, 656, 1115, 20% of 624 and 1113, 50% of 474, 80% of 655 Exclude ownership 69C on map 82G004	327.0 65.5	Proctor Lake Ecological Reserve - map reserve Earl Ranch - Section 101 Land Act transfer
Mapsheet 082G045 Forest cover polygons: 66, 150-153, 157-166, 171-173, 175-179, 227, 232-237, 257-264,	62.0	Fernie Ski Hill
Mapsheet 082F068 Forest cover polygons: 534, 518, 541, 544-547, 767 Mapsheet 082G072 Forest cover polygon 508 Mapsheet 082G051 Forest Cover polygons: 373, 375, 384, 387, 904, 905	125.2	Old-growth map notations: Baker Creek, Lewis Creek, Perry Creek

A.2 Definition of the Timber Harvesting Land Base

A.2.2 Non-forest land

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

A.2.3 Non-commercial cover

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

A.2.4 Environmentally sensitive areas (ESAs)

Environmentally sensitive areas include areas which have moderate to high non-timber values such as wildlife, water and areas which are prone to excessive site degradation if harvested because of geological and topographical conditions. Table A-3. shows the percentage area reduction by ESA category.

Table A-4. Per cent area reductions for environmentally sensitive areas

ESA code	ESA description	Per cent area reduction	Operable area to be excluded (hectares)
Ea1	High avalanche concerns	100	67
Eh1	Watershed protection forest	90	111
Ep1	High regeneration problems	90	10 197
Ep2	Regeneration problems	50	1 480
Er ₁	High recreation concerns: Recreation management class is "0"	100	4 702
Er2	Recreation feature significance is "A" or "B" and the management class is "1" and no VQO has been assigned	50	5 452
VQO - P	Visual quality objective of preservation	100	635
Es ₁	High soil and steepness concerns	90	12 754
Es2	Soil and steepness concerns	50	4 314
Ew1	High fish and wildlife concerns	100	720

A.2 Definition of the Timber Harvesting Land Base

A.2.5 Low site

Low sites are areas of low growth potential (productivity) which, for the most part, renders them unsuitable for timber production. Other than FPY, Py, F, and FPl types, the areas with a site class of 'L' on the inventory file were netted out of the land base. The above forest types with site class of 'L' were only netted down by 20%, with the remainder (80%) being attributed to analysis unit 12.

A.2.6 Deciduous stands

As deciduous species are not utilized at present, all stands with deciduous as the major component are removed from the land base. Deciduous stands are identified on the inventory file as type group 35 to 42 inclusive.

A.2.7 Non-merchantable stands

This category includes coniferous stands that are available for harvesting but are not economic to harvest because of excessive decay or poor stocking. Non-merchantable stands are excluded from the land base as follows.

Table A-5. Area exclusion by forest type

Type group or species	Criteria				Per cent excluded	Area excluded ^a (hectares)
	Age class	Height class	Stocking class	Site class		
35 - 42	any	any	any	any	100	6 674
all	≥3	<2	any	G,M,P	80	6 918
1,5,6,32	any	any	any	L	20	304
2-4,7-31,33,34	any	any	any	L	100	11 130
5-8,32	3	2	0, 2	M,P	10	5 227
5-8,32	4	2	0, 2	M,P	20	9 820
5-8,32	≥5	2	0, 2	M,P	40	15 888
9-17	8	any	any	G,M,P	40	865
9-17	9	any	any	G,M,P	100	1 367
18,19	≥8	any	any	G,M,P	60	1 161
20	≥8	any	any	G,M,P	30	2 125
28-31	3	2	0, 2	G,M,P	15	6 157
28-31	4	2	0, 2	G,M,P	25	13 102
28-31	≥5	2	0, 2, 4	G,M,P	50	0
ESSFdk-p	any	any	any	any	100	478
ESSFwm-p	any	any	any	any	100	3 719

(a) Rounded to the nearest hectare.

A.2.8 Inoperable areas

Inoperable land is that part of the forested area that is not likely to be accessible for timber harvesting because of the combination of rough terrain, difficult access and economic factors. All areas with inoperable identifier 'I' are excluded from the land base.

A.2 Definition of the Timber Harvesting Land Base

A.2.9 Existing unclassified roads, trails and landings

Past timber harvesting operations have resulted in a loss of productive forest land. However, many of the existing roads, trails, landings and related disturbances are not accounted for in the inventory file. To account for this loss in the area available for timber harvesting a 4.5 % reduction was applied. The area in existing roads and landings was determined using both digitized Coordinated Access Management Plan information and using Engineering records, PHSP, and ISIS/MLIS information.

A.2.10 Future roads, trails and landings

There will also be losses in productive area as future harvesting occurs. All existing stands will also be subject to future losses which are assumed to be 4.5%. This estimate is consistent with the estimate for existing roads. The area that will eventually be lost (to timber production) is not initially excluded from the land base. The B.C. Forest Service timber supply model (FSSIM) simply reduces the areas by 4.5% after the first time all stands currently over 20 years old are harvested.

A.2.11 Not satisfactorily restocked adjustments

The NSR area must also be made to agree with the silviculture history records for the Cranbrook TSA. The first step in the adjustment procedure was to exclude all areas that are classified as NSR on the inventory file (type identity codes 4 and 9). As shown in Table 1 of the main report, the area excluded was 46 749 hectares (a 4.5% reduction for existing roads, trails and landings had already been applied).

All backlog and current NSR area is assumed to become restocked in the first decade. The following explains how the NSR area was adjusted for this analysis.

Table A-6. NSR area adjustments

Analysis unit	Backlog NSR		Current NSR		Excluded NSR ^a	Total area (hectares) ^b
	Area (hectares)	Rate of restocking per cent /decade	Area (hectares)	Rate of restocking per cent /decade		
1	524	100	853	100	90	1 467
2	122	100	195	100	20	337
3	2 790	100	4 569	100	460	7 819
4	1 109	100	1 815	100	180	3 104
5	0	0	0	0	0	0
6	4 508	100	7 408	100	740	12 656
7	1 365	100	2 242	100	220	3 827
8	73	100	110	100	10	193
9	61	100	97	100	10	168
10	353	100	585	100	60	998
11	1 462	100	2 400	100	240	4 102
12	231	100	378	100	40	649
13	1 998	100	3 278	100	330	5 606
14	597	100	987	100	100	1 684
15	1 474	100	2 425	100	240	4 139
Total	16 668		27 341		2 740	46 749

(a) Excluded NSR are those areas which have been denuded and are inaccessible for treatment. Area returning to the land base is 46 749 minus 2 740 = 44 009 hectares.

(b) These values include the excluded NSR.

A.3 Forest Management Practices

This section describes forest management as currently practiced in the Cranbrook TSA. The information was provided by the Cranbrook Forest District staff and Nelson Forest Region staff.

A.3.1 Utilization levels

Harvesting is assumed to be carried out to a utilization level of 12.5 cm diameter at breast height (dbh) (1.3 metres) for lodgepole pine timber types and 17.5 cm dbh for all other timber types.

A.3.2 Utilization standards

For modelling purposes, interior close utilization standards of a maximum 30 cm stump height and a minimum 10 cm inside-bark diameter at tree top, less decay were used.

A.3.3 Minimum harvestable ages

Minimum harvestable ages used in the analysis were set by Cranbrook Forest District staff after review of volume per hectare requirements, culmination ages and field experience. Minimum harvestable ages are listed in Table A-7.

Table A-7. Minimum harvestable age for each analysis unit

	Analysis unit		Minimum average DBH (cm)	Estimated minimum harvestable age
1	PI (pure)	G,M		70
2	PI (pure)	P		80
3	PI (leading)	G,M		70
4	PI (leading)	P		80
5	PI (age class 3)	G,M,P		50
6	SB types, Pw, Pa, FS	G,M		100
7	SB types, Pw, Pa, FS	P		100
8	CH types, FC, FH	G,M		100
9	CH types, FC, FH	P		100
10	FPy, Py	G,M		80
11	FPy, Py	P	28 cm	100 ^a
12	FPy, Py, F, FPI	L	28 cm	200 ^a
13	FL types, FPI	G,M		100
14	FL types, FPI	P		100
15	High elevation	G,M,P	28 cm	170 ^a
20	Forage	all		130
21	Forage	all		130

(a) Derived from variable density yield prediction (VDYP) curves to meet target diameter breast height (DBH).

These minimum harvestable ages are based on current management practices. For some species, they are somewhat lower than what was used in previous analyses. This reflects the type of harvesting that has been occurring in the Cranbrook Forest District (e.g. harvesting of mountain pine beetle infested or susceptible stands - see also Table A-12).

A.3 Forest Management Practices

A.3.5 Basic silviculture and regeneration assumptions

Table A-8. shows the regeneration regime after harvesting occurs in existing analysis units. Managed stand yield tables (MSYTs) were created to reflect the proportions of analysis units converted to other analysis units and the percentages of stands that are assumed to be managed. The resultant MSYTs are shown in Section A.4.2, "Yield tables for regenerated stands." The regeneration assumptions shown below apply to all zones.

A.3 Forest Management Practices

Table A-8. Regeneration assumption

Existing analysis unit	Regenerated analysis unit	Per cent conversion	Per cent of area natural	Per cent of area planted	Regen delay (years)	Initial stocking (sph)
1 PI (pure) G,M	1	15	100	0	7	3000
	3	50	90	10	7	3000
	6	20	90	10	7	4000
	13	15	90	10	7	4000
2 PI (pure) P	2	15	100	0	4	3000
	4	60	70	30	7	3000
	7	10	50	50	7	4000
	11	15	100	0	7	3000
3 PI (leading) G,M	3	50	90	10	4	3000
	6	25	70	30	4	4000
	13	25	90	10	7	3000
4 PI (leading) P	4	50	80	20	7	3000
	7	15	100	0	7	4000
	11	35	100	0	7	3000
5 PI age class 3	1	20	100	0	7	3000
	2	30	100	0	7	3000
	3	20	100	0	7	3000
	4	30	100	0	7	3000
6 SB types G,M	3	30	20	80	7	3000
	6	70	20	80	4	4000
7 SB types P	4	30	40	60	7	3000
	7	70	50	50	4	4000
8 CH types G,M	3	40	10	90	4	3000
	6	40	20	80	4	3000
	8	10	50	50	7	4000
	13	10	50	50	7	4000
9 CH types P	9	100	80	20	7	3000
10 FPy, Py G,M	10	40	100	0	7	2000
	13	60	100	0	7	3000
11 FPy, Py P	11	80	100	0	7	3000
	14	20	100	0	7	3000
12 FPy, Py, F, FPI L	14	100	100	0	7	3000
13 FL types, FPI G,M	3	25	100	0	7	3000
	6	10	80	20	7	4000
	13	65	80	20	4	3000
14 FL types, FPI P	7	15	100	0	7	4000
	11	10	100	0	7	3000
	13	75	100	0	7	3000
15 High elevation stands	15	100	85	15	7	4000
20	20	100	100	-	7	3000

A.3 Forest Management Practices

Analysis unit 21 represents existing stands that will be maintained as range after harvest. Therefore, no regeneration regime is shown for that analysis unit.

Data source and comments

Data from ISIS/MLSIS

Regeneration delay is calculated from the time logging commences on a block.

Initial stocking of natural stands is an estimate based on stocking surveys, local knowledge, and MLSIS/ISIS data. High stocking reflects high total stems/hectare on most sites in the Cranbrook Forest District.

A.3.6 Rehabilitation of brush areas

Over the next 10 years, 1130 hectares of current brush areas are planned for rehabilitation. Specifically, 180 hectares are to be converted to analysis unit 1, 900 hectares to analysis unit 3, and 50 hectares to analysis unit 8.

A.3.7 Harvest profile

Table A-9. illustrates the harvest profile used in the analysis. At least 5 % of the harvest is to come from analysis unit 5 (Pl age class 3) for the first decade only. After 10 years, analysis unit 5 no longer exists — it is transferred to analysis unit 3.

Table A-9. *Historical harvest profile*

Analysis unit	Per cent of total harvest volume
5	5

A.3 Forest Management Practices

A.3.8 Forest cover requirements

Table A-10. specifies the forest cover requirements needed to achieve the forest management objectives for each zone.

Table A-10. Management zone forest cover requirements

	Management zone	Height 1 (metres)	Green-up age (years)	Maximum per cent area younger than green-up age	Old-growt h age (years)	Minimum per cent area older than old-growth age
1	VQO - R/PR	6	27	10	140	10
2	Watershed	9	39	25	140	10
3	Riparian	9	38	35	120	25
4	VQO - M	6	28	20	140	10
5	Caribou	3	23	35	140	12
6	Forage - predominant	0		90	140	3
7	Forage - significant	0		70	140	6
8	Timber - PPdh2	3	20	35	140	6
9	Timber - IDFdm2	3	18	35	140	6
10	Timber - ICHmk1	3	17	35	140	6
11	Timber - ICHmw2	3	17	35	140	10
12	Timber - MSdk	3	18	35	140	6
13	Timber - ESSFdk South	3	19	35	140	3
14	Timber - ESSFdk East	3	21	35		a
15	Timber - ESSFdk West	3	20	35		a
16	Timber - ESSFwm South	3	21	35		a
17	Timber - ESSFwm East	3	22	35		a
18	Timber - ESSFwm West	3	20	35		a

(a) Old-growth requirements, as per the *Interim Old Growth Strategy*, can be met through existing old growth in protected areas, non-contributing areas, and other management zone constraints.

A.3 Forest Management Practices

Data source and comments

The forest cover requirements for the VQO zones are based on the procedures outlined in *Procedures for Factoring Recreation Resources into Timber Supply Analyses Technical Report 1993:1* and applying TSR inventory file information on total and net forested area by VQO, analysis unit, and zone.

The forest cover requirements for the watershed zone are based on the Mark Creek IWMP and regional and provincial watershed guidelines.

The forest cover requirements for the riparian zone are based on the *Cranbrook Forest District Riparian Management Guidelines* and information from Geographic Information System (GIS) riparian projects on Mark Creek and the Moyie Corridor.

The forest cover requirements for the caribou zone are based on a best estimate of current management practices and a commitment to maintaining some old-growth stands within this zone.

The forest cover requirements for the forage predominant zone and the forage significant zone are based on the *Trench Integrated Renewable Resource Management Plan* and the *Cranbrook Forest District Interim Old Growth Strategy*.

The forest cover requirements for the timber zones are based on a first-pass of 40% and on the net operable old-growth area required (from TSR inventory file) to meet the overall objectives of the *Cranbrook Forest District Interim Old Growth Strategy*.

The years required to achieve the various heights were based on area-weighting the time required to achieve the specified green-up heights for each analysis unit. The average site indices were obtained through the use of FREDTAB and then FREDDIE was used to project the required height-age relationships.

A.3 Forest Management Practices

A.3.9 Unsalvaged losses

Table A-11. shows the estimated average annual volume loss to catastrophic events such as wildfires and insect attacks. Regeneration of these denuded areas is expected to occur within 4 years. Estimated annual losses are deducted from the gross timber supply to determine the projected net volumes that will be harvested over time.

Table A-11. Unsalvaged losses

Cause of loss	Gross losses in cubic metres/year	Net losses in cubic metres/year	Salvaged volume in cubic metres/year	Net annual unsalvaged losses in cubic metres per year
Insects	1 176 000 ^a	517 000 ^b	440 000 ^c	77 000
Disease	- ^d	22 000 ^e	11 000 ^f	11 000
Fire	30 000 ^g	13 000 ^h	12 000 ⁱ	1 000
Wind damage	- ^j	84 000 ^k	34 000 ^l	50 000
Other				
Total	1 206 000	709 000	497 000	139 000

(a) Ten year average from FIDS survey.

(b) 56% netdown for operable land base.

(c) 700 000 m³ in salvage permits @ 60% infested.

(d) No information available - no systematic surveys.

(e) From FS surveys. Does not include areas not identified, growth loss, or licensee surveys.

(f) 50% of surveyed area salvaged.

(g) Ten year average from Protection records.

(h) 56% netdown for operable land base.

(i) 80% salvage, 10% burned, 10% not salvaged (20% net loss).

(j) No information available - no systematic surveys.

(k) From surveys.

(l) Volume from blowdown/snowdown salvage permits.

The purpose of this section is to estimate the average annual unsalvaged volume loss to insect and disease epidemics, fires, wind damage or other agents over the long term on the net operable land base.

A.4 Yield Tables

A.4.1 Yield tables for existing stands

The yield tables applied to most existing stands in the analysis are shown in Table A-12. These tables were generated for each zone and analysis unit using the Variable Density Yield Prediction (VDYP) system. Through the use of the l_OAF.dat file used by the FSSIM model, some of the yields were further reduced by a proportion equal to 15% of volumes to account for seed-tree systems. These tables are not applied to the current area of NSR. The yield tables for these areas are presented in Section A.4.2, "Yield tables for regenerated stands."

A.4 Yield Tables

Table A-12. Yield estimates for existing stands

	PI pure G, M 1	PI pure P 2	PI lead G, M 3	PI lead P 4	PI - AC 3 G, M, P 5	SB G, M 6	SB P 7	CH FC FH G, M, P 8	FPy, Py G, M 10
0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	13	2	13	1	19	1	0	1	1
40	57	7	52	6	63	12	3	12	13
50	101	30	90	25	107	38	10	38	35
60	141	57	125	50	146	71	23	70	60
70	176	84	156	73	180	104	44	102	84
80	208	108	183	94	211	133	68	131	107
90	237	131	208	114	239	158	91	156	130
100	265	152	232	132	266	181	113	179	151
110	290	173	253	149	290	202	133	199	170
120	314	192	273	165	313	220	152	217	187
130	337	211	292	181	335	238	170	237	203
140	351	224	305	192	349	253	188	255	216
150	363	235	315	201	360	268	203	271	228
160	371	242	322	208	367	281	218	286	238
170	375	247	325	213	372	292	231	299	247
180	376	249	327	215	373	303	244	312	254
190	374	249	326	216	371	312	255	323	261
200	376	252	329	219	373	321	266	335	266
210	379	254	331	222	376	330	276	346	271
220	381	257	333	225	378	338	286	358	276
230	384	259	336	227	381	345	295	369	280
240	386	262	338	230	383	352	304	380	284
250	388	264	340	232	385	359	312	390	287
260	391	266	342	234	387	362	315	393	287
270	393	268	343	235	389	365	319	397	288
280	394	269	345	236	391	368	322	400	288
290	396	271	346	238	393	370	325	402	288
300	398	272	347	239	394	373	328	405	288
310	399	273	348	240	395	375	330	407	288
320	400	274	349	240	397	377	332	409	288
330	401	275	350	241	398	378	334	411	288
340	402	276	351	242	399	380	336	413	287
350	403	276	351	242	399	382	338	415	287

continued

A.4 Yield Tables

Table A-12. Yield estimates for existing stands (concluded)

	FPy, Py P 11	FPy Py F FPI L 12	FL, FPI G, M 13	FL, FPI 14	Hi-Elev G, M, P 15	Forage significant 20	Forage predominant 21
0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	2	0	2	1	1
40	2	0	16	3	17	10	10
50	11	0	40	14	40	28	28
60	26	1	68	33	65	50	50
70	43	5	98	54	91	71	71
80	59	11	127	75	116	92	92
90	75	19	155	97	139	112	112
100	90	27	183	118	161	131	131
110	104	36	209	138	181	149	149
120	117	43	233	156	200	165	165
130	129	51	256	174	219	180	180
140	140	58	275	189	233	193	193
150	149	64	288	201	246	203	203
160	158	69	297	210	256	213	213
170	165	74	303	217	265	220	220
180	172	79	307	222	271	227	227
190	178	84	310	228	276	233	233
200	184	89	313	233	282	239	239
210	190	93	317	238	288	245	245
220	195	97	320	243	293	250	250
230	200	101	323	247	299	255	255
240	204	105	325	251	304	259	259
250	208	109	328	255	309	263	263
260	209	109	328	256	311	263	263
270	210	109	329	256	314	263	263
280	210	109	329	256	316	264	264
290	210	109	329	256	318	264	264
300	211	109	329	256	320	264	264
310	211	109	329	256	321	265	265
320	211	109	329	256	323	265	265
330	211	109	329	256	324	265	265
340	211	110	329	256	325	265	265
350	211	110	329	256	326	265	265

A.4 Yield Tables

A.4.2 Yield tables for regenerated stands

Yield tables applied to future regenerated stands, existing managed stands and NSR are shown in the following tables. These tables are based on managed stand yield tables (MSYTs) - table interpolation program for stand yields (TIPSY) developed by the Research Branch of the B.C. Forest Service. To construct the tables for the analysis, average site productivity (site index) for each analysis unit and the basic silviculture regeneration assumptions described in Section A.3.5, "Basic silviculture and regeneration assumptions" were applied. To account for operational conditions, a 15% reduction was applied to all yield values. Yields were further reduced in older ages by 5% to account for decay, waste and breakage.

A.4 Yield Tables

Table A-13. Yield tables for regenerated stands

	PI pure G, M 101	PI pure P 102	PI lead G, M 103	PI lead P 104	PI - AC 3 G, M, P 105	SB G, M 106	SB P 107	CH FC FH G, M 108
0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
30	8	2	8	0	20	2	0	1
40	33	13	31	3	75	13	1	8
50	78	34	69	13	128	34	4	20
60	128	72	113	25	174	72	10	46
70	185	120	163	45	218	120	22	78
80	233	170	207	66	250	170	40	115
90	274	216	244	87	277	216	61	151
100	309	259	276	109	299	259	84	186
110	338	299	302	128	318	299	105	220
120	361	330	324	150	334	330	125	249
130	382	353	342	169	345	353	143	272
140	399	373	358	186	355	373	162	290
150	412	387	371	200	363	387	178	306
160	424	400	382	212	370	400	192	319
170	433	411	391	222	376	411	203	332
180	441	420	398	232	380	420	212	343
190	447	428	404	239	385	428	220	354
200	453	433	409	246	388	433	227	363
210	458	438	413	253	391	438	232	371
220	461	442	417	258	393	442	237	381
230	464	445	420	263	393	445	241	389
240	467	446	422	268	393	446	245	396
250	469	446	424	272	393	446	248	404
260	471	446	425	275	393	446	251	410
270	472	445	427	278	393	445	253	417
280	473	445	427	280	393	445	254	422
290	473	444	428	282	393	444	255	427
300	473	444	428	284	393	444	256	431
310	473	444	428	284	393	444	256	431
320	473	444	428	284	393	444	256	431
330	473	444	428	284	393	444	256	431
340	473	444	428	284	393	444	256	431
350	473	444	428	284	393	444	256	431

continued

A.4 Yield Tables

Table A-13. Yield tables for regenerated stands (concluded)

	FPy, Py G, M 110	FPy, Py P 111	FPy Py F FPI L 112	FL, FPI G, M 113	FL, FPI P 114	Hi-Elev G, M, P 115	Forage significant 120
0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	3	0	0	0
40	0	0	0	15	0	0	0
50	6	0	0	40	1	2	2
60	25	2	0	76	9	20	16
70	52	9	0	120	29	56	40
80	84	23	0	161	55	104	69
90	115	39	0	195	84	154	106
100	142	55	1	226	114	199	139
110	166	77	4	254	142	241	168
120	188	97	6	278	166	286	192
130	210	114	10	298	185	321	214
140	228	129	15	317	203	351	237
150	245	142	20	334	219	372	257
160	259	153	24	349	235	391	274
170	274	164	29	361	248	405	288
180	287	174	34	372	259	416	302
190	299	184	39	381	269	427	315
200	310	193	43	389	278	435	328
210	320	201	47	396	286	443	339
220	329	209	50	403	293	450	348
230	337	215	55	410	300	454	358
240	344	221	60	415	306	458	366
250	350	226	64	420	312	461	374
260	355	231	68	424	316	464	381
270	360	235	72	427	320	466	387
280	364	239	76	430	325	465	393
290	368	243	79	433	328	464	397
300	372	246	82	434	331	464	401
310	372	246	96	434	331	464	401
320	372	246	96	434	331	464	401
330	372	246	96	434	331	464	401
340	372	246	96	434	331	464	401
372	372	246	96	434	331	464	401

Forage predominant (initial analysis unit 21) areas are harvested once and put onto a '0' volume curve as these areas are intended to be managed for range. Forage significant areas (initial analysis unit 20) are harvested and regenerated (regenerated analysis unit 120).