Prince George 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 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 the Prince George 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 the 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 Prince George TSA consists of about 7 510 000 hectares of land located in the central interior of British Columbia. About 3 620 000 hectares of the area are considered available for timber harvesting under current management practices. The area is dominated by forests of hybrid Engleman-white spruce, lodgepole pine, and subalpine fir with minor amounts of Douglas-fir, cedar, trembling aspen, and hemlock.

The results of this analysis indicate that using current inventory and timber growth information, and assuming continuation of current forest management practices, the current AAC for the TSA of 9 073 661 cubic metres per year can be maintained. (This AAC and analysis do not address allowable harvests from woodlots.) The analysis indicates that it is possible to harvest at a rate of 9 630 000 cubic metres per year — 6% higher than the current AAC — without declining for 250 years. Alternative harvest forecasts indicate that the intial harvest level can be increased without affecting the long-term harvest level.

This analysis reflects current knowledge and information on forest inventory and growth. However, it is important to recognize that uncertainty exists about several of the factors that define timber supply. A series of sensitivity analyses indicate that these uncertainties can affect timber supply to varying degrees. Three important factors which may affect future harvest levels are uncertainty about the size of timber harvesting landbase, and uncertainty about estimates of timber volume in existing and future stands.

Uncertainty in the size of the timber harvesting land base is particularly important because the projected increase in timber supply, relative to the current AAC, is due primarily to the increased inclusion of marginally economic stands that were previously considered non-merchantable. The timber supply analysis does not account for possible future changes in the land base due to the Protected Areas Strategy, Forest Practices Code, Land and Resource Management Plans, Native land claims and Local Resource Use Plans.

Another important factor contributing to the projected increase in timber supply is the use of managed stand yield estimates to project the volume of regenerated stands. In general, the managed stand yield estimates are about 20% more productive than the existing stands they will replace.

The results of sensitivity analysis indicate that the harvest forecast shown in the base case is generally unaffected by changes to forest management assumptions, especially in the short term. This is due primarily to the abundance of existing mature timber that allows flexibility in the schedule of harvests.

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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 Prince George TSA. 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 alues such as recreation and visual quality.

1 Description of the Prince George TSA

The Prince George TSA is one of six TSAs in the Prince George Forest Region. As indicated in Figure 1, it is located in the north central interior of the province. The TSA covers approximately 7 510 000 hectares and is administered by the Prince George, Vanderhoof and Fort St. James Forest Districts. Population centres of the TSA include the City of Prince George and the communities of Vanderhoof, Fort St. James, Hixon, Fraser Lake, Fort Fraser, Strathnaver, Giscome, Upper Fraser and Bear Lake.

During the 1960s, the expansion of the forest industry made the Prince George area the commercial center in the northern interior. Forest industries such as pulp, paper, lumber and plywood still constitute the bulk of the area's manufacturing with 13 large and medium sized sawmills, a plywood plant and three pulp mills.

The Prince George TSA is topographically diverse. The large central and south western portion is fairly flat and rolling with gentle slopes. This area supports forests of predominantly lodgepole pine and white spruce. The eastern edge of the TSA runs along the Rocky Mountains. Spruce and balsam (sub-alpine) stands dominate these mountains while the foothills support large stands of cedar and hemlock. In the Fort St. James Forest District the terrain is more mountainous comprised in the north by the Omineca and Skeena mountains ranges. In this forest district, pine dominates the valley bottoms, spruce dominates the lower and mid slopes and balsam dominates the upper slopes.

The Prince George Forest District contains Tree Farm Licences (TFLs)*: 30 and 53; and the Fort St James Forest District contains TFL 42. The timber supply in these areas is assessed as part of a separate planning process for tree farm licences and, therefore, is not examined in this report. Three Land and Resource Management Planning (LRMP) processes, associated with the three forest districts, are underway.

Tree Farm Licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

1 Description of the Prince George TSA

Figure 1. Map of the Prince George Timber Supply Area.

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 July of 1993. This file contains a considerable amount of data about the thousands of pieces of forest land that make up a TSA, including the geographic location, area and nature of the forest cover (such as presence or absence of trees, number of trees, species, age and timber volume).

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

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

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

All study areas, as identified under the Protected Area Strategy, are assumed to be available for timber harvesting. This is because Cabinet has not made these land-use decisions. When these decisions are made, further analysis will ensure that impacts on timber supply are evaluated.

In the summer of 1993, when analysis information was being documented, current forest practices were consistent with the spirit and intent of the new Forest Practices Code. Both B.C. Forest Service and Ministry of Environment, Lands and Parks staff believe the provisions made in this analysis will not account fully for all the management practices of the Forest Practices Code. Areas on which timber harvesting is not expected to occur, under current forest management in the Prince George TSA, are:

- areas not managed directly by the B.C. Forest Service — these include non-Crown land, areas managed by other agencies (for example, parks, recreation areas) and forest land not administered as part of the TSA (for example, woodlot licences or TFLs);
- non-forest areas — areas not capable of growing productive forest (for example rock, swamp and alpine areas);

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.

Riparian
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

- environmentally sensitive areas* — portions of the areas classified as sensitive are considered unavailable for timber harvesting;
- non-commercial cover areas — areas occupied by non-commercial tree or brush species;
- residual stands — areas with only a few trees per hectare due to previous timber harvesting methods that cut only trees of usable species or physical dimension. The result is stands of relatively low volume per hectare composed of less desirable species. Many of these areas are scheduled to be rehabilitated under various silviculture initiatives;
- low site productivity — sites with low timber growing potential (low site index*);
- non-merchantable forest types* — areas occupied by timber stands of low volume or non-merchantable species;
- inoperable areas — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (for example presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Detailed studies of physical operability and economic viability of harvesting helped define the timber harvesting land base;
- existing roads, trails and landings — forest land lost to future timber production due to past access development and harvesting;
- sensitive caribou and riparian habitat — areas where any timber harvesting will damage or disturb habitat. These areas include moutain caribou habitat in the east portion of the TSA, a riparian area within Government Creek Management Zone and the Sustut River Preservation Zone. To account for additional riparian areas as mentioned previously, the timber harvesting land base was reduced 1% across all stand types and ages;
- preservation visual quality areas — areas of specific significance that are not available for timber harvesting in order to maintain aesthetic value;
- future roads, trails, and landings — to account for future losses of productive land to development. These areas are initially included in the harvesting land base, and are removed as part of the first harvest.

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

Table 1 summarizes the areas in each category, and shows the area of the timber harvesting land base. Figure 2 shows that approximately 71% of total area of the TSA is productive forest land managed by the B.C. Forest Service, and Figure 3 shows that approximately 65% of that land is available for timber harvesting. This means that slightly less than half of the total area of the TSA is considered part of the timber harvesting land base.

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

Site index
A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia’s major commercial tree species.

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

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

2 Information Preparation

Table 1. Timber harvesting land base for the Prince George TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file[a]	7 512 789	100.0	
Not managed by B.C. Forest Service	430 920	5.7	
Non-forest	1 770 990	23.6	
Total productive forest managed by Forest Service (Crown forest)	5 310 879	70.9	100.0
Reductions to Crown forest:			
Environmentally sensitive areas	335 806	4.5	6.3
Non-commercial cover (brush)	83 111	1.1	1.6
Residual stands	1 625	0.0	0.0
Low site productivity	303 232	4.0	5.7
Non-merchantable forest types	517 340	6.9	9.7
Inoperable	317 457	4.2	6.0
Existing roads	46 070	0.6	0.9
Sensitive Caribou Habitat	47 589	0.6	0.9
Riparian areas	35 389	0.5	0.7
Visually Sensitive Preservation areas	2 503	0.0	0.0
Total current reductions[b]	1 699 379	22.6	31.9
Initial timber harvesting land base (includes 212 409 hectares not satisfactorily restocked* land[c])	3 620 757	48.2	68.1
Future reductions:			
Future roads	170 045	2.3	3.2
Long-term timber harvesting land base	3 450 712	45.9	64.9

Note: Appendix A, "Description of Data Inputs and Assumptions" contains details for each forest district.

(a) The total area on the inventory file used for this analysis does not account for several parks within the Prince George TSA boundary. These parks include Carp Lake Provincial Park, Kakwa Recreation Area, Eskers Provincial Park and others.

(b) Reductions to the land base were made in the order that they appear.

(c) NSR includes: current NSR; backlog NSR; NSR due to natural disturbances; and 2 700 hectares of residual stands resulting from old logging.

Figure 2 Classification of total land base, Prince George TSA, 1994.

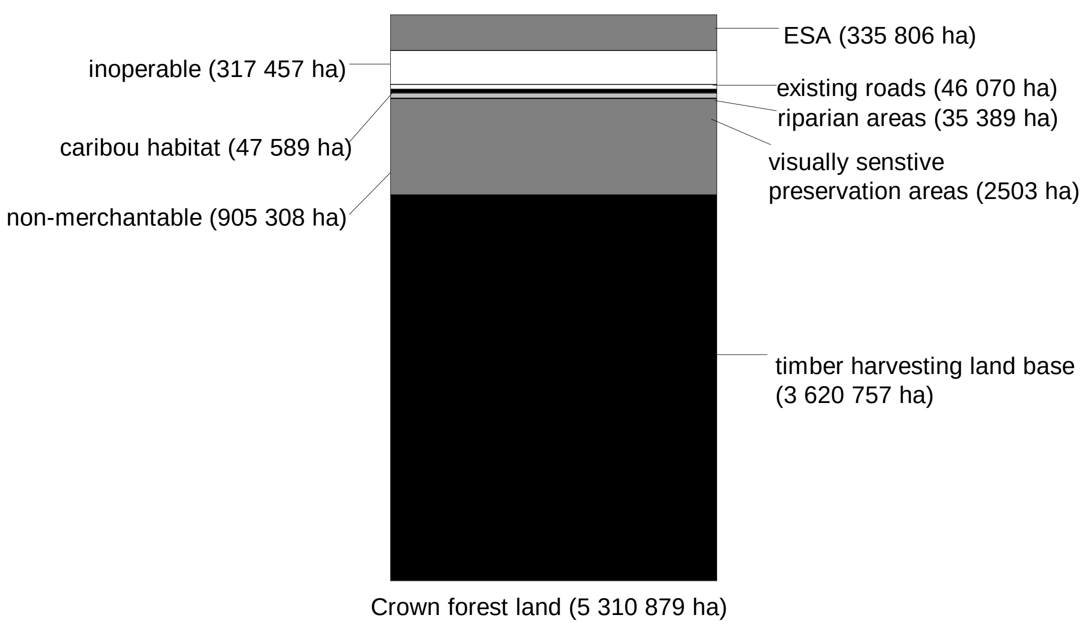


Figure 3 Classification of the productive forest land base, Prince George TSA, 1994.

Figure 4 shows the stand age distribution, by leading species, of the timber harvesting land base. The figure illustrates a well balanced composition that is vitally important to the timber supply situation for this TSA. There is a large proportion of area covered by stands aged 40 to 140 years. These stands support harvesting in the medium term.

This age profile is unlike many of the TSAs in the province. In many other management units, there are very few stands between 40 and 140 years old. This gap in the distribution of age classes has significant impacts on timber supply, if current harvest levels are to be maintained, because the harvesting of existing mature stands must be scheduled to last until younger stands become available for harvest. The balanced age distribution of the Prince George TSA allows greater flexibility of harvest schedules.

Figure 4 also illustrates the tree species that make up the current age class distribution. Stands between the ages of 0 and 40 years are dominated by spruce and pine. This is because reforestation activities of the 1960s focused on spruce as the desired species while pine redily regenerates naturally. Pine dominates stands aged 41 to 160 years with a small component of spruce. The pine stands that are between 41 and 140 years are mainly a result of wild fires. The burned over areas regenerate pine stands that result in large areas being covered by trees of the same age. Most of the stands older than 160 years are made up of spruce and balsam species. There are very few older pine stands because most are disturbed by fire and pest infestations at a relatively young age.

Figure 5 illustrates the composition of the timber harvesting land base by forest district, tree species and timber growing potential or site productivity. Pine stands on sites of medium growing potential make up the single largest component of the TSA (26%). The bulk of the TSA's medium and poor pine stands (52.6%) are in the Vanderhoof Forest District. The Prince George and Fort St. James Forest Districts contain virtually all of the good site pine stands (88.5%).

The timber harvesting land base is comprised of 1.4% fir stands (51 730 hectares), 16.1% balsam stands (583 862 hectares), 33.0% spruce stands (1 193 796 hectares) and 49.4% pine stands (1 789 350 hectares). There is a considerably larger portion of the timber harvesting land base dominated by balsam leading stands than is reflected by current harvest profiles, especially in the Fort St. James Forest District. If harvest levels are to be maintained, more harvesting of balsam must occur.

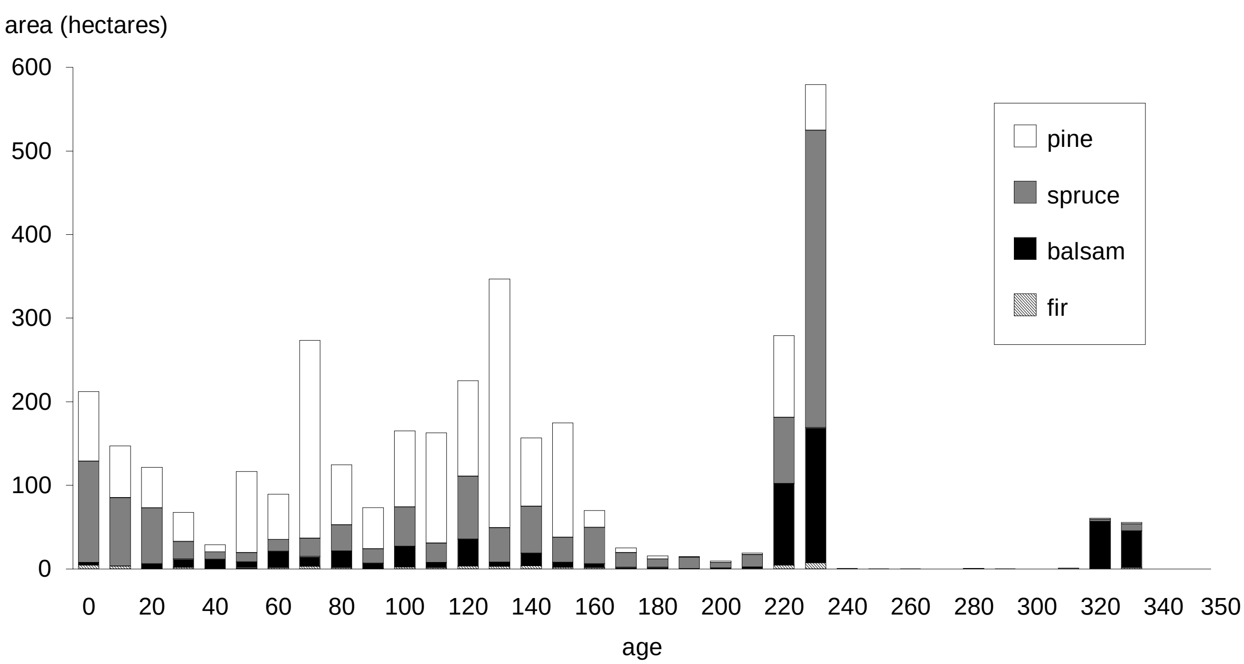
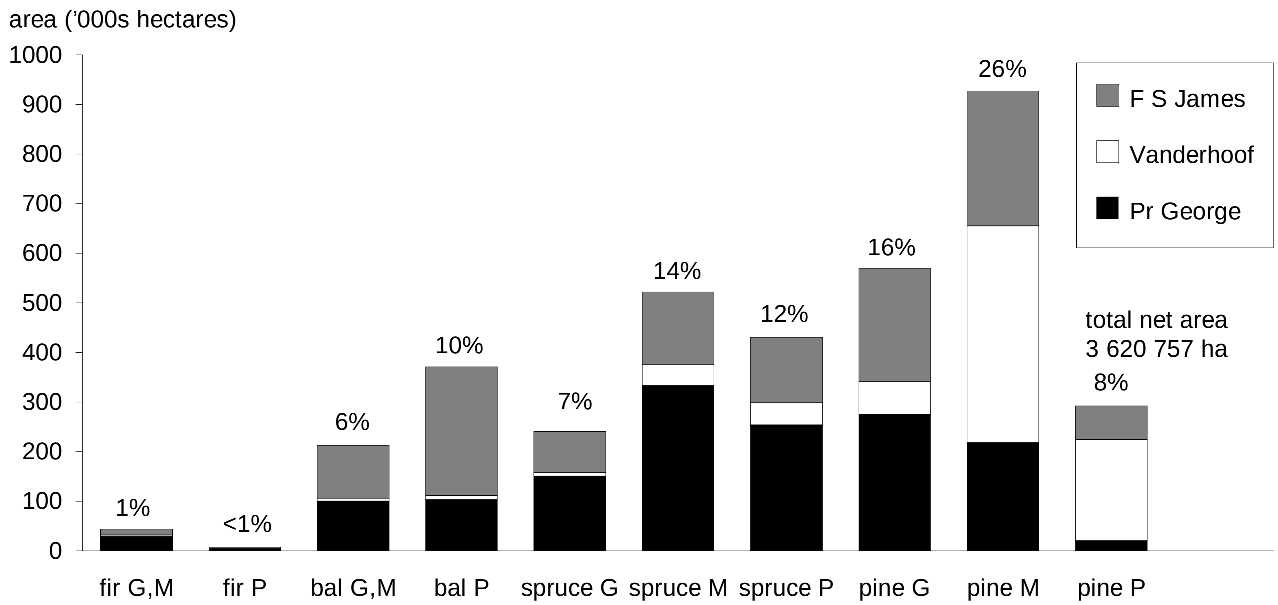


Figure 4. Area by stand age and dominant tree species, Prince George TSA timber harvesting land base.

2 Information Preparation



G = good site class
M = medium site class
P = poor site class

Figure 5. Area by dominant tree species, site productivity and forest district, Prince George TSA timber harvesting land base, 1994.

2.2 Timber growth and yield

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

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

2.3 Management practices

Timber supply is directly affected by forest management activities. The focus of the Timber Supply Review is to describe the timber supply based on current management activities, as implemented in plans and various other policies and regulations. Staff in the Prince George, Vanderhoof and Fort St. James Forest Districts and in the Prince George Forest Region defined these practices as described in the following management assumptions:

- Basic silviculture levels — include reforestation activities required to establish free-growing stands of acceptable species. In the Prince George TSA, almost all areas are harvested using the clearcut harvesting system and restocked by planting;
- Backlog silviculture program — includes reforestation of areas harvested prior to 1987 when the law changed requiring licencees to reforest harvested areas;

- Forest health and unsalvaged losses — expected losses due to fire, pest (insect and disease) and wind damage. These losses are estimated to be 254 500 cubic metres per year, due mainly to insects including mountain pine beetle and spruce bark beetle;
- Utilization levels — specify the minimum size of a tree that must be harvested and removed from the site. These are specified by a maximum stump height, and a minimum diameter at the tree base and top. The maximum height of a stump is 30 centimetres. Spruce trees are generally required to be removed from a harvested area if the diameter at the stump is greater than or equal to 20 centimetres. For most pine trees harvested this diameter is 15 centimetres. There are exceptions where licence documents specify that trees with smaller diameters are to be taken. Tops can be cut off and left on site if the diameter (inside the bark) at the large end of the top piece is 10 centimetres or less;
- Minimum harvestable age — the minimum age at which a stand is allowed to be harvested. Currently, pine stands must be at least 100 years old, balsam must be at least 120 years old, and fir and spruce must be at least 140 years old to be considered available for harvest. These minimum ages were established to ensure that the older, slower growing, more disease susceptible timber is harvested first. As more of these older stands are harvested and less are available, the minimum harvestable age will be lowered to be closer to the age at which stands reach their maximum average growth. Minimum ages for this analysis were generally set at the youngest age at which stands reach within 5% of their maximum average growth or culmination age*. For all stands within the TSA, the minimum age used ensures that trees are much larger than the minimum merchantable size acceptable for harvesting or processing in local sawmills. Actual harvest age in the analysis may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives (e.g. for adjacency and visual quality) and overall timber harvest objectives;
- Cutblock adjacency* — regenerated stands on a harvested site must reach a desired condition such as a height before timber harvesting may occur on areas directly adjacent. The time taken for a regenerated stand to reach this average height is known as green-up age*. In the Prince George TSA this minimum height was established for two reasons — to ensure adequate hiding cover for large animals such as moose and bear, and to ensure adequate buffering of rainwater runoff to prevent adverse hydrological events sometimes associated with clearcut harvesting systems. For the Vanderhoof and Fort St. James Forest Districts, the green-up height is 2.5 metres. The Prince George District uses 3.0 metres. The difference between these districts relates to average snow depth. More snow in the Prince George Forest District requires that regenerated stands be taller to provide adequate hiding cover.

As well as requiring a minimum green-up height, the 1986 Prince George TSA Plan established detailed maximum cutblock sizes and minimum reserve widths between adjacent harvested areas. The criteria for minimum reserve widths and cutblock size are based on a detailed evaluation of integrated resource management objectives for each part of the TSA. These criteria were also used to quantify the current harvest pattern.

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 management guidelines. They can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.

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

2 Information Preparation

A review of development plans indicates that to harvest all of the timber in a watershed without violating reserve widths or cutblock sizes requires 3 to 5 passes or entries into the watershed. A 3-pass system allows a third of the watershed to be harvested on each of the three passes. At any time, no more than 33% of the area may be under cover of stands younger than green-up age. For a 5-pass system, a fifth of the area may be harvested per pass so that no more than 20% of the area may be under cover of stands younger than green-up age. For this analysis, the average is assumed — that no more than 25% of an area may be under cover of stands younger than green-up age. It is likely that when harvests are actually scheduled, more than 25% of the timber harvesting land base within a watershed will be harvested. This is because there are forested areas within the watershed that are not considered part of the timber harvesting land base (i.e. environmentally sensitive areas or wildlife habitat areas such as those listed in Table 1) that contribute to the total area within the watershed.

- Visual quality — in visually sensitive areas, green-up conditions are achieved when the trees on a previously harvested area are approximately 5 metres tall. The proportion of each visually sensitive area that may have stands that do not meet the green-up requirement varies depending on the visual quality objectives* for the area. This analysis includes four classes of visually quality objectives: preservation*, retention*, partial retention* and modification*. Areas classified as maximum modification* were combined with those classified as modification and areas classified as preservation were not considered part of the timber harvesting land base. Appendix 1 contains details of these objectives.
- Large block management — trees in some areas of the Prince George Forest District are prone to being blown down. These trees are generally found in the reserve strips adjacent to harvested areas. To minimize losses, management prescriptions include harvesting activities such as adjusting the shape of cutblock edges so that trees there will be less susceptible to prevailing winds. Where this is not possible, adjacency and green-up requirements are relaxed and harvesting proceeds in a windward direction with only the establishment of a regenerated stand as criteria for allowing the harvest of an adjacent cutblock. This management technique results in large amounts of area being under cover of stands that have not reached green-up conditions. This large block management technique is permitted on only one third of 1% of the TSA. Without this special management, significant amounts of timber would be blown down and subject to salvage operations.
- Bowron Watershed — between 1980 and 1987 a large portion of the Bowron Watershed was harvested to salvage timber that was infested with spruce bark beetle. Until sufficient vegetation regenerates to mimic adequately the previous forest's interception of snow and moderation of water runoff, no further harvesting in this area is permitted. Therefore, cutblock adjacency guidelines do not allow any harvesting until the regenerated forest meets hydrologic green-up requirements.

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.

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

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

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

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

- Fisheries management — the Forfar Creek Watershed has been identified as part of the Stuart-Takla Fisheries/Forestry Interaction Project. This is a study that is designed to examine the long-term impacts of timber harvesting on salmon habitat. The Forfar Creek Watershed is, therefore, designated a control area; this means that no timber harvesting activities will be permitted for 20 years. For the purposes of this analysis, harvesting from this area was deferred 20 years.
- Local resource use plan* areas — several areas within the TSA are the subject of local planning processes. In some of these areas, Entiako, Blackwater, and Herrick, timber harvesting activities have been halted while plans are being developed. A similar deferral of harvesting activities is occurring in the Treaty 8 Moratorium area while the McLeod Lake Indian Band and the provincial government negotiate a settlement. For the purposes of this analysis, harvesting from these areas was deferred for 10 years.

Table 2 presents the composition of the harvesting land base according to the main management emphasis. Figures A-1., A-2. and A-3. in the appendix indicate where the management areas are located. The sensitivity of the harvest forecast* to changes in the estimates of forest cover requirements is examined in Section 5.6, "Sensitivity to uncertainty in cutblock adjacency guidelines".

Table 2. Proportion of the timber harvesting land base subject to each forest management consideration

Management category	Area (ha)	Per cent
Visual Quality — retention	57 313.20	1.58
Visual Quality — partial retention	97 322.08	2.69
Visual Quality — modification	14 716.60	0.41
Local Resource Use Plans and Treaty 8	148 405.67	4.10
Forfar Creek Fisheries Study Area	1 277.70	0.04
Caribou medium habitat	17 632.30	0.49
Caribou corridors	17 369.20	0.48
Chedakuz riparian zone	26 646.70	0.74
Bowron Watershed	32 653.80	0.90
Large block management zone	11 204.10	0.31
Integrated resource management	3 196 216.00	88.27
Timber harvesting land base	3 620 757.00	100.00

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

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.

Local resource use plan
A strategic plan for a portion of a timber supply area or tree farm licence that provides management guidelines for integrating resource use in the area.

3 Analysis Methods

The purpose of this analysis was to examine both the short- and long-term timber harvesting opportunities in the Prince George 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 Prince George 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." The base case provides only a part of the timber supply picture in the Prince George TSA, and should not be viewed in isolation of the sensitivity analysis.

It should be noted that this analysis does not address the timber supply that may or may not be eligible to harvest under the authority of various Pulpwood Agreement and wood lots that exist in this TSA.

The base case harvest forecast level is 9 630 000 cubic metres per year (Figure 6). This is 6% above the current AAC of 9 073 661 cubic metres per year. Several criteria were used to define the base case harvest forecast. The initial level was defined by attempting to maintain the current harvest level for as long as possible without compromising future timber harvests. Because the current harvest level can be achieved for the entire harvest forecast, non-declining levels were successively increased until future harvest shortfalls resulted. The base case harvest forecast is the maximum non-declining harvest level that can be achieved without resulting in future shortfalls. Furthermore, in the long term, the timber growing stock* for the base case harvest forecast remains at an even level indicating that harvesting could continue at this constant level in perpetuity (Figure 7). A continually declining growing stock would signify that timber is being harvested at a rate greater than the productivity of the land.

The non-declining harvest forecast shown is possible because of many factors. The two main factors are the large amount of mature timber that is available for harvest and the use of managed stand volume estimates for regenerated stands. In the Prince George TSA, regenerated stands are predicted to yield approximately 20% more volume than existing stands at any given age. This means that an increase in the harvest rate would be expected at the point where managed stands begin to be harvested, approximately 90 to 130 years from now. However, this does not happen because there is currently enough mature growing stock to sustain the current harvest at the same rate as predicted by regenerated yields. This is demonstrated through sensitivity analysis of regenerated stand yields found in Section 5.3. The last two tables of the appendix show the regenerated timber volume estimates used in this analysis.

Another important factor is the size of the timber harvesting land base. The previous analysis indicated a timber harvesting land base of 3 415 300 hectares. For the analysis contained in this report, a refinement of the definition of the timber harvesting land base, using detailed assessments of physical and economical operability, resulted in a timber harvesting land base of 3 620 757 hectares, 6% larger than the land base used in the previous analysis.

The base case shows a non-declining harvest flow slightly above the current AAC. This harvest flow does not maximize total timber harvest possible from the forest. There is an abundance of mature timber available for harvest that could be used to increase short-term harvest levels without affecting the long-term harvest flow. This is demonstrated in Section 5.1, "Alternative harvest flows." Many of the sensitivity analyses conducted resulted in smaller impacts than seen in many other TSA's because of the abundance of mature volume available in the short term.

To account for estimated unsalvaged losses to insects, fire and wind, 254 000 cubic metres per year has been subtracted from all harvest forecasts shown in this report.

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

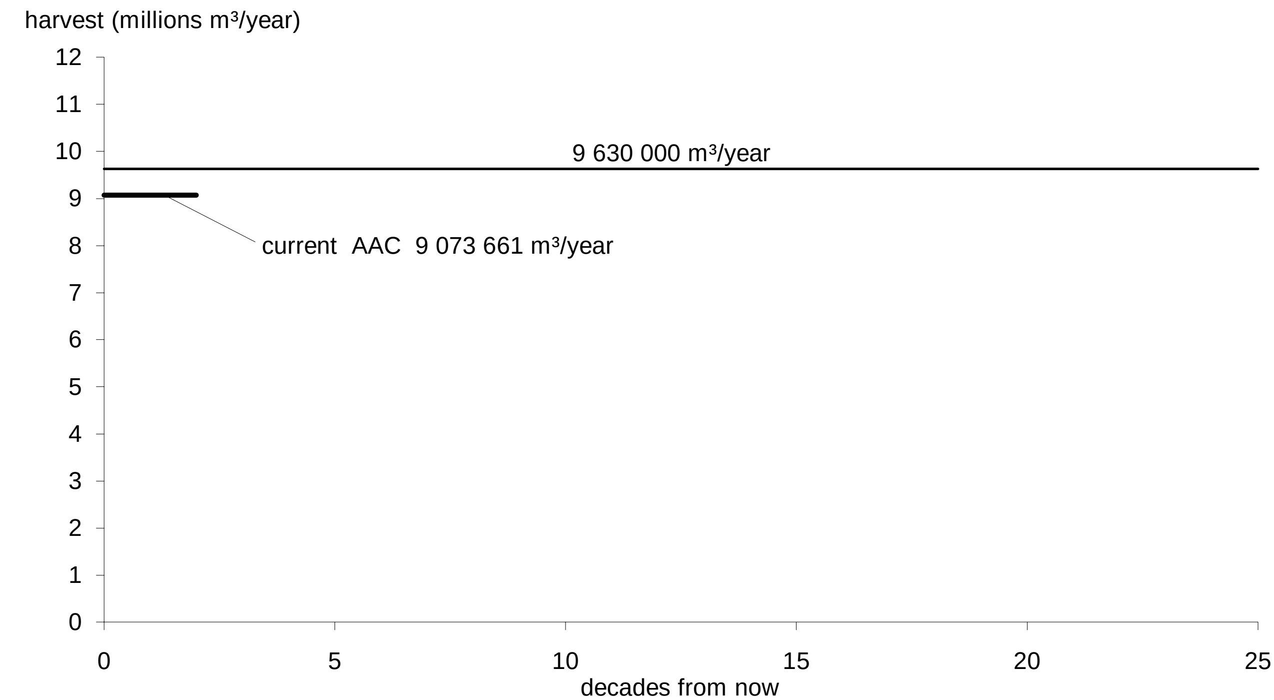


Figure 6. Base case harvest forecast for the Prince George TSA, 1994.

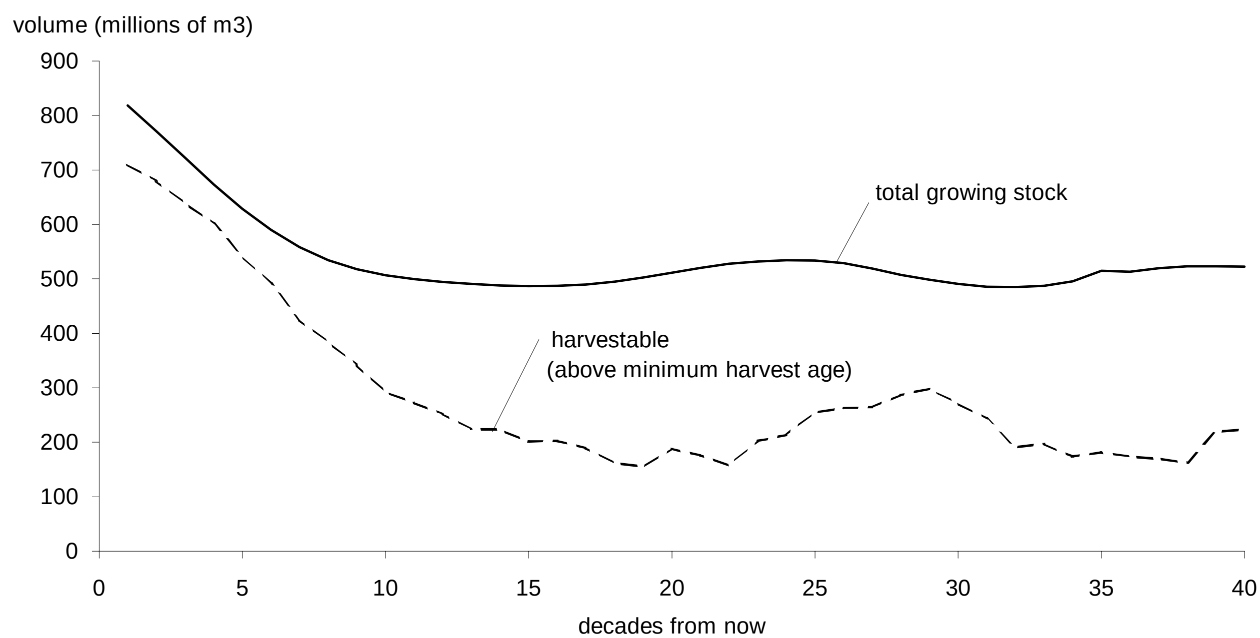


Figure 7. Changes in timber growing stock over time, Prince George TSA base case, 1994.

Figure 8 shows how the area harvested would change over the next 250 years if the base case harvest forecast were followed. Figure 9 shows the average timber volume per hectare harvested over the same period. Both of these graphs display very little fluctuation around the average. The average volume per hectare harvested over the first 250 years is 335 cubic metres. The average area harvested per year is 29 500 hectares. Peaks in area harvested, at decades 4, 7, 10 and 11, correspond to low points in average volume per hectare harvested. Low points in area harvested, during decades 2, 8 and 13, correspond to peaks in average volume per hectare harvested. This relationship is expected since the annual volume of timber harvested is constant.

Figure 10 tracks the change in average stand age harvested over time. Over the next 100 years, harvesting occurs in existing natural stands. The average harvest age of these stands is about 200 years. From this period on, harvesting is concentrated in regenerated stands (second-growth). The average age harvested for the regenerated stands is about 120 years. Figure 9 shows very little fluctuation in average volume per hectare harvested over time. This means that the volume recovered from harvesting existing stands, that are on average 200 years old, is very close to the volume predicted to be harvested from regenerated stands that are on average 120 years old. Generally, the more intensively managed second-growth stands yield approximately 20% more volume than the existing stands at a given age. This can be seen in Table A-22. of Appendix A.

In Figure 10, the peaks in average age harvested generally correspond to times when stands growing on sites with poor productivity make up a larger part of the harvest. For example, between years 220 and 230 over 30% of the volume harvested is from poor site stands. This harvest is fairly evenly distributed between all three districts with poor site balsam dominating the Fort St. James Forest District, poor site spruce dominating the Prince George Forest District and poor site pine dominating the Vanderhoof Forest District.

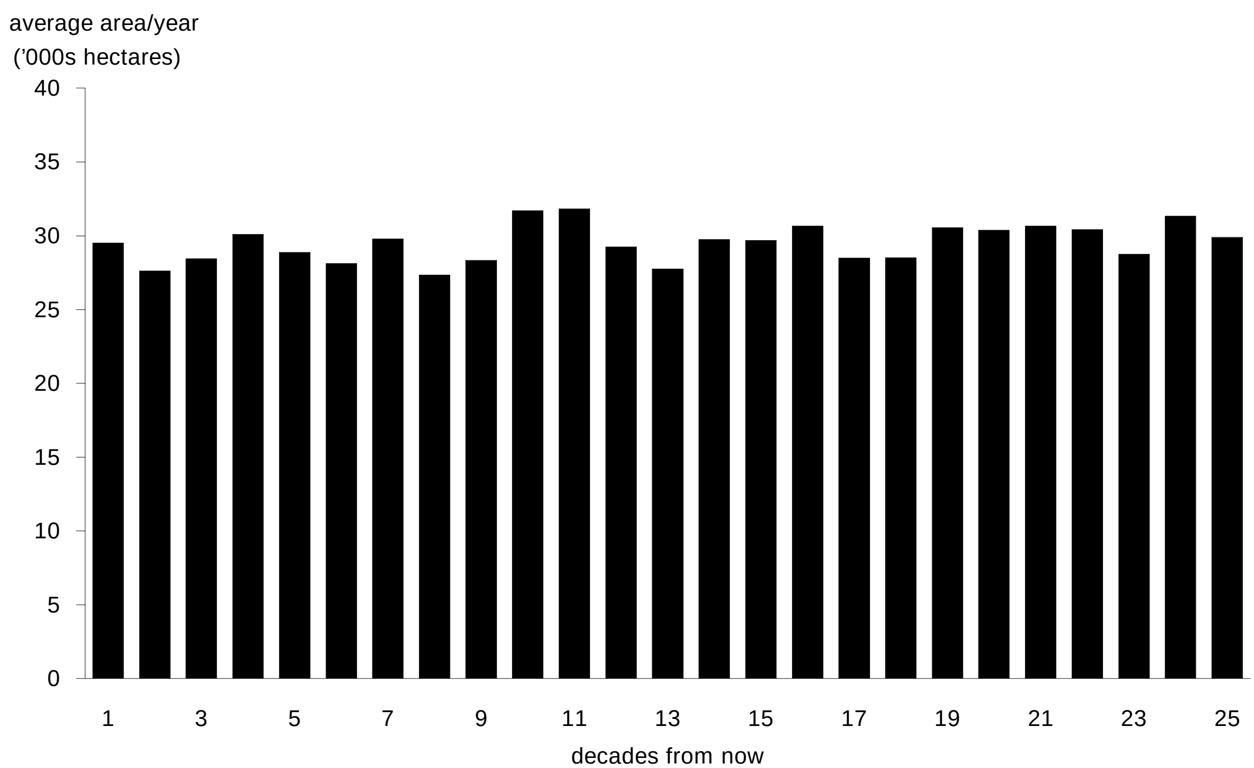


Figure 8. Area harvested over time Prince George TSA base case, 1994.

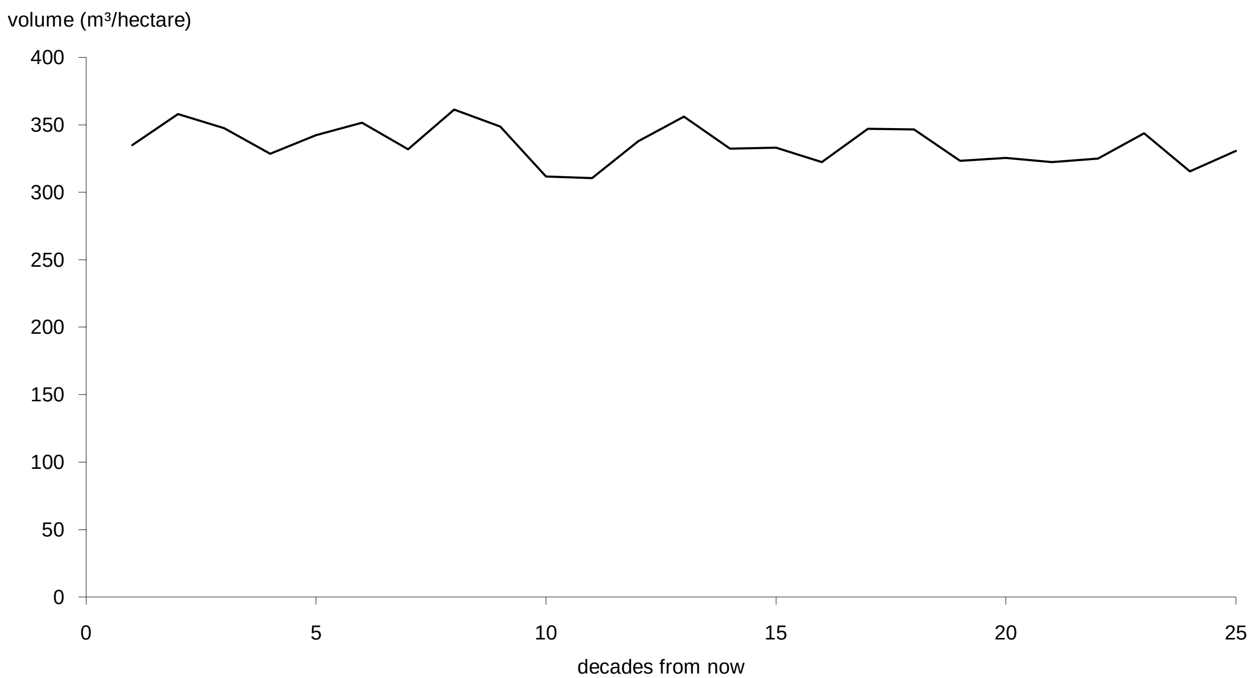


Figure 9. Average volume per hectare harvested over time, Prince George TSA base case, 1994.

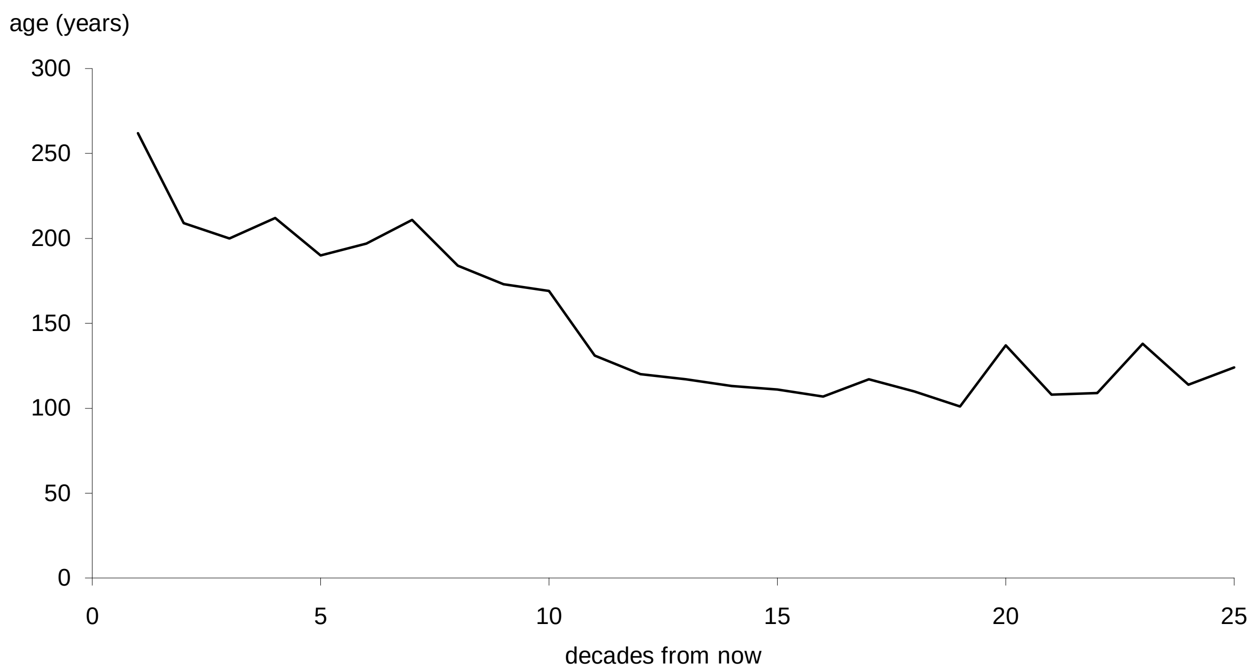


Figure 10. Average age of harvested stands over time, Prince George TSA base case, 1994.

4 Results

Figure 11 shows how the age composition of the forest, within the timber harvesting land base, would change over the next 200 years under the base case harvest forecast. Forecasts have been shown for the current land base, the land base predicted for 50 years from now, 120 years from now and 200 years from now. The current distribution shows a fairly even spread of areas across both immature and mature ages. This even distribution is repeated for 50 years from now. Although not shown, the distribution at 100 years is much more skewed to the immature forest areas. By year 120, the amount of mature forest present is the lowest experienced in the entire 400 year planning horizon. After 120 years from now, the balance of age classes improves and by year 200, the distribution shows the pattern expected in a second-growth forest that is subject to forest cover guidelines.

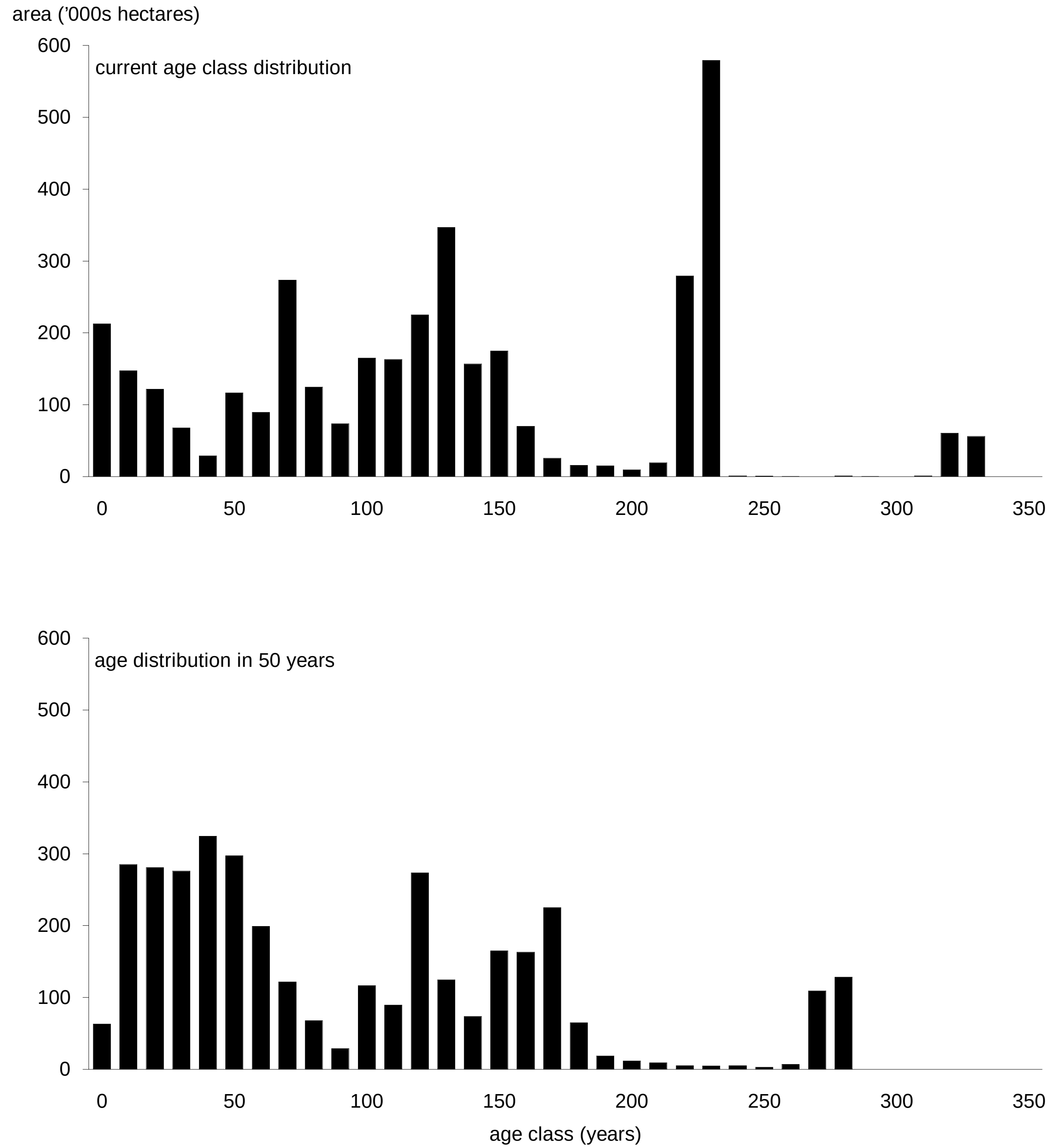


Figure 11. Age class distribution of the timber harvesting land base, Prince George TSA base case, 1994.(continued)

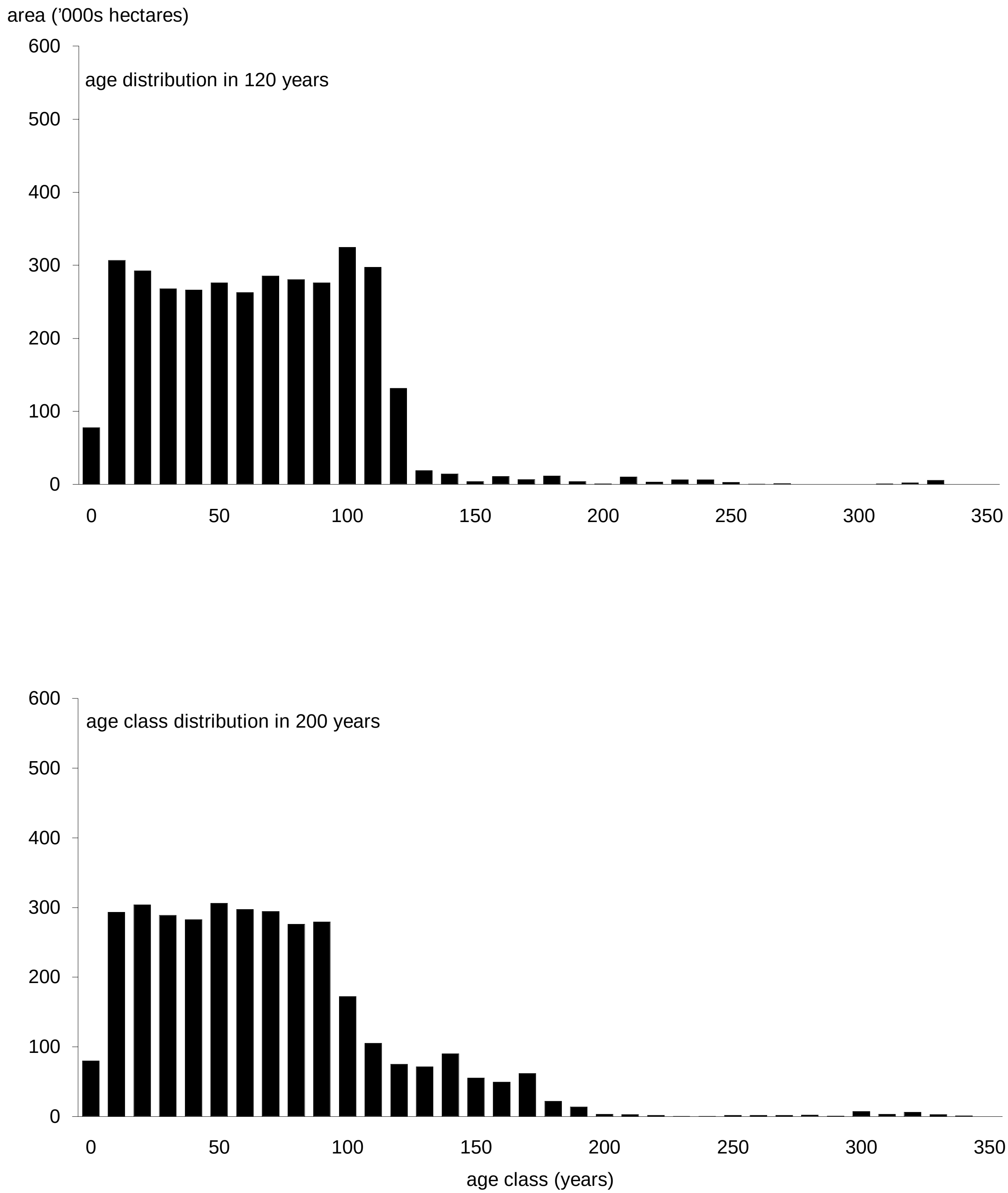


Figure 11. Age class distribution of the timber harvesting land base, Prince George TSA base case, 1994 (concluded).

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 6-11) are referred to as the base case.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows

Figure 12 shows some alternative harvest flows to the base case harvest forecast, that illustrate the variety of possible harvest levels for the Prince George TSA given the characteristics of the timber harvesting land base, yield estimates and the current management practices already described. Three alternate harvest flows examined are:

- the current harvest level is maintained;
- the harvest in the first decade is maximized and the decline to the long-term level is 10% per decade;
- the initial rate of harvest is set at 12% above the current harvest level and is maintained for as long as possible.

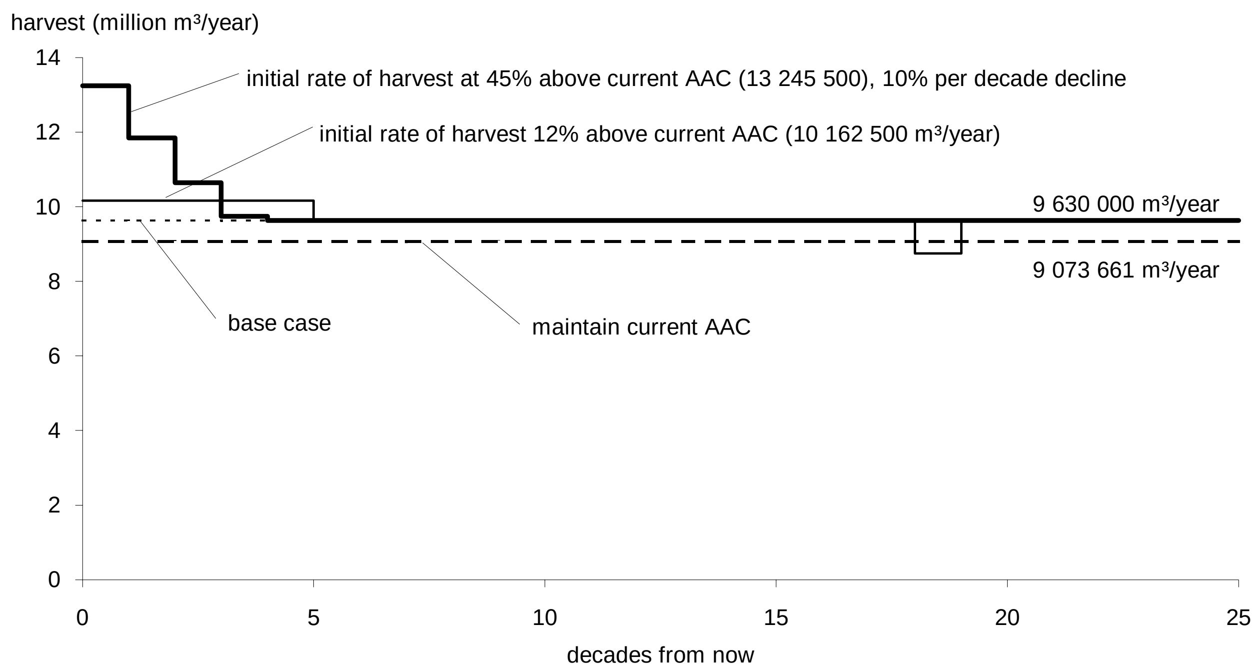


Figure 12. Alternative harvest flow patterns using base case assumptions, Prince George TSA,1994.

5 Timber Supply Sensitivity Analyses

The base case harvest forecast shown in Figure 6 is the maximum harvest possible if declines in the harvest level are to be avoided. An alternative to the base case is to maintain the current harvest level. Figure 13 compares the changes in growing stock over time for this alternative and the base case. During the period 250 to 400 years from now, the total growing stock for the alternative in which current harvest levels are maintained is on average 13% higher than the base case and continues to increase in the long term. The volume of mature growing stock for this alternative is on average 30% greater than the base case growing stock after 250 years. This means that in the case of the alternative forecast there is a larger mature proportion of the forest maintained at all times. Figure 14 shows the age class distribution at 400 years from now for the base case and the alternative harvest forecast. The current harvest level alternative results in substantially more area in the 100 to 120 year age range. This additional area covered by mature forest may contribute to old-growth and biodiversity characteristics. It also represents lower harvest levels and consequently a lower total volume harvested over the long-term. In addition, it poses increased risk because of the greater chance of such things as disease and fire.

Instead, if the objective is to maximize the harvest in the first decade with no shortfall in the long term, the harvest can be set at 45% above the current AAC as depicted by the thick solid line in Figure 12. This level can be maintained for 10 years followed by declines of 10% per decade to the base case level of 9 630 000 cubic metres per year.

As mentioned in the previous section, the base case harvest is 6% above the current AAC. If the initial harvest is set at a further 6% above the base case (10 162 500 cubic metres per year), and maintained for 50 years, a small shortfall appears between 180 and 190 years from now. Attempts to maintain the 6% increase longer than 50 years result in a more significant shortfall.

These two harvest flow alternatives suggest that the non-declining base case harvest flow does not maximize the total timber harvest possible from the forest. Based on current knowledge and management practices, an abundance of merchantable timber currently exists which could increase short-term harvest levels with little or no effect on the long-term harvest level.

Figures 13 and 15 show the total growing stock and the volume of harvestable timber over time for two of the alternative harvest flows. For the alternative where the current harvest level is maintained, both the total and mature volume show an upward trend after 150 years from now. This indicates that in this alternative, surplus volume slowly accumulates. For the alternative where the initial harvest level is set 45% above the current harvest level, growing stock falls sharply in the first few decades and then after 250 years gradually stabilizes around the levels indicated in the base case. This means that given the current management objectives, the initial harvest level could be increased without affecting the growing stock over the long term.

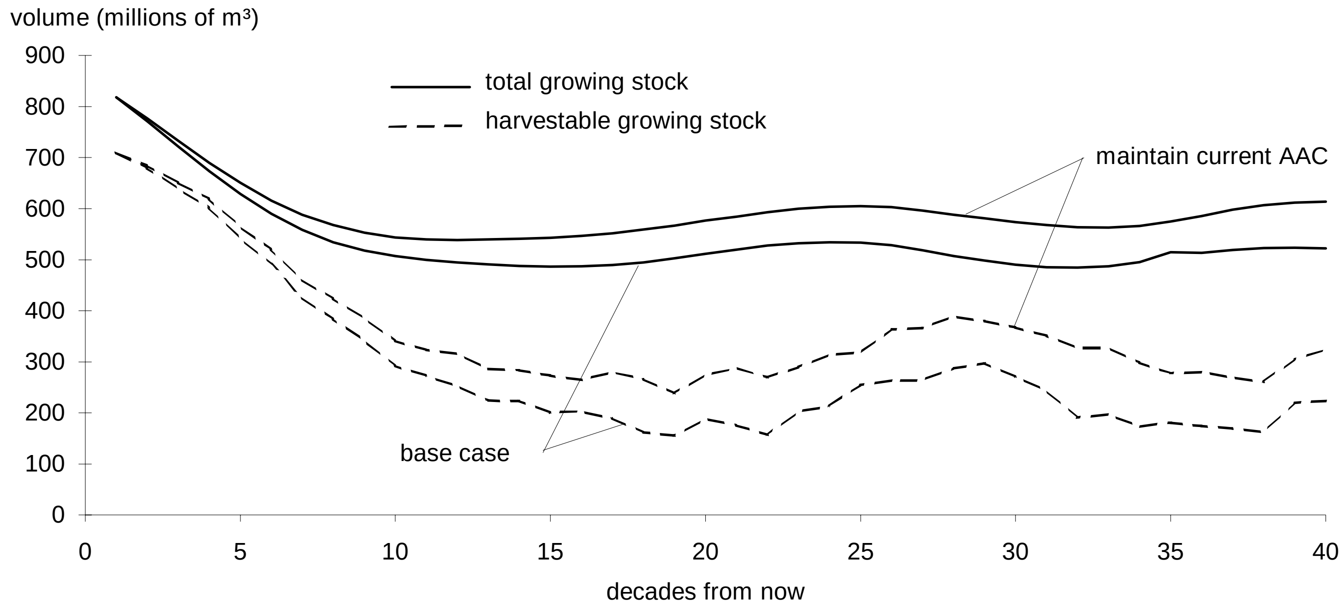


Figure 13. Growing stock over time if the current harvest level is maintained, Prince George TSA, 1994.

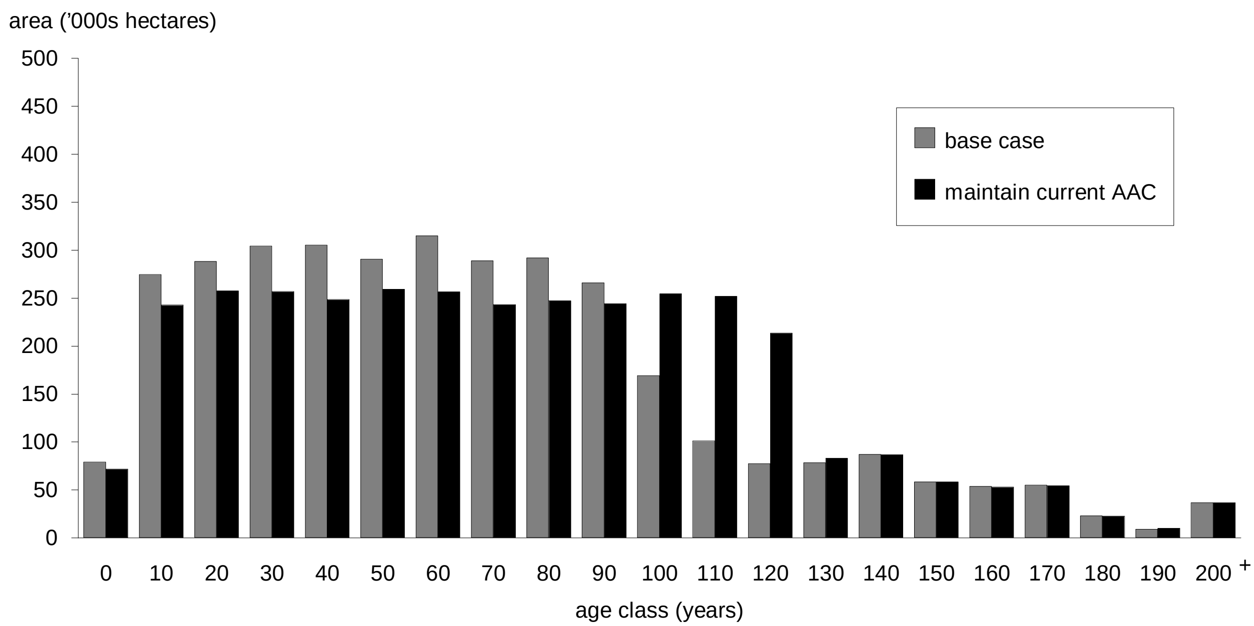


Figure 14. Age class distribution at 400 years from now if the current harvest level is maintained, Prince George TSA, 1994.

5 Timber Supply Sensitivity Analyses

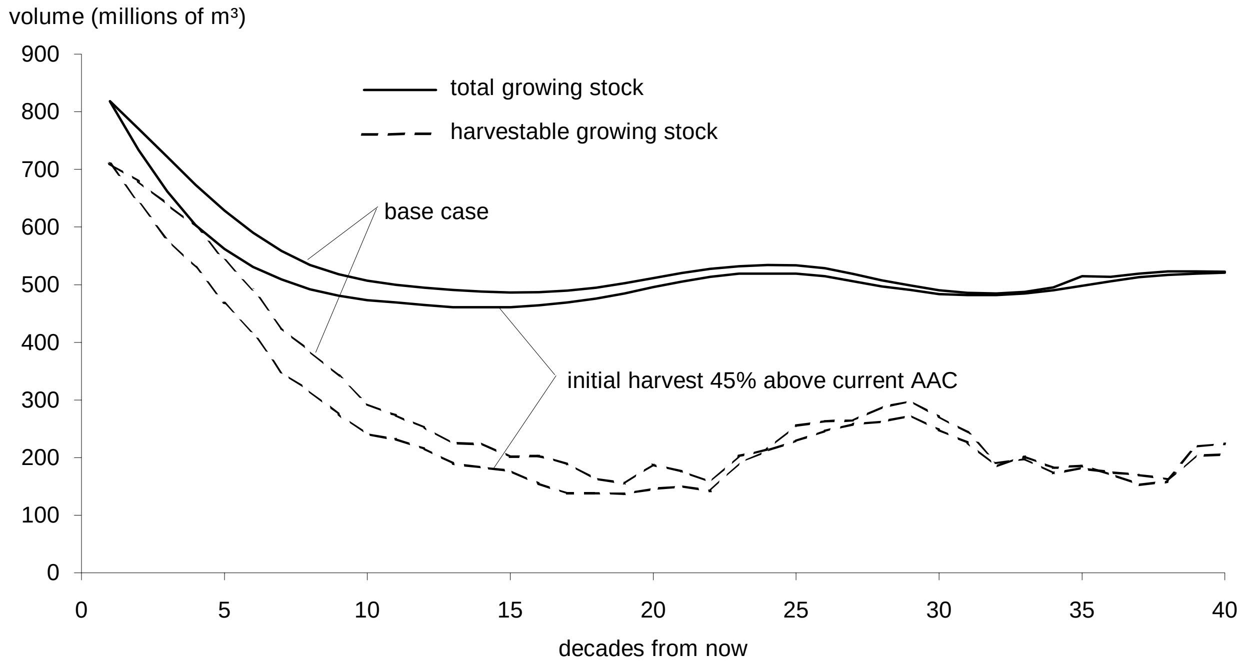


Figure 15. Growing stock over time if initial harvest level is 45% above current harvest level, Prince George TSA, 1994.

5.2 Sensitivity to uncertainty in minimum harvestable ages

The minimum harvestable age for a given stand of timber is an estimate of the time needed for the stand to grow to a merchantable condition. Minimum harvestable ages define when existing and second-growth stands will be available for harvest, and therefore influence how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain, partly because we cannot foresee future conditions that will determine merchantability. The minimum harvestable ages of the base harvest forecast meet certain criteria (i.e. harvesting before stands become susceptible to pests and disease infestations), and maximizing the timber produced over time. The minimum harvestable ages used in the base case range from 80 to 140 years for existing stands and 80 to 180 years for regenerated stands. Stands growing on more productive sites tend to have lower minimum harvestable ages then stands growing on poorer sites. The minimum harvestable ages used ensure trees are well above the minimum sizes that can be processed in local mills.

5.2.1 Sensitivity to uncertainty in minimum harvestable ages for existing stands

The sensitivity of the harvest forecast to changing the minimum harvestable ages for existing stands by 10, 20 and 30 years is examined in this section. (Minimum harvestable ages for regenerated stands remain as they were in the base case). The Prince George TSA harvest forecast is not sensitive to changes in minimum harvestable ages for existing stands. The harvest level is not affected when the harvestable ages are increased or decreased by 10 or 20 years or decreased by 30 years. The long-term harvest remains fixed at 9 630 000 cubic metres per year. An increase in the harvestable ages by 30 years results in a very small decrease (0.1%) in the initial harvest level.

There are two main reasons that the harvest forecast is not significantly affected by this relatively large change in minimum harvestable ages. One reason is that the actual average age at which stands are harvested (about 200 years old during the first 100 years of the harvest forecast) is much greater than the average minimum harvestable ages (about 115 years). A second reason that the harvest forecast is not affected by the increased minimum harvestable ages is that at ages within 20 years of the culmination ages, the estimated average growth rate of the forest is fairly constant. The results of this sensitivity analysis show that changes in harvestable ages, for existing stands alone, are not a limiting factor in the base case.

5.2.2 Sensitivity to uncertainty in minimum harvestable ages for existing and regenerated stands

The sensitivity of the harvest forecast to changing the minimum harvestable ages for both existing natural and regenerated stands by 10 and 20 years is examined in this section. Great uncertainty exists about regenerated stand yield estimates and the minimum harvestable ages of future stands. This is due to numerous factors such as the use of inventory data from existing mature forests to predict the growth and yield of future regenerated stands, uncertainty about the effect upon harvests of replacing existing forests with different tree species, and the effects of soil degradation, pests and forest disease on future forest productivity. Uncertainty in yield estimates also affects uncertainty concerning the minimum harvestable ages.

The harvest forecast is more sensitive to changes in harvestable ages when both existing and regenerated stands are affected. Figure 16 shows that a 10-year increase in harvestable ages reduces the long-term sustainable harvest level by 4.5% to 9 190 000 cubic metres per year. A 10-year decrease in the harvestable ages results in an increase in the harvest level to 9 890 000 cubic metres per year, an increase of 2.7% over the base case. If the minimum harvestable ages are increased 20 years the long-term harvest level drops 9.2% to 8 740 000 cubic metres per year but the current harvest level can still be maintained for 40 years. If the minimum harvestable ages are lowered by 20 years, the long-term harvest level increases 3.5% to 9 970 000 cubic metres per year.

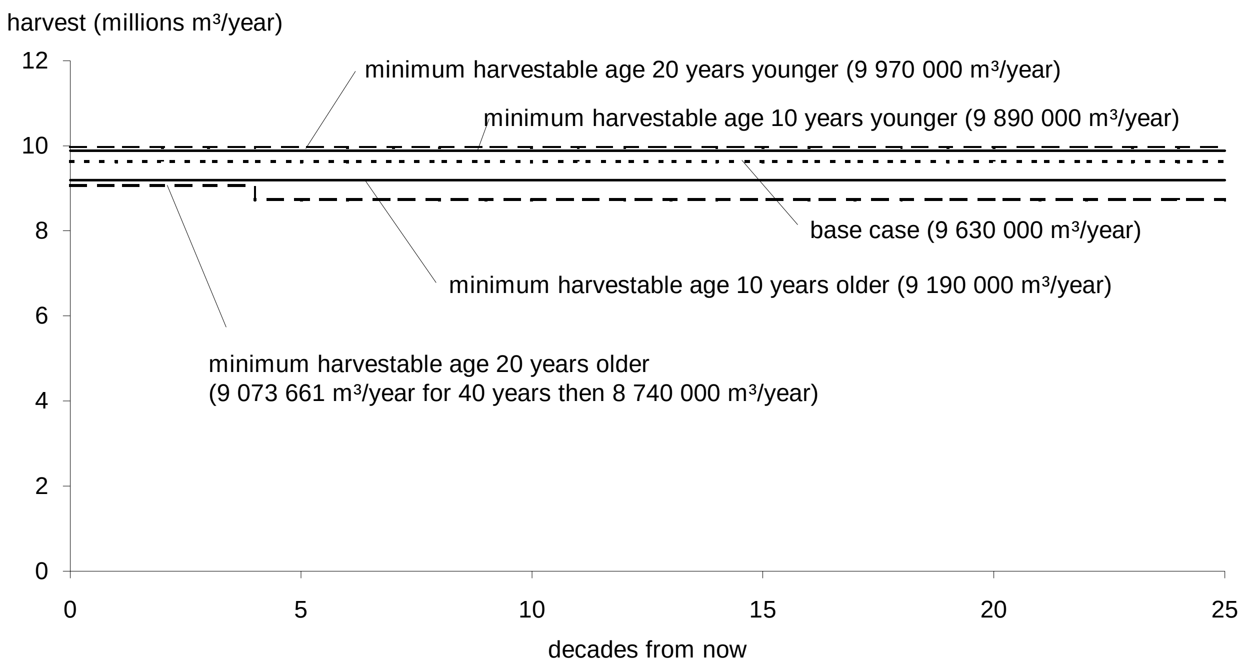


Figure 16. Harvest forecasts when minimum harvestable age is varied, Prince George TSA, 1994.

5.3 Sensitivity to uncertainty in existing stand yield estimates

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

The thick solid line in Figure 17 illustrates the effect on the harvest forecast if the estimated timber yields from existing stands are 10% higher than predicted in the base case forecast. During the first 110 years the harvest is increased by approximately 10.6% to 10 650 000 cubic metres per year. The long-term level is the same as that of the base case forecast because regenerated yield estimates remain unchanged. Adding 10% more volume, has a large effect on timber volume available for harvest.

The thin solid line in Figure 17 shows the harvest forecast if estimated timber yields from existing stands are 10% lower than predicted. In the time period between 31 and 110 years the harvest is reduced approximately 10% to 8 652 000 cubic metres per year. Current harvest levels are still achievable in the first 30 years of the forecast even with the reduction in volume estimates. This is because of the large amount of existing timber that is available for harvest. Again the long-term level is the same as that of the base harvest forecast because harvests at this time are of regenerated stands that are not affected by existing stand yield estimates.

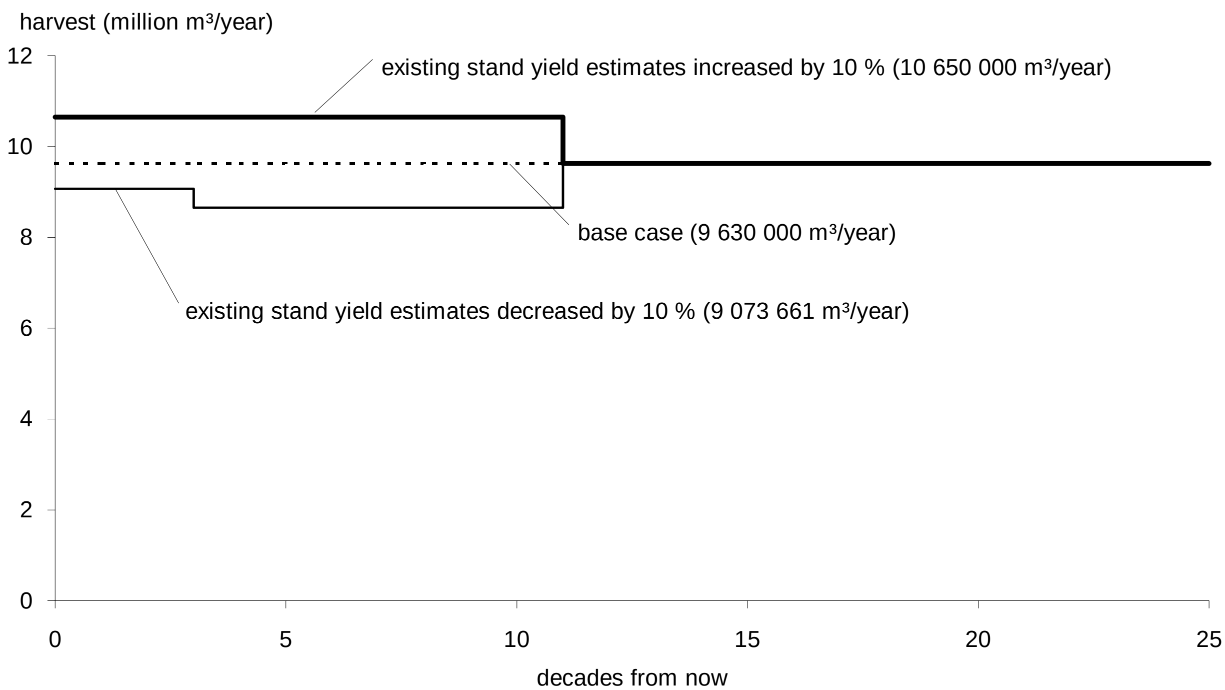


Figure 17. Harvest forecasts with existing stand yield estimates increased and decreased by 10%, Prince George TSA, 1994.

5.4 Sensitivity to uncertainty in regenerated stand yield estimates

Uncertainty in regenerated stand yield estimates is affected by the same factors that affect existing stand yield estimates. In addition to these factors, regenerated stand yield estimates are affected by uncertainty associated with replacing existing forests with different tree species after logging, and the effects of soil degradation, pests and forest diseases on future forest productivity. The Prince George TSA presently has a large amount of older timber. Estimating site productivity in these older stands is difficult. Site productivity estimates determine the stand volumes; thus, there is uncertainty around the regenerated stand volume estimates. The following sensitivity analysis examines the effect that uncertainty in the estimated yields from regenerated stands has on the harvest forecast.

Increasing or decreasing the volume from regenerated stands has no effect on the short-term harvest levels because all of the timber harvested in the short term is from existing stands. The effect of varying regenerated stand yields is projected to appear 110 years from now when regenerated stands will be harvested. The thin solid line in Figure 18 shows the effect on the harvest forecast of increasing the estimated timber yields from all regenerated stands by 10%. The long-term harvest level increases 10.4% from the base case to 10 630 000 cubic metres per year. Similarly, the thick solid line in Figure 18 shows that a 10% reduction in estimated timber volume from regenerated stands results in a long-term harvest level of 8 650 000 cubic metres per year. This is a reduction of 10.2% from the base case harvest level of 9 630 000 cubic metres per year.

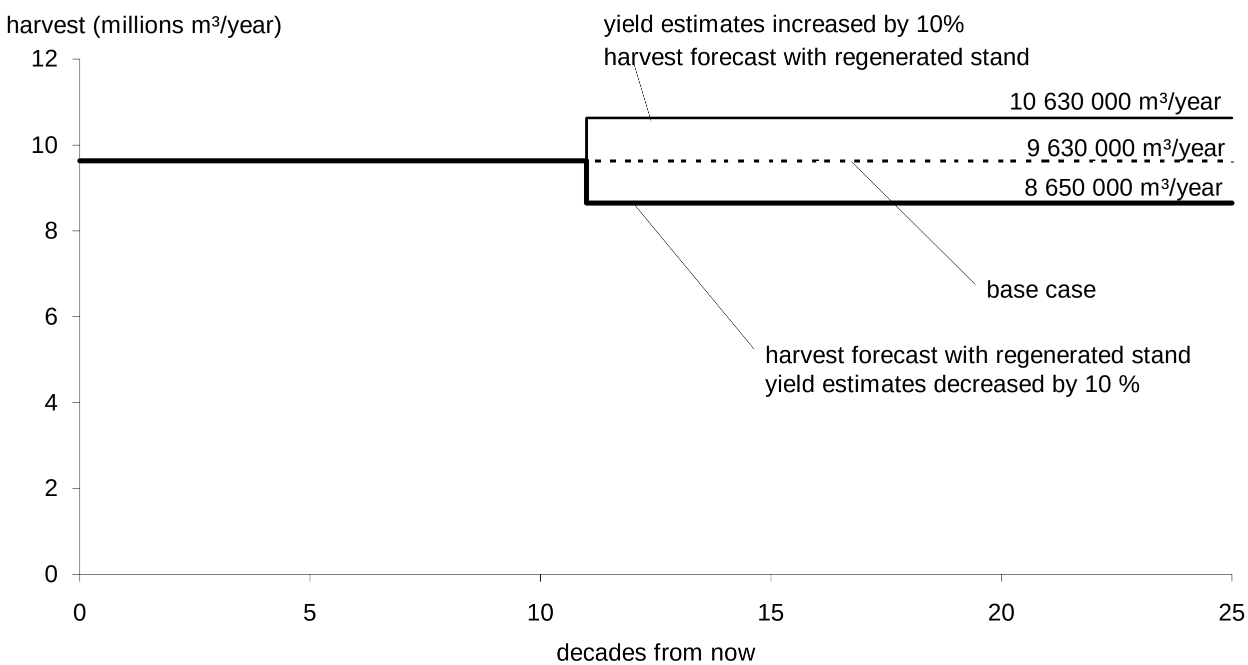


Figure 18. Harvest forecasts with regenerated stand yield estimates increased and decreased by 10 %, Prince George TSA, 1994.

5.5 Sensitivity to uncertainty in green-up age

As discussed in Section 2.3, the required green-up age used in the base case harvest forecast is the estimated number of growing years for the trees in a previously harvested area to reach a required height. Uncertainty in the required green-up age stems from both the uncertainty in stand height growth rates as well as the uncertainty about the height requirement that ensures protection of the forest resource. The following sensitivity analysis examines the effect that uncertainty in the required green-up age has on the harvest forecast.

When the time required for stands to reach green-up conditions is reduced, more volume is available because adjacent timber can be harvested sooner. Conversely, when the time required for stands to reach green-up conditions is increased, less volume may be available because adjacent timber cannot be harvested until later.

Changing green-up ages has a minimal effect on the harvest forecast because cover requirements are not a significant constraining factor in the base case. When the green-up age is increased by 3 years, the long-term harvest level is reduced to 9 560 000 cubic metres per year, 0.7% below the base case. When the green-up age is decreased by 3 years, the non-declining harvest level increases 1.0% to 9 730 000 cubic metres per year. The non-declining harvest level is reduced 120 000 cubic metres from the base case to 9 510 000 cubic metres per year when the green-up period is increased by 6 years. This is a 1% reduction in the non-declining harvest level. Decreasing the green-up age by 6 years increases the non-declining harvest level less than 1%. These results are not shown graphically.

5.6 Sensitivity to uncertainty in cutblock adjacency guidelines

In the base case, forest cover requirements used to model cutblock adjacency and green-up were based on the assumption that, at any time, no more than 25% of the timber harvesting land base may be forested with stands shorter than green-up height. However, this forest management requirement is only an average that applies to areas with no overriding management concerns such as visual quality or wildlife habitat. This assumption is a result of current Prince George TSA guidelines that specify, in detail, the maximum cutblock size, the cutblock shape and the minimum reserve width between adjacent cutblocks. Site specific forest cover requirements vary greatly from this average requirement. Uncertainty in the average forest cover requirements used to model cutblock adjacency and green-up in this analysis stems from these site specific variations from the average.

Because the cutblock adjacency guidelines are not a limiting factor in the base case, the harvest forecast is not changed by relaxing the requirements to allow more area to be covered with stands less than 3 metres tall. Tightening the requirements to allow a maximum of 20% (5-pass) or 16.6% (6-pass) also does not change the harvest forecast from the base case. However, if only 14.3% (7-pass) is allowed to be covered by trees less than 3 metres tall, the forecast is reduced 10.7% from the base case to 8 600 000 cubic metres per year. This reduction occurs immediately and lasts for 170 years; at which time, the higher volume recovered from future managed stands allows an increase to 9 430 000 cubic metres per year. This is illustrated by the solid line in Figure 19. The results of this sensitivity analysis show that forest cover requirements for cutblock adjacency are not a limiting factor in the base case.

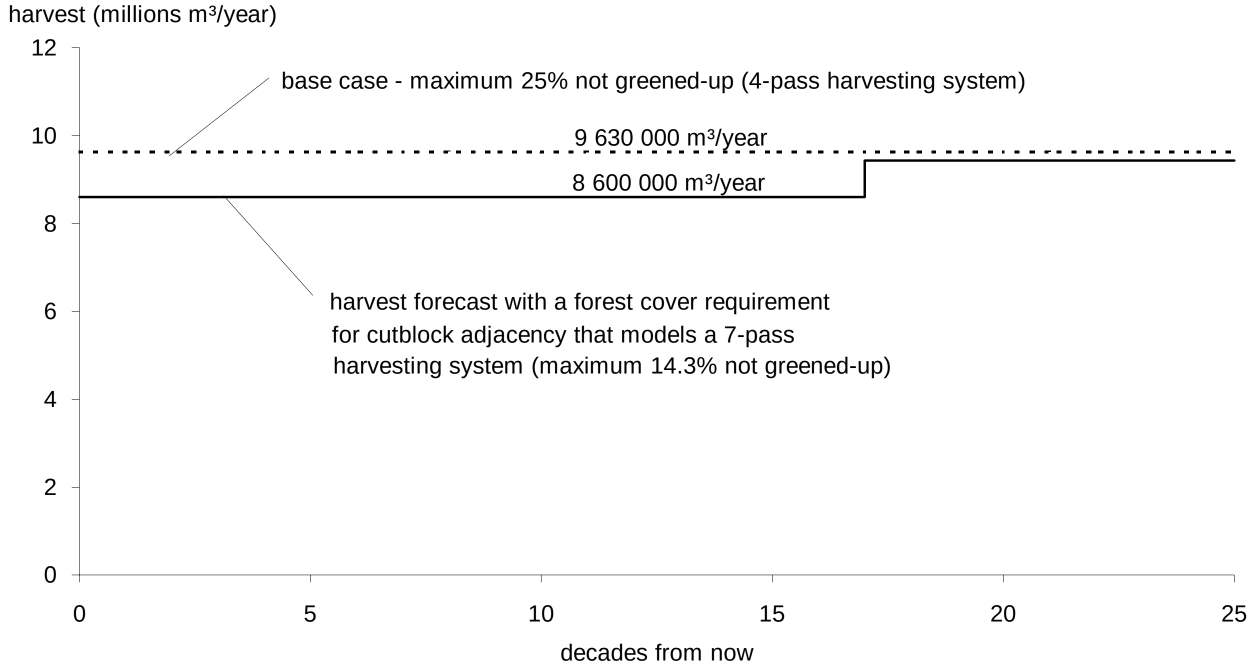


Figure 19. Harvest forecasts with a more stringent cutblock adjacency requirement, Prince George TSA, 1994.

5.7 Sensitivity to uncertainty in forest cover objectives for visual quality

In the base case, forest cover requirements for visually sensitive areas limit the maximum percentage of a visually sensitive forest area that may be under cover of stands that have not reached green-up height (5 metres tall). There is uncertainty associated with these cover requirements because the guidelines and recommendations they are based on are preliminary and may be adjusted.

As described in Section 2.3, "Management practices" the visual quality objectives (VQO) for the TSA are classified into four groups. This sensitivity analysis examines the effect on the harvest forecast of shifting the cover requirement of a visually sensitive area to be more and less restrictive.

To examine the effects of a more restrictive classification, all the area with a modification VQO classification was shifted to a partial retention VQO classification. This means that a maximum of 15% rather than 25% of the area could be visibly altered by harvesting activity. Likewise, all the area with a partial retention VQO classification was shifted to a retention VQO classification. This would allow only 5% rather than 15% of the area to be visibly altered by harvesting activity. Since retention VQO classification is the most restrictive, all the area classified as retention VQO retained the same forest cover requirement as the base case forecast.

To examine the effect of a less restrictive VQO classification, the area classified as retention VQO was shifted to a partial retention VQO, allowing 15% rather than 5% of the area to be visibly altered by harvesting activity. The area classified as partial retention VQO was shifted to modification VQO and all area that was modification VQO retained the same forest cover requirement as the base case forecast.

Figure 20 shows how the harvest level is affected by changing forest cover objectives for visual quality. The thick solid line shows the impact of using a more restrictive VQO classification. The non-declining harvest level is reduced by about 2.1% to 9 430 000 cubic metres per year. The thin solid line shows the impact of using a less restrictive VQO classification. The non-declining harvest level is increased by about 1.6% to 9 780 000 cubic metres per year.

The area that is managed for a specific visual quality objective makes up slightly less than 5% of the timber harvesting land base and yet a relatively small increase in the forest cover objectives to allow less of these areas to be visually altered results in an affect on the timber supply — it is reduced 2.1%. Similarly, a relatively small decrease in the forest cover objective, to allow more of these areas to be visually altered results in an increase in timber supply, 1.6%.

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

The area that is assumed to be suitable and available for timber harvesting is one of the primary factors of timber supply analysis. In the Prince George TSA, the timber harvesting land base could be larger or smaller than expected if any of the areas listed in Table 1 are different from what is expected.

The timber harvesting land base could be different than expected if, for example:

- harvesting costs changed, which would alter the economic feasibility of harvesting operations;
- improved operability* information indicated a different operable land base;
- guidelines to protect sensitive areas were not effective and additional protection was necessary;
- decisions to protect additional forest areas, such as those considered through the provincial Protected Areas Strategy are made. (It should be noted that all harvest forecasts in this report assume these areas are available for timber harvesting.)

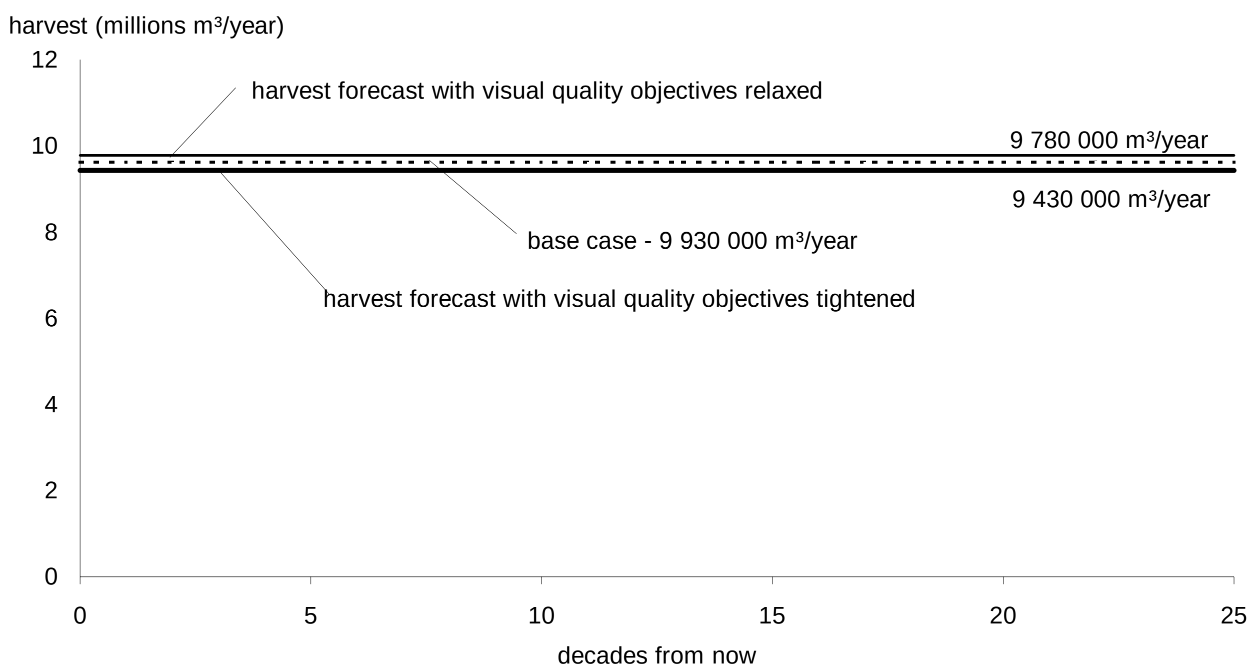


Figure 20. Harvest forecasts with visual quality objectives increased and decreased by 1 class, Prince George TSA, 1994.

Figure 21 shows the effects on harvest flow of decreasing the size of the current timber harvesting land base by 5, 10 and 20%. In the short term, the current harvest level can be achieved for all three alternatives because of the abundance of mature timber available for harvest. In the alternative that examines a 20% reduction to the land base, the current harvest level can only be achieved if a reduction of 15% at the end of the first decade is accepted. This alternative also results in a shortfall in decade 19.

The reductions to the long-term harvest level are directly proportional to the land base reduction tested. This means a 5% land base reduction results in a long-term harvest level of 9 140 000 cubic metres per year, 5.1% below the base case harvest level. A 10% reduction results in a long-term harvest level of 8 640 000 cubic metres per year, 10.3% lower than the base case level; and a 20% reduction results in a long-term harvest level of 7 650 000 metres per year, 20.5% lower than the base case level.

The timber harvesting land base could be increased as a result of improved timber harvesting techniques and equipment, or as a result of increases in the value of currently unmerchantable forest types. An example of currently unmerchantable wood are older cedar and hemlock stands. These stands are currently not included in the timber harvesting land base and, therefore, are not included in the base case. These stands are located in a small contiguous geographic area in the Fraser River trench east of the city of Prince George, where several smaller forest companies have attempted to operate over the last 20 years. Excessive decay and breakage has discouraged the continuation of harvesting. Improvements in harvesting techniques and recent increases in timber value are examples of factors that could make these stands economically viable to harvest.

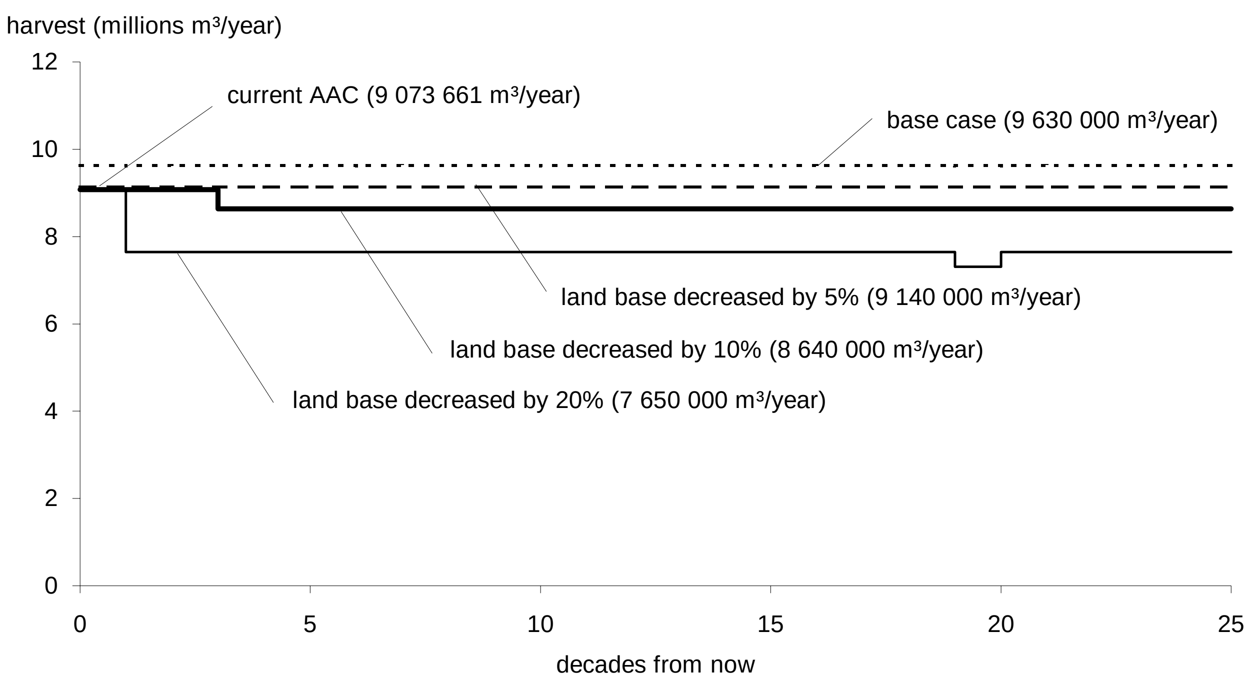


Figure 21. Harvest forecasts with decreases in the timber harvesting land base, Prince George TSA, 1994.

Figure 22 shows the effect on harvest flow of increasing the size of the timber harvesting land base by 5, 10 and 20%. The harvest level increases are directly proportional to the land base increases. A land base increase of 5% results in an non-declining harvest level of 10 130 000 cubic metres per year. This is 5.2% above the base case harvest level of 9 630 000 cubic metres per year. A 10% increase results in a long-term harvest level of 10 620 000 cubic metres per year and a 20% increase results in a long-term harvest level of 11 610 000 cubic metres per year.

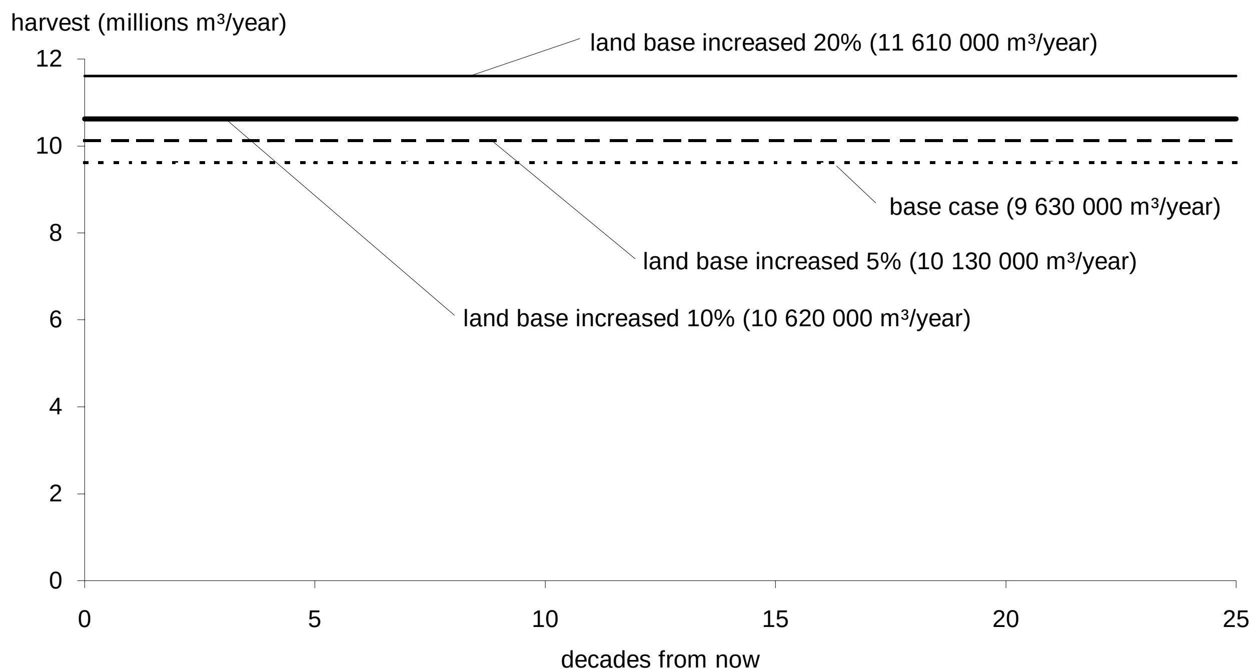


Figure 22. Harvest forecasts with increases in the timber harvesting land base, Prince George TSA, 1994.

6 Summary and Conclusions

This analysis indicates that a harvest level of 9 630 000 cubic metres per year, 6% higher than the current harvest level, can be maintained from the Prince George TSA for the duration of the harvest forecast period.

This harvest forecast is supported by two main factors. The first is the increased size of the timber harvesting land base and the consequent increase in the amount of mature timber that is available for harvest in the short term since the last timber supply analysis. The second factor is the use of managed stand volume estimates for regenerated stands which are 20% greater, on average, than volume estimates for existing stands. This results in additional volume being available for harvest in the long term. These two factors result in additional timber supply throughout the harvest forecast and consequently a higher possible non-declining harvest level. Alternative harvest forecasts to the base case forecast indicate that an initial harvest level greater than that of the base case is possible without affecting the long-term supply of timber.

The analysis results reflect current knowledge and information on forest inventory, growth and management practices. However, the sensitivity analyses indicate that one of the most important factors affecting the long-term timber supply is uncertainty about the size of the timber harvesting land base. Increases or decreases in the size of the timber harvesting land base cause proportionate increases or decreases in the long-term harvest level. When the timber harvesting land base is reduced by 20% the current harvest level can be maintained for 10 years after which the harvest level declines to a long-term level approximately 16% below the base case non-declining level.

The harvest forecast is also sensitive to changes in existing and regenerated stand volumes. Increases and decreases in regenerated stand volumes result in proportional changes to the harvest levels achievable after 110 years from now. Changes in the existing stand volumes have proportional effects on the harvests until 110 years from now. A decrease of 10% in the existing stand volumes causes a reduction from 9 630 000 cubic metres per year to the current harvest level of 9 073 661 cubic metres per year. This harvest level can be maintained for 30 years before a further decline to 8 652 000 cubic metres per year. After 110 years, the harvest increases to the base case non-declining harvest level.

Other sensitivity analyses show that the short-term harvest forecast is relatively insensitive to uncertainty in harvest ages, green-up ages and cutblock adjacency guidelines. In general, the sensitivity analyses conducted resulted in smaller impacts than seen in many other TSA's because of the abundance of mature volume available in the short term.

7 References

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8 Glossary

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

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

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.

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

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

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

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

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

Local resource use plan
A strategic plan for a portion of a timber supply area or tree farm licence that provides management guidelines for integrating resource use in the area.

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

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

8 Glossary

Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area. In Prince George TSA, operable areas are further classified as operable either for conventional systems (ground skidding, cable yarding and skyline systems with a maximum yarding distance of 750 metres) or non-conventional systems (skyline systems with a yarding distance of more than 750 metres, and helicopter systems).
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity **(see Visual quality objective)**.
Preservation VQO	Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity.
Riparian	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Site index	A measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by deducting non-contributing areas from the total land base according to specified management assumptions.
Timber Supply Area (TSA)	An integrated resource management unit established in accordance with *Section 6* of the *Forest Act.*
Tree Farm Licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
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 inputs for the timber supply analysis of the Prince George TSA. This information represents current forest management in the area. Current forest management is defined as the set of land-use decisions and forest and stand management practices that are 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 this analysis, as part of the provincial Timber Supply Review, is to provide information on the effects of current management on both short- and long-term timber supply in the Prince George TSA. Any changes in forest management objectives and practices will be included in subsequent timber supply analyses after the Timber Supply Review has been completed. A detailed version of this appendix has been published and is available upon request from the Prince George Forest Region office.

A.1 Forest Management Practices - Zone Definitions

In the Prince George TSA, 26 geographic areas, or zones, with different management practices were defined for this analysis. The following is a listing of the zones. Figures A-1., A-2. and A-3. following are maps showing the zones in each forest district.

Prince George Forest District

Management Zone Number	Management Emphasis
1	Visual Quality Objective - Preservation
2	Visual Quality Objective - Retention
3	Visual Quality Objective - Partial Retention
4	Visual Quality Objective - Modification and Maximum Modification
5	Integrated Resource Management zone
6	10 year harvest delay (Herrick & Lower Blackwater LRUPs and Treaty 8 adhesion area)
7	Caribou Medium Habitat
8	Caribou Corridors
9	Caribou High Habitat
10	Bowron watershed
11	Blowdown Management zone
12	Preservation zones (Aleza Lake, Government Creek)

Fort St. James Forest District

Management zone number	Management emphasis
21	Visual Quality Objective - Preservation
22	Visual Quality Objective - Retention
23	Visual Quality Objective - Partial Retention
24	Visual Quality Objective - Modification and Maximum Modification
25	Integrated Resource Management zone
26	Preservation zones (Sustut LRUP Preservation zone, Mount Pope Recreation Area, Murrey Ridge Ski Hill)
27	20 year harvest delay (Forfar Creek Watershed Study Area)

Vanderhoof Forest District

Management zone number	Management emphasis
31	Visual Quality Objective - Preservation
32	Visual Quality Objective - Retention
33	Visual Quality Objective - Partial Retention
34	Visual Quality Objective - Modification and Maximum Modification
35	Integrated Resource Management zone
36	10 year harvest delays (Entiako and Upper Blackwater LRUPs)
37	Chedakuz Riparian Management Area

A.1 Forest Management Practices - Zone Definitions

Figure A-1. Management zones in the Prince George Forest District, Prince George TSA, 1994

A.1 Forest Management Practices - Zone Definitions

Figure A-2. Management zones in the Vanderhoof Forest District, Prince George TSA, 1994

A.1 Forest Management Practices - Zone Definitions

Figure A-3. Management zones in the Fort St. James Forest District, Prince George TSA, 1994

A.1 Forest Management Practices - Zone Definitions

A brief description of each zone is as follows.

Visually Sensitive Areas

Visual quality objectives incorporated in the analysis are recommended values currently reflected in forest management. The majority of visual quality objectives for the Prince George TSA have not yet been approved in Management Plans. The visual quality codes are not considered final until public review is completed and consensus is reached on what each code should be, however the recommended values are applied to all planning processes at this time. This is expected to occur during the three on-going Land and Resource Management Plans (LRMP) (Prince George Forest District, Vanderhoof Forest District, Fort St. James Forest District) in the Prince George TSA.

Recommended non-green area percentages were calculated using green area to net area ratios and individual forest district dispersion factors. Dispersion factors used in the analysis were calibrated from sample mapsheets from Prince George and Vanderhoof Forest Districts and are listed in Table A-1.

Table A-1. Dispersion factors for the Prince George TSA

Forest District	dispersed %	clustered %	solid %	green/net ratio
Prince George	9.9	12.7	77.4	1.63
Vanderhoof	7.4	13.2	79.4	1.42
Fort St. James	16.1	19.9	64.0	1.58

Table A-2. shows the factored denudation percentages by forest district and VQO category. Details of the methodology used are in *Procedures for Factoring Recreation Resources into Timber Supply Analyses*, Recreation Branch, Ministry of Forests, Technical Report 1993:1.

Table A-2. Adjusted VQO percentages used for the timber supply analysis

Forest District	VQO adjusted		
	retention	partial retention	modification
Prince George	5.5	16.5	27.6
Vanderhoof	5.3	15.9	26.5
Fort St. James	5.8	17.3	28.8

Integrated Resource Management zones (zones 5, 25 and 35)

All areas not part of other zones fall within the Integrated Resource Management zones. Based on a review of numerous licensee development plans, a 4-pass system was identified as the operational status quo. This 4-pass harvesting system is a result of the *Regional Timber Harvesting Guidelines* and *The Prince George TSA Plan #1*. A 4-pass system is translated to the following guidelines for incorporation into the analysis.

Zone 5 (Prince George Forest District), at any time, no more than 25% of the area may be under cover of stands less than 3 metres tall.

Zone 25 (Fort St. James Forest District), at any time, no more than 25% of the area may be under cover of stands less than 2 1/2 metres tall.

Zone 35 (Vanderhoof Forest District), at any time, no more than 25% of the area may be under cover of stands less than 2 1/2 metres tall.

A.1 Forest Management Practices - Zone Definitions

10 year harvest delay zones

Harvest delay zones include the Herrick Local Resource Use Plan (LRUP), Lower Blackwater LRUP, the McLeod Lake band Treaty 8 Adhesion area, Entiako LRUP and Upper Blackwater LRUP. These ongoing land use processes are incorporated into the analysis as 10-year harvesting delays, in an attempt to reflect the log-around situation of current management. The 10 year period is likely an over estimate of time required to complete these initiatives, usually 2 to 4 years, but the simulation model (FSSIM) is limited to 10 year increments for deferrals. These areas are considered part of the timber harvesting land base, but are deferred from harvesting for the next 10 years. These areas are subsequently assumed to be managed as part of the Integrated resource management zone.

Caribou medium habitat zone (zone 7)

These areas are proposed to be harvested using partial cutting systems. The partial cutting regime is simulated by allowing only 1/3 of the volume in these areas to be available for harvest every 80 years.

Caribou corridors (zone 8)

To ensure adequate mature forest cover required for caribou migration, a maximum of 20% of the area may be in a non-green-up condition (less than 3 metres tall) at any time (a 5-pass management system). Table A-10. contains a detailed listing of portions of planning cells where caribou corridors are located.

Caribou high habitat (zone 9)

Over the past few years, the Ministry of Environment, Lands and Parks has declined approval of proposed harvesting in these high caribou habitat areas. These areas are currently not available for timber harvesting activities.

Bowron watershed (zone 10)

In the early 1980s, a large portion of the Bowron Watershed was harvested to salvage timber infested with spruce bark beetle. No special management objectives are applied to this zone, only integrated resource management guidelines apply. However the area is not available for harvest until the forest matures and meets hydrologic green-up requirements (3 metre top height). The area is treated as a management zone with the intent to localize spatial constraints.

Large block (blowdown) management zone (zone 11)

The approved 1992 - 97 development plan for Canfor (Polar division) identifies three areas where frequent strong wind events cause blowdown. Management of harvesting in these areas ensures wind firm boundaries. To accomplish this, harvest blocks generally tend to be larger, and adjacent harvest blocks are harvested in successive order, advancing into the wind. This means reducing the green-up age to 3 years before adjacent blocks can be harvested.

Fort St. James preservation zones (zone 26)

The approved Sustut LRUP plan identifies a zone along the Sustut River where no developement is permitted. This area does not contribute to the land base supporting this analysis. Other areas, such as the Mount Pope Recreation area and the Murray Ridge ski hill, that are missing from or have incomplete notations on the inventory file, are also excluded from the analysis.

Forfar Creek watershed study area (zone 27)

The Forfar Creek watershed has been identified by the Stuart-Takla Fisheries/Forestry Interaction Project as a control area where no harvesting will occur during the life of the project. As this research project is a long-term study of the impacts of harvesting on salmon habitat, it can be assumed that the Forfar Creek watershed will be exempted from logging for at least 20 years. This area is incorporated as a 20-year harvest delay in the analysis. Table A-15. contains a listing of planning cells included in the Forfar creek Watershed study area.

A.1 Forest Management Practices - Zone Definitions

Chedakuz wildlife management zone (zone 37)
These riparian zones were identified to ensure that a minimum of 15% of all stands are greater than 100 years old at all times.

Prince George Forest District preservation areas
The preservation zones in Government Creek and Aleza Lake Research Forest are mainly for ecological reserves and natural forest reserves. These areas do not contribute to the timber harvesting land base.

A.2 Analysis unit characteristics

To simplify timber supply modelling, given the high number of unique forested stands in the Prince George TSA, as well as to reflect the precision of inventory sampling, individual stands are grouped into analysis units. Analysis units are defined by forest cover (inventory type groups), site quality (new site class), and silvicultural prescription. Each analysis unit is assigned its own timber volume projection (yield table). Fredtab, supported by the Forest Service, Research Branch, was used to generate the site index (SI) for each forest stand on the inventory file. The average site index for an analysis unit was used to generate the managed stand yield tables.

Table A-3. documents the variables used to define each analysis unit. Type groups are BC Forest Service Inventory Branch categories that denote the dominant tree species as well as other species present in a forest stand.

Table A-3. Analysis unit characteristics

Analysis unit	Species groups	Type groups	Site class	Prince George Forest District area weighted SI	Vanderhoof Forest District area weighted SI	Fort St. James Forest District area weighted SI
1	Fir	1 - 8	G, M	17.20	16.88	17.18
2	Fir	1 - 8	P	15.21	13.16	12.85
3	Cedar	9 - 11	G, M, P	13.52	N/A	N/A
4	Hemlock	12 - 17	G, M, P	12.23	N/A	10.88
5	Balsam	18 - 20	G, M	14.89	14.07	12.97
6	Balsam	18 - 20	P	10.00	9.79	9.53
7	Spruce	21 - 26	G	20.01	21.43	20.75
8	Spruce	21 - 26	M	15.65	14.96	15.77
9	Spruce	21 - 26	P	10.74	10.32	10.94
10	Pine	28 - 31, 34	G	20.55	19.55	20.68
11	Pine	28 - 31, 34	M	16.34	15.70	16.60
12	Pine	28 - 31, 34	P	12.24	11.82	12.69
13	Pine (fire origin PG Forest District only)	28 - 31, 34	L	6.30	N/A	N/A
14	Caribou high (PG Forest District only)	All	All	11.59	N/A	N/A

Timber yields were developed for each of the analysis unit and forest district combinations.

In the Prince George Forest District a small portion of the land base was identified as young pine stands originating from fires 20 to 30 years ago. These regenerated into extremely high density pine stands and were classified as having a low site productivity. Prince George Forest District Silviculture staff and Prince George Forest Region Silviculture Research staff have inspected these stands and recommended they be included into the timber harvesting land base at a site index of 6.3 (measured at breast height age 50) and regenerate at a site index base of 11.3. An analysis unit was created to ensure that the stands identified by the listing of planning cells in Table A-19., follow the growth recommendations.

A.3 Definition of the timber harvesting land base

This section provides the information used to define the land base considered available for timber harvesting in the analysis. The harvesting land base is derived by excluding the areas identified in the following sections from the total area in the inventory file. Tables A-4a,b and c summarize land base reductions for each forest district.

Table A-4a. Land base area summary for the Prince George Forest District

Classification	Area (ha)	Per cent of total area
Total area on inventory file	3 020 015	100.0
Private land, reserves, parks	225 056	7.5
Non-forest land	524 994	17.4
Crown forest land	2 269 965	75.2
Reductions to Crown forest:		
Parks & reserves not yet on the inventory file	4 242	0.1
Environmentally sensitive areas	129 441	4.3
Non-commercial cover (NC brush)	51 787	1.7
Residual Stands (old I.U. Logging)	2 591	0.1
Stands with 'low' productivity	110 418	3.7
Non-merchantable deciduous stands	130 687	4.3
Non-merchantable coniferous stands	62 714	2.1
Inoperable areas	144 505	4.8
Existing Roads not on inventory file	31 313	1.0
Not satisfactorily restocked (NSR)	124 017	4.1
Stream side buffers	14 782	0.5
Highly sensitive caribou habitat	47 589	1.6
Visually sensitive preservation areas	1 067	0.0
Unmerchantable cedar and hemlock stands	45 039	1.5
Total Reductions	**900 192**	**29.8**
Initial timber harvesting land base	1 369 773	45.4
Additions to initial timber harvesting landbase:		
Current NSR	46 657	1.5
Backlog NSR	74 139	2.5
Total Additions	**120 796**	**4.0**
Current timber harvesting landbase	1 490 569	49.4
Future reductions:		
Future roads, trails and landings	61 011	2.0
Future timber harvesting landbase	1 429 558	47.3

A.3 Definition of the timber harvesting land base

Table A-4b. Land base area summary for the Vanderhoof Forest District

Classification	Area (ha)	Per cent of total area
Total area on inventory file	1 377 831	100.0
Private land, reserves, parks	164 619	11.9
Non-forest land	140 504	10.2
Crown forest land	1 072 708	77.9
Reductions to Crown forest:		
Parks & reserves not yet on the inventory file	0	0.0
Environmentally sensitive areas	40 727	3.0
Non-commercial cover (NC brush)	267	0.0
Residual Stands (old I.U. Logging)	662	0.0
Stands with 'low' productivity	75 613	5.5
Non-merchantable deciduous stands	49 175	3.6
Non-merchantable coniferous stands	17 197	1.2
Inoperable areas	62 281	4.5
Existing Roads not on inventory file	8 280	0.6
Not satisfactorily restocked (NSR)	31 934	2.3
Stream side buffers	7 866	0.6
Highly sensitive caribou habitat	0	0.0
Visually sensitive preservation areas	783	0.1
Unmerchantable cedar and hemlock stands	0	0.0
Total Reductions	**294 785**	**21.4**
Initial timber harvesting land base	777 923	56.5
Additions to initial timber harvesting landbase:		
Current NSR	11 244	0.8
Backlog NSR	27 948	2.0
Total Additions	**39 192**	**2.8**
Current timber harvesting landbase	817 115	59.3
Future reductions:		
Future roads, trails and landings	40 087	2.9
Future timber harvesting landbase	777 028	56.4

A.3 Definition of the timber harvesting land base

Table A-4c. Land base area summary for the Fort St. James Forest District

Classification	Area (ha)	Per cent of total area
Total area on inventory file	**3 114 943**	100.0
Private land, reserves, parks	31 988	1.0
Non-forest land	1 105 492	35.5
Crown forest land	1 977 463	63.5
Reductions to Crown forest:		
Parks & reserves not yet on the inventory file	5 015	0.2
Environmentally sensitive areas	165 638	5.3
Non-commercial cover (NC brush)	31 057	1.0
Residual Stands (old I.U. Logging)	1 072	0.0
Stands with 'low' productivity	117 201	3.8
Non-merchantable deciduous stands	112 116	3.6
Non-merchantable coniferous stands	100 345	3.2
Inoperable areas	123 215	4.0
Existing Roads not onn inventory file	6 477	0.2
Not satisfactorily restocked (NSR)	41 214	1.3
Stream side buffers	12 741	0.4
Highly sensitive caribou habitat	0	0.0
Visually sensitive preservation areas	653	0.0
Unmerchantable cedar and hemlock stands	67	0.0
Total Reductions	**716 811**	**23.0**
Initial timber harvesting land base	1 260 652	40.5
Additions to initial timber harvesting land base:		
Current NSR	23 000	0.7
Backlog NSR	29 421	0.9
Total additions	**52 421**	**1.7**
Current timber harvesting land base	1 313 073	42.2
Future reductions:		
Future roads, trails and landings	68 947	2.2
Future timber harvesting land base	1 244 126	39.9

A.3 Definition of the timber harvesting land base

A.3.1 Land not managed by the British Columbia Forest Service

Ownership codes on the inventory file are used to determine which areas are not under Forest Service jurisdiction. Ownership codes as defined by Inventory Branch denote both ownership and administrative designation. Areas such as crown grants, Indian reserves, and private lands are not administered by the provincial government. Most land in the Prince George TSA is administered by the provincial government, but not all of it is managed by the Ministry of Forests, for example, the Ministry of Environment, Lands and Parks, administers parks. Further, some forest land administered by the Ministry of Forests is not managed as part of a timber supply area (TSA). For example, woodlot licences, once allocated, are managed as separate units. Table A-5. outlines the total area in each ownership category for all three forest districts within the Prince George TSA.

Table A-5. Land base ownership area summary

Ownership code number	Ownership	Ownership character description	Gross area (ha)
01	None Specified on inventory file	N	208.2
40	Crown grants - private administration	N	351 669.0
50	Federal lands - federal reserve	N	628.0
52	Federal lands - Indian Reserve	N	10 121.3
53	Federal lands - Military Reserve	N	94.6
60	Crown lands - Ecological Reserve	N	318.3
61	Crown lands - Use, Recreation, Enjoyment of Public	C	1 436.7
61	Crown lands - Use, Recreation, Enjoyment of Public	N	10 148.2
62	Crown lands - forest management unit	C	7 036 692.5
62	Crown lands - forest management unit	N	65.8
63	Crown lands - Provincial Park - Class A	N	494.6
67	Crown lands - Provincial Park - special	N	178.5
69	Crown lands - Government reserve	C	51 731.7
69	Crown lands - Government reserve	N	3 477.7
70	Crown lands - Timber Licence	N	1 063.8
72	Crown lands - Tree Farm Licence (private)	B	75.60
75	Crown lands - Christmas tree permit	N	26.1
76	Crown lands - Tree Farm Licence	N	3.1
77	Crown lands - Woodlot licence	N	40 258.0
78	Crown lands - Community pasture	N	3 755.6
99	Crown lands - miscellaneous leases	N	341.7
Total		**All**	**7 512 789**

All areas with ownership codes (Owner, Owner Char) other than 62N, 62C, or 69N, 69C are excluded from the timber harvesting land base for this analysis. In addition all areas that are untyped (TYPID_PR=8) or classified as non-forest (TYPID_PR=6) are excluded from the timber harvesting land base. Ownership character descriptions include N which indicates *non-contributing* and C which indicates *contributing.*

A.3 Definition of the timber harvesting land base

A.3.2. Inoperable areas

Areas defined as physically inoperable were not considered as part of the timber harvesting land base. Characteristics used in defining operability include slope, topography (for example the presence of gullies or exposed rock), difficulty of road access, soil instability, elevation and a minimum volume per hectare requirement for each of the operability classes, see the following criteria listing.

Operability Mapping Characteristics

a) Slope, soil and mature volume/ha criteria were used to define the following operability classes.

Conventional	(A)	skidder-type yarding (rubber-tired, low ground pressure).
Cable	(C)	Cable yarding systems.
Mixed	(M)	Mixed conventional/cable yarding. This class was used for complex broken ground where it was impractical to type out conventional and cable ground separately.
Inoperable	(I)	Those areas that did not meet the mature volume/ha criteria, non-forest types, active areas of instability and alienation's (I.R., private property, etc.).

b) The soil/slope criteria used is:

	Slope by Operability Class	
soil	**conventional**	**cable**
Lacustrine	0 - 30%	> 30%
Non-Lacustrine	0 - 55%	> 55%

c) The mature volume/ha (net of decay, waste and breakage) criteria used was:

Operability class	Mature volume/ha (m^3/ha)
A	over 140
M	over 200
C	over 250

- The volume/ha for immature stands was extrapolated to maturity based on site class and timber type from equivalent adjacent mature stands.
- Any stand that did not meet the mature volume per hectare criteria was typed inoperable.

The following steps were used to create the operability linework:

1. Air photos were typed based on the soil and slope criteria.
2. Air photo type lines were transferred onto forest cover maps.
3. Color-coded mature volume per hectare and ownership plots were produced for each forest cover map.
4. The forest cover maps were placed over the volume per hectare and ownership plots on a light table and the mature volume per hectare criteria was used to produce the final operability class.

A.3 Definition of the timber harvesting land base

*Table A-6. Area by operability class for the timber harvesting land base**

Oper. class	Spruce	Pine	Fir	Balsam	Cedar**	Hemlock**	Totals
Conventional	975 927.06	1 649 037.65	40 058.15	475 623.69	27 127.58	11 396.08	3 179 170.21
Mixed	77 781.39	46 054.66	5 351.17	64 237.83	5 134.82	2 085.61	200 645.48
Cable	73 085.27	14 960.09	2 334.66	32 067.54	25.68	1 257.78	123 731.02
Totals	1 126 793.72	1 710 052.40	47 743.98	571 929.06	32 288.08	14 739.47	3 503 546.71

*Notes: * Totals do not include aproximately 212 000 hectares of NSR and Residual types that contribute to the timber harvesting land base. Some areas have not been inventoried for operability class.

** Cedar and hemlock types do not contribute to the timber harvesting land base for the base case.

A.3.3 Environmentally Sensitive Areas

The forest inventory file includes an assessment of the environmental sensitivity of some forest areas. Most areas rated as highly sensitive are generally unavailable for timber harvesting. Areas with highly sensitive habitat and recreation potential in the Vanderhoof Forest District were mis-classified. During the last re-inventory project areas having a category 2 (moderate sensitivity) designation were reclassified as category 1 (high sensitivity) by default. The table below has been adjusted to account for this. The area inclusion factors for ESAs are listed in Table A-7.

Table A-7. Area inclusions factors for Environmentally Sensitive Areas

	Fort St. James Forest District		Vanderhoof Forest District		Prince George Forest District	
ESA Class	**Cat.1**	**Cat.2**	**Cat. 1**	**Cat. 2**	**Cat.1**	**Cat. 2**
A	0.10	n/a	n/a	n/a	n/a	n/a
C	0.10	n/a	0.30	n/a	n/a	n/a
H	n/a	n/a	n/a	n/a	n/a	n/a
P	0.10	n/a	0.25	n/a	0.10	0.70
R	0.00	0.70	0.75	0.75	0.00	0.20
S	0.10	0.20	0.20	n/a	0.20	0.70
W	0.10	0.70	0.80	0.80	0.10	0.20

Notes:
Application of Area Inclusion Factors for ESAs:
For forest inventory polygons with a single ESA category, area inclusion factors are multiplied by the polygon area to obtain the net merchantable area. If more than one ESA category is on a single polygon the most restrictive AIF will be applied.

A N/A in table entries indicate that no area exists in the forest inventory files in the Forest District, ESA category and class.

ESA Categories and Classifications:

A: SNOW AVALANCHE AREA. An area intended to protect man-made structures and valuable natural resources from snow avalanches.

C: AREAS WITH MANAGEMENT PROBLEMS. Include isolated patches of mature timber, snow chutes, sites with excessive regeneration delay, high elevation forest and watershed protection forest. This classification was used in PSYUs surveyed prior to 1976. After which C is replaced by P,I,A & H).

H: WATER. An area identified as being a watershed or portion thereof that requires special protection or special management to maintain water quality, quantity and seasonal distribution for consumptive use.

P: FOREST REGENERATION. An area having actual or potential critical regeneration problems.

R: RECREATION. An area having significant value for recreational activity or viewing enjoyment.

A.3 Definition of the timber harvesting land base

S: SOILS. An area having actual or potentially unstable soils that may deteriorate unacceptably after forest harvesting.

W: WILDLIFE. An area having a significant value for food, shelter or reproduction for wildlife.
ESA Classification: Explanation
1: High constraint
2: Moderate Constraint

A.3.4 Non-merchantable forest types

Several forest stands are not currently utilized, because they contain non-commercial tree species, low timber volumes, or have low productive potential for timber. Deciduous forest areas are not currently harvested and are removed from the analysis. Coniferous stands that have not reached minimum height or volume are considered unavailable for timber harvesting. Areas classified as low sites, except the pine fire sites discussed previously, are also removed from the timber harvesting land base. Tables A-8. and A-9. summarize the inclusions of forest types by forest district and operability class. An inclusion factor of 1 signifies full inclusion and a 0 signifies a full exclusion.

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Table A-8. Area inclusion factors for mature merchantable stands

Type Group. No. (leading species)	Forest District:	Prince George			Vanderhooof			Fort St. James		
	Logging System:	Conv	Mix	Cable	Conv	Mix	Cable	Conv	Mix	Cable
	Age,height & Stock Class									
1-8 (Douglas-fir)	Age≥7,Ht≥3,Stock=1	1	1	1	1	1	1	1	1	0
	752,852,952,742,842,942	1	1	1	1	1	1	1	1	0
	732,832,932	1	1	0	1	1	0	1	1	0
	721,821,921	1	1	0	1	1	0	1	1	0
	722,822,922	0	0	0	0	0	0	0	0	0
	Age≥7,Ht=1,All Stock	0	0	0	0	0	0	0	0	0
9 - 11 (Cedar)	All Age, Height & Stock	0	0	0	0	0	0	0	0	0
12 - 17 (Hemlock)	All Age, Height & Stock	0	0	0	0	0	0	0	0	0
18-20 (Balsam)	Age≥6,Ht≥3,Stock=1	1	1	1	1	1	1	1	1	1
	642,742,842,942	1	1	1	1	1	1	1	1	1
	632,732,832,932	1	1	0	1	1	0	1	1	0
	621,721,821,921	1	1	0	1	1	0	1	1	0
	622,722,822,922	0	0	0	0	0	0	0	0	0
	Age≥6,Ht=1,All Stock	0	0	0	0	0	0	0	0	0
21-26 (Spruce)	Age≥7,Ht≥3,Stock=1	1	1	1	1	1	1	1	1	1
	742,842,942	1	1	1	1	1	1	1	1	1
	732,832,932	1	1	1	1	1	1	1	1	1
	721,821,921	1	1	0	1	1	0	1	1	0
	722,822,922	0	0	0	0	0	0	0	0	0
	Age≥7,Ht=1,All Stock	0	0	0	0	0	0	0	0	0
27-31 (Pine)	Age≥5,Ht≥3,Stock=1	1	1	1	1	1	1	1	1	1
	542,642,742,842,942	1	1	1	1	1	1	1	1	1
	532,632,732,832,932	1	1	0	1	1	0	1	1	0
	533,633,733,833,933	1	1	0	1	1	0	1	1	0
	534,634,734,834,934	0	0	0	0	0	0	0	0	0
	521,621,721,821,921	1	0	0	1	0	0	1	0	0
	522,622,722,822,922	0	0	0	1	0	0	0	0	0
	523,623,723,823,923	0	0	0	1	0	0	0	0	0
	524,624,724,824,924	0	0	0	0	0	0	0	0	0
	Age≥5,Ht=1,All Stock	0	0	0	0	0	0	0	0	0
35-42 (Deciduous)	All Age,Height & Stock	0	0	0	0	0	0	0	0	0

A.3 Definition of the timber harvesting land base

Table A-9. Area inclusion factors for immature stands

Leading species	Age class(es)	Site class(es)	Area inclusion factor
Cedar,Hemlock,Decid.	All (& Type ID = 1)	All	0
Fir	>2 & <7	G,M	1
Balsam	>2 & <6	G,M	1
Spruce	>2 & <7	G,M	1
Pine	>2 & <5	G,M	1
All	>2 & <7	P	Prince George Forest District: 0.993677 * Vanderhoof Forest District: 1.0 * Fort St. James Forest District: 0.979964 *
Balsam	>2 & <6	P	Prince George Forest District: 0.995571 * Vanderhoof Forest District: 0.999067 * Fort St. James Forest District: 0.993548 *
Spruce	>2 & <7	P	Prince George Forest District: 0.999918 * Vanderhoof Forest District: 0.995798 * Fort St. James Forest District: 0.998679 *
Pine	>2 & <5	P	Prince George Forest District: 0.711973 * Vanderhoof Forest District: 0.995174 * Fort St. James Forest District: 0.893886 *
Fir,Balsam,Sruce,Pine	1 & 2	G,M & P	1
All	All (& Type ID = 1)	Low	0

* Based on Mature Net/Gross Ratio.

Table A-10. Age and height class codes

Age class	Age class age range (years)
1	1-20
2	21-40
3	41-60
4	61-80
5	81-100
6	101-120
7	121-140
8	141-250
9	250+

Height code	Height code height range (metres)
1	0.0-10.4
2	10.5-19.4
3	19.5-28.4
4	28.5-37.4
5	37.5-46.4
6	46.5-55.4
7	55.5-64.4
8	64.5+

Table A-11. Stocking class codes

Stocking class	Applies to	Limits Number of trees/ha, dbh
0	all immature	n.a.
1	all mature	over 76/ha, 27.5+ cm
2	all mature	less than 76/ha, 27.5+ cm
3	all mature pine stands	over 311/ha 17.5+ cm dbh and 50% of stems greater than 7.5 cm dbh are over 12.5 cm dbh
4	all mature pine stands	less than 311/ha, 17.5+ cm dbh or over 311/ha,17.5 cm dbh and less than 50% of stems greater than 7.5 cm dbh are over 12.5 cm dbh

A.3 Definition of the timber harvesting land base

Cedar and Hemlock leading types were excluded from the base case analysis. Currently these stands are not being harvested because their poor quality and marginal economic viability. These stands could be potentially merchantable in the future. Table A-12. summarizes the gross and net (included in the timber harvesting land base) areas if the best of these stands were to be included in the timber harvesting land base.

Table A-12. Gross and potentially merchantable (net) land base for cedar and hemlock stands

Age (years)	Cedar		Hemlock	
	gross area (ha)	net area (ha)	gross area (ha)	net area (ha)
1-20	314	233	135	69
21-40	95	87	2 404	2 013
41-60	0	0	57	33
61-80	18	2	253	228
81-100	0	0	758	507
101-120	78	48	2 437	1 789
121-140	93	38	2 882	1 196
141-250	6 024	3 929	13 687	6 784
250+	42 409	26 798	4 031	1 265
Total	49 031	32 288	26 644	14 739

Note:
Potentially merchantable cedar and hemlock stands include stands in which the average height reaches 19.5 metres by the time it is 121 years old. These stands must be fully stocked (stocking class 1). All immature stands (less than 121 years old) are considered to be merchantable. These stands are subject to all other forest management considerations such as physical operability and environmental sensitivity.

A.3.5 Unclassified roads, trails and landings

Past timber operations have resulted in a loss of productive forest land because of road construction and other long-term productivity losses. However, most of the existing roads are not accounted for in the inventory file. To account for land lost to date during timber harvesting and road building, areas in the Prince George, Vanderhoof and the Fort St. James Forest District are deducted according to the following table. Reductions expected from future operations are also shown in Table A-13.

Table A-13. Per cent area reductions for roads, trails and landings

Forest District	Per cent reduction for existing 'on-block' roads, trails and landings (applied to existing NSR and stands aged 1 to 40 years)	Per cent reduction for existing 'off-block' roads and trails (applied to stands older than 41 years)	Per cent Reduction Future roads (applies to all areas harvested)
Prince George	5.4	0.8	5.4
Vanderhoof	5.7	0.3	5.7
Fort St. James	5.7	0.1	5.7

A.3.6 Streamside buffers

A 1% reduction from the final net land base will account for riparian habitat along streams that are not already accounted for through land base reductions for such things as ESAs, operability or landscape.

A.4 Forest Management Practices

A.4.1 Utilization levels

The utilization level defines the maximum allowable stump height and minimum diameter by species used to calculate merchantable volume. These are listed in Table A-14.

Table A-14. Utilization levels and standards

Species	Utilization level dbh* (outside bark) (cm)	Utilization level top (inside bark) (cm)	Stump height (cm)
All coniferous, except Pine Supply blocks A, B, C, E, G, H	17.5	10	30
All coniferous, except Pine Supply blocks D, F	15.0	10	30
Lodgepole Pine except for below	12.5	10	30
Lodgepole Pine Supply block D - Small diameter stands**	10.5	10	15

Notes:

* dbh: diameter at breast height (1.3 metres)

**Includes only pine stands eligible for harvest under Forest Licence A30526. All other pine stands in Supply block D are assumed to have a utilization level of 12.5cm dbh.

A.4.2 Minimum harvestable ages for each analysis unit

Minimum harvestable ages define the earliest age at which an area may be harvested, not the age at which harvesting must occur. Minimum ages are defined as the age at which 95% of the maximum average growth rate (culmination mean annual increment) is reached. The ages listed in the following table were determined for existing stand yields using VDYP and Regional Priority Cutting ages, and for regenerated stand yields using TIPSY. The exceptions are for balsam analysis units (5 and 6), where a pathological rotation was used. The lower of 95% of culmination age or the Regional Priority Cutting Age (from Ministry of Forests Standard Operating Procedures 3-1) is used. Regenerated minimum harvesting ages are set at the regenerated yield curve culmination ages. Tables A-15a,b and c summarize minimum harvesting ages by forest district.

A.4 Forest Management Practices

Table A-15a. Minimum harvestable age by analysis unit for the Prince George Forest District

Anal. unit	Species groups	Priority cutting age	95% of Existing culmination age	Existing minimum harvestable age	Regenerated minimum harvestable age
1	Fir G,M	141+	110	110	120
2	Fir P	141+	120	120	130
3	Cedar G,M,P	141+	80	80	120
4	Hemlock G,M,P	121+	110	110	140
5	Balsam G,M	121+	120	120	110
6	Balsam P	121+	170	120	180
7	Spruce G	141+	100	100	80
8	Spruce M	141+	120	120	110
9	Spruce P	141+	160	140	150
10	Pine G	101+	80	80	60
11	Pine M	101+	100	100	80
12	Pine P	101+	130	100	90
13	Pine fires	101+	140	100	100

Table A-15b. Minimum harvestable age by analysis unit for the Fort St. James Forest District

Anal. unit	Species groups	Priority cutting age	95% of Existing culmination age	Existing minimum harvestabl e age	Regenerated minimum harvestable age
1	Fir G,M	141+	110	110	90
2	Fir P	141+	130	130	130
3	Cedar G,M,P	141+	N/A	N/A	N/A
4	Hemlock G,M,P	121+	130	120	130
5	Balsam G,M	121+	140	120	120
6	Balsam P	121+	170	120	180
7	Spruce G	141+	100	100	80
8	Spruce M	141+	130	130	100
9	Spruce P	141+	160	140	160
10	Pine G	101+	80	80	60
11	Pine M	101+	100	100	80
12	Pine P	101+	130	100	100

Table A-15c. Minimum harvestable age by analysis unit for the Vanderhoof Forest District

Anal. unit	Species groups	Priority cutting age	95% of Existing culmination age	Existing minimum harvestable age	Regenerated minimum harvestable age
1	Fir G,M	141+	110	110	90
2	Fir P	141+	130	130	110
3	Cedar G,M,P	141+	N/A	N/A	N/A
4	Hemlock G,M,P	121+	N/A	N/A	N/A
5	Balsam G,M	121+	130	120	110
6	Balsam P	121+	150	120	180
7	Spruce G	141+	100	100	70
8	Spruce M	141+	130	130	110
9	Spruce P	141+	160	140	150
10	Pine G	101+	90	90	70
11	Pine M	101+	110	100	80
12	Pine P	101+	130	100	90

A.4.3 Forest cover requirements

The computer model used for this analysis, FSSIM (Ver. 4.2) can incorporate forest cover requirements that specify either the maximum portion of an area allowed in a disturbed condition (usually defined by the height of young trees translated into an age at which the desired height is reached), or a minimum percentage of old age forest that must remain at all times. Pass systems for timber harvesting can be linked to stand level adjacency concerns; that is, experience may show that a certain number of harvest passes may be necessary to meet adjacency guidelines. Therefore, forest cover guidelines can approximate the effect of adjacency guidelines as well as broader forest level goals.

For example, in the IRM zone, the forest cover guidelines result from the application of the Regional Timber Harvesting Guidelines for the Prince George Forest Region. A review of current development plans indicated that a 4-pass system is being used in most cases. An area cannot be logged until trees in any adjacent logged areas have reached a height of 2.5 metres in the Fort St. James and Vanderhoof Forest District, and 3 metres in the Prince George Forest District. A 4-pass harvesting cycle translates into 25% of the operable area in a unit may be cut during a pass.

Fredtab, a site index computer model, supplied by the British Columbia Forest Service, Research Branch was used to estimate when trees in each management zone will reach the required green up height. Since each area supports a range of growth rates, average green-up ages were used for each zone, except for the integrated Resource Management zones, where green-up ages and site index were calculated and applied for each analysis unit. The green-up ages do not include regeneration delays.

Table A-16. summarizes the forest cover requirements for the Prince George TSA for each Forest District. A detailed explaination of management strategies and associated forest cover requirements for each zone are found in Section A.1.1.

A.4 Forest Management Practices

Table A-16. Forest cover requirements

Management zone	Green-up height (metres)	Green up age (years)	Max. non green (percent)
Prince George Forest District			
Visual Quality Objective - Preservation	5	18	0
Visual Quality Objective - Retention	5	24	5.5
Visual Quality Objective - Partial Retention	5	21	16.5
Visual Quality Objective - Modification & Max. Modification	5	23	27.6
Integrated Resource Management Zone AU1	3	15	25
Integrated Resource Management Zone AU2	3	16	25
Integrated Resource Management Zone AU3	3	22	25
Integrated Resource Management Zone AU4	3	25	25
Integrated Resource Management Zone AU5	3	21	25
Integrated Resource Management Zone AU6	3	30	25
Integrated Resource Management Zone AU7	3	16	25
Integrated Resource Management Zone AU8	3	20	25
Integrated Resource Management Zone AU9	3	27	25
Integrated Resource Management Zone AU10	3	12	25
Integrated Resource Management Zone AU11	3	14	25
Integrated Resource Management Zone AU12	3	17	25
Integrated Resource Management Zone AU13	3	19	25
10 year harvest Delay Zone	n.a.	25	25
Caribou Medium Habitat	3	80	33
Caribou Corridors	3	24	20
Bowron Watershed	3	19	25
Blowdown Management Zone	n.a.	3	25
Vanderhoof Forest District			
Visual Quality Objective - Preservation	5	23	0
Visual Quality Objective - Retention	5	22	5.3
Visual Quality Objective - Partial Retention	5	23	15.9
Visual Quality Objective - Modification & Max. Modification	5	23	26.5
Integrated Resource Management Zone AU1	2.5	13	25
Integrated Resource Management Zone AU2	2.5	15	25
Integrated Resource Management Zone AU3	2.5	20	25
Integrated Resource Management Zone AU4	2.5	28	25
Integrated Resource Management Zone AU5	2.5	14	25
Integrated Resource Management Zone AU6	2.5	19	25
Integrated Resource Management Zone AU7	2.5	25	25
Integrated Resource Management Zone AU8	2.5	11	25
Integrated Resource Management Zone AU9	2.5	13	25
Integrated Resource Management Zone AU10	2.5	16	25
10 year Harvest Delays	2.5	15	25
Chedakuz Riparian Management Area*		15	25
Fort St. James Forest District			
Visual Quality Objective - Preservation	5	29	0
Visual Quality Objective - Retention	5	25	5.8
Visual Quality Objective - Partial Retention	5	25	17.3
Visual Quality Objective - Modification & Max. Modification	5	25	28.8
Integrated Resource Management Zone AU1	2.5	13	25
Integrated Resource Management Zone AU2	2.5	17	25
Integrated Resource Management Zone AU4	2.5	25	25
Integrated Resource Management Zone AU5	2.5	19	25
Integrated Resource Management Zone AU6	2.5	25	25
Integrated Resource Management Zone AU7	2.5	14	25
Integrated Resource Management Zone AU8	2.5	17	25
Integrated Resource Management Zone AU9	2.5	25	25
Integrated Resource Management Zone AU10	2.5	11	25
Integrated Resource Management Zone AU11	2.5	12	25
Integrated Resource Management Zone AU12	2.5	15	25
Forfar Creek Watershed Study Area	2.5	20	25

*this area also has an old age constraint, refer to Section A.1.

A.4.4 Unsalvaged losses

Unsalvaged losses are timber volumes destroyed or damaged by a natural cause and not salvaged. Insects and wildfires are the two main sources of natural timber volume loss in the Prince George TSA. Endemic timber volume losses (i.e.,losses that normally occur in a stand) are accounted for through growth and yield or inventory sampling, and are incorporated in yield tables.

The purpose of the unsalvaged loss estimate, is to account for losses to epidemic infestations and other factors not accounted for in timber volume estimates.

The following table summarizes estimates of the average annual unsalvaged volume loss to insects, wildfires, wind and disease over the long term on the timber harvesting landbase by forest district.

Table A-17a. Unsalvaged losses for the Prince George Forest District

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 cubic metres/year
Insects	97 800	59 700	17 400	42 300
Fire	139 300	85 000	24 200	60 800
Wind Damage	332 300	202 700	182 400	20 300
Total				123 400

Table A-17b. Unsalvaged losses for the Vanderhoof Forest District

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 cubic metres/year
Insects	30 000	21 600	2 700	18 900
Fire	7 200	5 200	3 400	1 800
Wind Damage	75 000	54 000	52 100	2 700
Total				23 400

Table A-17c. Unsalvaged losses for the Fort St. James Forest District

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 cubic metres/year
Insects	183 600	115 700	22 000	93 700
Fire	18 400	11 600	1 000	10 600
Wind Damage	35 955	22 600	19 200	3 400
Total				107 700

Note: Gross losses are on the total forested land base. Net losses are on the timber harvesting land base.

A.4 Forest Management Practices

A.4.5 Basic silviculture and regeneration assumptions

Basic silviculture includes any activities required to establish free-growing stands of commercially valued species. Basic silviculture is assumed to occur over the long term in the Prince George TSA. Regeneration assumptions are summarized by forest district in Tables A-18a,b and c.

Table A-18a. Silviculture asumptions for the Prince George Forest District

Existing analysis unit number: species-site	Regenerated analysis unit(s)	Per cent to AU	Per cent planted	Initial stocking (stems/ha.)	Delay to entering growth curve	Regenerated site index*
1:Fir G,M	fir	90	100	1600	2	17.2
	fir	10	0	5000	4	17.2
2:Fir-P	fir	90	100	1600	2	15.21
	fir	10	0	5000	4	15.21
3:Cedar-G,M,P	spruce	85	100	1600	3	14.86
	fir	10	100	1600	3	15.66
	hemlock	5	100	1600	3	13.52
4:Hemlock-G,M,P	spruce	95	100	1600	3	12.23
	hemlock	5	0	2500	4	12.23
5:Balsam-G/M	spruce	90	100	1600	3	15.32
	balsam	10	100	1600	3	14.89
6:Balsam-P	spruce	90	100	1600	3	9.65
	balsam	10	100	1600	3	10.0
7:Spruce-G	spruce	90	100	1600	3	20.01
	pine	10	0	5000	4	20.38
8:Spruce-M	spruce	90	100	1600	3	15.65
	pine	10	0	5000	4	16.37
9:Spruce-P	spruce	75	100	1600	3	10.74
	balsam	20	100	1600	3	10.91
	balsam	5	0	500	4	10.91
10:Pine-G	pine	95	100	1600	2	20.55
	pine	5	0	5000	3	20.55
11:Pine-M	pine	95	100	1600	2	16.34
	pine	5	0	5000	3	16.34
12:Pine-P	pine	95	100	1600	2	12.69
	pine	5	0	5000	3	12.69
13:Pine fires	pine	100	100	1600	3	11.3

*Note: Regenerated site indicies are determined from *Formulated site index conversion equations* provided by Ministry of Forests Research Branch.

A.4 Forest Management Practices

Table A-18b. Silviculture assumptions for the Vanderhoof Forest District

Existing analysis unit number: species-site	Regenerated analysis unit(s)	Per cent to AU	Per cent planted	Initial stocking (stems/ha.)	Delay to entering growth curve	Regenerated site index
1:Fir G,M	fir	50	100	1400	2	16.88
	pine	50	100	1400	2	17.30
2:Fir-P	fir	50	100	1400	2	13.16
	pine	50	100	1400	2	13.32
3:Cedar-G,M,P	N/A					
4:Hemlock-G,M,P	N/A					
5:Balsam-G/M	spruce	90	100	1400	3	14.37
	balsam	10	100	1400	3	14.07
6:Balsam-P	spruce	90	100	1400	3	9.41
	balsam	10	0	500	15	9.79
7:Spruce-G	spruce	95	100	1400	3	21.43
	pine	5	100	1600	3	21.69
8:Spruce-M	spruce	95	100	1400	3	14.96
	pine	5	100	1600	3	15.73
9:Spruce-P	spruce	95	100	1400	3	10.32
	pine	5	100	1600	3	11.46
10:Pine-G	pine	100	100	1600	2	19.55
11:Pine-M	pine	100	100	1600	2	15.70
12:Pine-P	pine	100	100	1600	2	11.82

A.4 Forest Management Practices

Table A-18c. Silviculture assumptions for the Fort St. James Forest District

Existing analysis unit number: species-site	Regenerated analysis unit(s)	Per cent to AU	Per cent planted	Initial stocking (stems/ha.)	Delay to entering growth curve	Regenerated site index
1:Fir G,M	fir	30	100	1400	2	17.18
	pine	60	100	1400	2	17.62
	spruce	10	100	1400	2	16.93
2:Fir-P	fir	100	100	1400	2	12.85
3:Cedar-G,M,P	N/A					
4:Hemlock-G,M,P	spruce	100	100	1400	3	10.88
5:Balsam-G/M	spruce	40	100	1400	3	13.09
	pine	30	100	1400	3	13.62
	balsam	30	100	1400	3	12.97
6:Balsam-P	balsam	100	100	1400	3	9.53
7:Spruce-G	spruce	60	100	1400	3	20.75
	pine	30	100	1400	3	21.06
	balsam	10	100	1400	3	19.53
8:Spruce-M	spruce	60	100	1400	3	15.77
	pine	30	100	1400	3	16.48
	balsam	10	100	1400	3	15.24
9:Spruce-P	spruce	100	100	1400	3	10.94
10:Pine-G	pine	100	100	1400	2	20.68
11:Pine-M	pine	100	100	1400	2	16.6
12:Pine-P	pine	100	0	3000	2	12.69

A.4.6 Not Satisfactorily Restocked (NSR) areas and Residual type add back

For this analysis, areas classified as NSR and Residual are assumed to be restocked over the next several decades. Residual types are areas that have been harvested in the early 1970s.

Table A-19. Areas currently classified as NSR that are assumed to be regenerated (by analysis unit)

	Rate of restocking (ha./decade)			
Analysis unit regenerated	**now**	**during decade 1**	**during decade 2**	**during decade 3**
1:Fir G,M	1 672	2 402	351	174
2:Fir-P	0	0	0	0
3:Cedar-G,M,P	0	0	0	0
4:Hemlock-G,M,P	0	0	0	0
5:Balsam-G/M	4 896	2 909	633	314
6:Balsam-P	1 971	13 472	3 811	1 891
7:Spruce-G	8 431	8 554	1 519	754
8:Spruce-M	28 885	21 472	3 500	1 737
9:Spruce-P	8 358	8 024	2 103	1 044
10:Pine-G	18 614	11 808	1 064	528
11:Pine-M	20 166	14 260	1 152	572
12:Pine-P	10 332	3 945	730	362
Total	103 325	86 846	14 863	7 376

NSR areas shown in Table A-19. are distributed into the various forest management zones as shown in Table A-20.

Table A-20. Areas currently classified as NSR that are assumed to be regenerated (by zone)

Forest management zone	Area (hectares)
Prince George Forest District	
2:Visual quality objective - retention	224
3:Visual quality objective - partial retention	578
4:Visual quality objective - modification	500
5:Integrated resource management zone	106 045
6:Harvest delay zone	2 828
7:Caribou medium habitat	1 371
8:Caribou corridors	1 869
10:Bowron watershed	6 073
11:Blowdown zone	1 309
Fort St. James Forest District	
22:Visual quality objective - retention	1 541
23:Visual quality objective - partial retention	902
24:Visual quality objective - modification	136
25:Integrated resource management zone	49 841
Vanderhoof Forest District	
32:Visual quality objective - retention	167
33:Visual quality objective - partial retention	1 703
35:Integrated resource management zone	34 837
36:Harvest delays	2 228
37:Chedakuz riparian management area	258
Total	212 410

A.5 Yield Estimates

A.5.1 Volume estimates for existing stands

The Variable Density Yield Prediction (VDYP) model, version 4.5, developed by the British Columbia Forest Service Inventory Branch, was used to estimate timber yields for existing stands. Volume estimates were generated for yield curves for every forest district/analysis unit combinations and are summarized by forest district in tables A-21a,b&c.

Table A-21a. Existing stand volume estimates for the Prince George Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 3	Analysis unit 4	Analysis unit 5	Analysis unit 6	Analysis unit 7
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	2	0	0	0	3	0	0
40	23	11	4	6	21	2	12
50	58	43	18	25	50	8	67
60	93	74	34	59	81	20	123
70	125	105	47	98	114	38	173
80	156	133	59	133	141	56	217
90	184	159	68	162	166	73	255
100	211	183	74	186	189	88	287
110	235	205	78	207	210	103	315
120	256	225	81	224	230	117	339
130	276	244	88	245	249	130	360
140	293	260	94	264	267	143	377
150	308	275	100	282	284	155	392
160	322	287	106	298	300	167	404
170	333	297	112	313	315	178	414
180	344	306	117	326	329	189	423
190	354	315	122	338	343	199	430
200	364	323	127	350	356	209	437
210	373	332	132	361	368	218	443
220	382	339	137	373	380	228	449
230	390	346	143	383	391	236	454
240	397	353	148	394	402	245	458
250	405	359	153	403	412	253	462
260	406	360	154	410	414	255	465
270	406	361	155	416	415	256	468
280	407	362	156	422	417	257	470
290	408	363	156	428	418	259	472
300	408	363	157	433	419	260	473
310	409	364	158	438	420	261	475
320	409	364	158	443	421	262	476
330	410	365	159	447	422	263	477
340	410	365	159	450	423	264	478
350	410	365	160	454	424	265	479

(continued)

Table A-21a. Existing stand volume estimates for the Prince George Forest District (concluded)

Age	Analysis unit 8	Analysis unit 9	Analysis unit 10	Analysis unit 11	Analysis unit 12	Analysis unit 13
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	35	4	0	0
40	1	0	94	41	6	0
50	16	2	147	83	26	0
60	59	7	192	121	55	0
70	102	26	232	155	83	0
80	141	50	266	186	108	2
90	175	78	298	214	132	17
100	206	103	326	240	154	31
110	233	126	352	264	175	46
120	256	147	375	286	195	60
130	278	166	398	307	213	75
140	296	184	412	321	226	87
150	313	201	423	332	237	97
160	326	216	431	340	245	105
170	338	229	436	344	250	111
180	349	242	437	346	253	116
190	358	253	435	345	254	118
200	366	264	437	348	257	122
210	374	274	440	350	260	126
220	381	283	442	353	263	129
230	388	291	445	356	266	132
240	393	299	448	358	269	135
250	399	306	450	361	271	138
260	403	311	452	363	274	140
270	406	315	455	365	276	142
280	409	318	457	367	278	144
290	412	322	458	368	279	146
300	414	325	460	370	281	147
310	416	328	462	371	282	148
320	418	330	463	372	283	149
330	420	333	464	373	284	150
340	421	335	465	374	285	151
350	423	337	466	375	286	151

Table A-21b. Existing stand volume estimates for the Vanderhoof Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 5	Analysis unit 6	Analysis unit 7	Analysis unit 8	Analysis unit 9
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	3	0	4	1	1	0	0
40	25	3	18	5	25	1	1
50	60	19	44	13	85	14	4
60	94	41	74	25	144	56	11
70	125	65	106	43	198	100	24
80	155	87	132	61	244	141	49
90	182	108	156	77	285	178	79
100	207	127	177	93	320	211	108
110	231	145	197	107	351	241	135
120	252	162	215	120	378	268	161
130	271	177	235	133	402	293	185
140	288	189	252	146	420	314	206
150	303	200	269	158	436	332	226
160	316	210	284	169	449	346	243
170	327	218	298	179	459	359	258
180	338	225	311	189	468	369	271
190	347	231	323	198	474	378	282
200	356	238	335	208	480	386	294
210	365	244	347	216	486	394	304
220	374	250	358	225	492	401	314
230	382	256	369	233	497	408	323
240	389	262	379	241	501	414	331
250	396	267	389	248	505	419	339
260	397	268	392	250	509	424	346
270	398	268	395	253	512	428	352
280	398	269	397	255	514	432	357
290	399	270	400	257	517	435	363
300	399	270	402	258	519	438	367
310	399	271	404	260	521	441	372
320	400	271	407	262	522	444	376
330	400	271	409	263	524	446	379
340	400	272	411	265	525	448	383
350	400	272	412	266	526	450	386

(continued)

A.5 Yield Estimates

Table A-21b. Existing stand volume estimates for the Vanderhoof Forest District (concluded)

Age	Analysis unit 10	Analysis unit 11	Analysis unit 12
10	0	0	0
20	0	0	5
30	24	2	5
40	79	32	10
50	128	72	26
60	171	109	54
70	210	142	82
80	243	171	107
90	274	199	131
100	303	224	153
110	328	247	174
120	352	269	193
130	375	290	212
140	389	304	225
150	401	315	236
160	409	322	244
170	413	327	250
180	414	329	253
190	412	328	253
200	415	331	257
210	417	334	260
220	420	336	263
230	423	339	266
240	425	342	268
250	428	344	271
260	430	346	273
270	432	348	275
280	434	350	277
290	436	352	279
300	438	354	280
310	440	355	282
320	441	356	283
330	443	358	284
340	444	359	285
350	445	359	285

A.5 Yield Estimates

Table A-21c. Existing stand volume estimates for the Fort St. James Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 4	Analysis unit 5	Analysis unit 6	Analysis unit 7	Analysis unit 8
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	3	0	0	1	0	0	0
40	23	1	1	9	1	16	1
50	56	10	7	30	5	73	15
60	91	29	23	56	17	132	59
70	124	50	52	86	35	185	103
80	155	72	79	111	53	231	144
90	185	92	102	133	70	272	180
100	212	111	122	155	85	308	213
110	237	129	139	174	101	339	243
120	259	145	153	193	115	365	269
130	279	161	169	212	129	389	293
140	297	174	183	229	143	408	313
150	313	186	196	245	155	423	330
160	327	196	207	260	167	436	344
170	339	205	217	275	179	446	357
180	351	213	225	289	190	455	367
190	362	221	233	302	200	462	376
200	372	229	241	314	211	468	384
210	382	237	248	326	221	475	392
220	391	244	256	338	230	480	399
230	400	251	263	349	239	485	405
240	408	258	270	360	248	290	411
250	416	264	276	371	257	494	416
260	417	265	281	372	259	497	420
270	418	266	286	374	260	500	424
280	418	266	291	376	261	502	427
290	419	267	295	377	262	504	430
300	419	268	299	379	263	506	433
310	420	268	303	380	265	508	435
320	420	269	307	381	266	509	437
330	420	269	310	382	267	511	439
340	421	269	313	383	267	512	441
350	421	269	316	384	268	513	442

(continued)

Table A-21c. Existing stand volume estimates for the Fort St. James Forest District (concluded)

Age	Analysis unit 9	Analysis unit 10	Analysis unit 11	Analysis unit 12
10	0	0	0	0
20	0	0	0	0
30	0	36	6	1
40	0	96	45	10
50	2	149	88	34
60	8	195	127	65
70	26	234	161	93
80	51	269	192	119
90	81	300	220	143
100	108	328	245	165
110	134	354	269	185
120	157	377	290	205
130	179	399	311	223
140	199	414	325	236
150	217	425	335	246
160	233	433	343	254
170	247	437	348	260
180	260	439	350	263
190	271	437	350	264
200	282	439	352	267
210	292	442	355	270
220	302	445	358	273
230	310	447	360	277
240	318	450	363	279
250	325	452	366	282
260	331	455	368	284
270	336	457	370	286
280	340	459	372	288
290	344	461	373	290
300	348	462	375	291
310	351	464	376	292
320	354	465	378	293
330	357	467	379	294
340	360	468	380	295
350	362	469	380	296

A.5 Yield Estimates

A.5.2 Volume Estimates for Regenerated Stands

Yield tables for all regenerated stands were produced using the Table Interpolation Program for Stand Yields (TIPSY) growth and yield model developed by the B.C. Forest Service, Research Branch. Regenerated stand yield tables are based on the assumptions listed in Table 18a,b,c. Mean area weighted site indices of the existing stands are assumed to apply to the regenerated stands. TIPSY reports potential yields for a specific site, species and management regime. Operationally these yields will be reduced if irregular stocking, disease, etc. reduce productivity. Operation adjustment factors (OAFs) alter the magnitude (OAF1) and shape (OAF2) of the base TIPSY yield curves. OAF1 reflects reduced productivity due to unproductive areas (e.g. swamps, rock outcrops) while OAF2 reflects losses towards maturity (e.g. diseases). For all regenerated stands waste and breakage factors are assumed to be included in the operational adjustment factor 2 used in the TIPSY model inputs. The specific operational adjustment factors used are:

Operational adjustment factor 1 : 15%   Operational adjustment factor 2 : 5%

Table A-22a. Regenerated stand volume estimates for the Prince George Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 3	Analysis unit 4	Analysis unit 5	Analysis unit 6	Analysis unit 7
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	0	0	0	5
40	1	0	0	0	0	0	45
50	22	5	4	0	20	0	134
60	64	24	35	14	77	0	221
70	117	56	86	49	146	5	302
80	162	94	143	100	206	24	372
90	200	131	192	152	259	55	417
100	237	162	238	196	217	94	446
110	273	188	283	237	362	134	467
120	303	211	325	277	394	170	484
130	332	236	357	319	418	202	496
140	358	259	380	350	434	233	503
150	383	278	399	376	448	263	503
160	404	295	413	393	458	295	503
170	423	311	426	410	467	321	502
180	439	326	437	420	474	343	500
190	453	341	445	431	479	362	498
200	466	353	453	439	484	375	496
210	479	365	459	446	487	387	495
220	490	376	463	452	486	397	494
230	501	385	468	457	484	405	492
240	510	394	471	461	483	411	490
250	517	401	474	464	481	417	489
260	517	401	474	464	481	417	489
270	517	401	474	464	481	417	489
280	517	401	474	464	481	417	489
290	517	401	474	464	481	417	489
300	517	401	474	464	481	417	489
310	517	401	474	464	481	417	489
320	517	401	474	464	481	417	489
330	517	401	474	464	481	417	489
340	517	401	474	464	481	417	489
350	517	401	474	464	481	417	489

(continued)

Table A-22a. Regenerated stand volume estimates for the Prince George Forest District (concluded)

Age	Analysis unit 8	Analysis unit 9	Analysis unit 10	Analysis unit 11	Analysis unit 12	Analysis unit 13
10	0	0	0	0	0	0
20	0	0	3	0	0	0
30	1	0	61	17	0	0
40	6	0	144	62	13	5
50	34	0	211	122	41	28
60	95	1	276	163	71	54
70	163	17	322	202	108	83
80	220	52	359	243	133	112
90	275	95	385	273	154	132
100	329	142	405	297	173	150
110	370	182	422	317	192	166
120	398	218	435	334	212	180
130	418	252	446	348	229	196
140	434	290	455	359	244	212
150	447	323	455	368	255	225
160	457	349	455	375	265	237
170	466	371	455	381	273	246
180	472	386	455	386	281	253
190	477	400	455	390	287	260
200	481	411	455	394	293	266
210	481	419	455	397	298	271
220	480	427	455	399	302	276
230	479	433	455	401	306	280
240	478	438	455	403	309	284
250	476	442	455	404	312	287
260	476	442	455	404	312	287
270	476	442	455	404	312	287
280	476	442	455	404	312	287
290	476	442	455	404	312	287
300	476	442	455	404	312	287
310	476	442	455	404	312	287
320	476	442	455	404	312	287
330	476	442	455	404	312	287
340	476	442	455	404	312	287
350	476	442	455	404	312	287

A.5 Yield Estimates

Table A-22b. Regenerated stand volume estimates for the Vanderhoof Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 5	Analysis unit 6	Analysis unit 7	Analysis unit 8	Analysis unit 9
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	13	1	0	0	9	1	0
40	47	12	1	0	80	5	0
50	89	32	21	0	181	33	6
60	130	59	67	0	268	88	27
70	175	85	126	3	356	151	59
80	214	108	184	18	414	207	98
90	246	131	234	47	451	257	139
100	275	155	281	83	478	309	177
110	303	178	331	120	498	353	210
120	325	197	367	155	513	386	241
130	344	213	394	186	517	409	272
140	363	227	416	215	518	428	305
150	380	239	431	242	516	441	333
160	394	251	444	274	513	453	354
170	407	261	456	303	511	464	372
180	418	272	465	325	509	473	385
190	427	280	473	345	507	478	397
200	436	288	478	359	505	483	407
210	443	295	482	373	503	487	415
220	450	301	486	384	503	488	422
230	456	306	489	393	503	487	427
240	461	311	488	401	503	486	432
250	466	315	486	408	503	484	433
260	466	315	486	408	503	484	433
270	466	315	486	408	503	484	433
280	466	315	486	408	503	484	433
290	466	315	486	408	503	484	433
300	466	315	486	408	503	484	433
310	466	315	486	408	503	484	433
320	466	315	486	408	503	484	433
330	466	315	486	408	503	484	433
340	466	315	486	408	503	484	433
350	466	315	486	408	503	484	433

(continued)

Table A-22b. Regenerated stand volume estimates for the Vanderhoof Forest District (concluded)

Age	Analysis unit 10	Analysis unit 11	Analysis unit 12
10	0	0	0
20	2	0	0
30	50	17	0
40	127	64	13
50	185	122	42
60	250	163	72
70	296	203	108
80	332	244	133
90	360	273	154
100	382	297	173
110	398	317	192
120	412	334	212
130	423	347	229
140	432	358	244
150	440	367	255
160	446	375	265
170	451	381	273
180	451	386	281
190	451	390	287
200	451	393	293
210	451	396	298
220	451	399	302
230	451	401	306
240	451	402	309
250	451	403	312
260	451	403	312
270	451	403	312
280	451	403	312
290	451	403	312
300	451	403	312
310	451	403	312
320	451	403	312
330	451	403	312
340	451	403	312
350	451	403	312

A.5 Yield Estimates

Table A-22c. Regenerated stand volume estimates for the Fort St. James Forest District

Age	Analysis unit 1	Analysis unit 2	Analysis unit 4	Analysis unit 5	Analysis unit 6	Analysis unit 7	Analysis unit 8
10	0	0	0	0	0	0	0
20	0	0	0	0	0	1	0
30	17	0	0	1	0	20	5
40	52	0	0	8	0	73	20
50	96	0	0	18	0	161	54
60	143	4	4	49	0	242	109
70	196	16	16	91	4	318	170
80	237	35	35	137	22	378	223
90	273	58	58	180	54	417	272
100	303	81	81	220	92	446	320
110	329	106	106	257	131	468	355
120	351	128	128	295	168	485	381
130	370	146	146	324	200	498	402
140	386	162	162	348	230	500	417
150	400	176	176	365	260	501	430
160	412	189	189	380	293	500	441
170	422	200	200	392	321	498	450
180	431	212	212	401	343	497	457
190	438	224	224	410	363	495	462
200	444	234	234	417	377	493	467
210	451	243	243	423	389	492	468
220	456	252	252	428	400	490	467
230	460	259	259	432	408	488	467
240	463	266	266	435	416	488	467
250	466	272	272	437	423	488	467
260	466	272	272	437	423	488	467
270	466	272	272	437	423	488	467
280	466	272	272	437	423	488	467
290	466	272	272	437	423	488	467
300	466	272	272	437	423	488	467
310	466	272	272	437	423	488	467
320	466	272	272	437	423	488	467
330	466	272	272	437	423	488	467
340	466	272	272	437	423	488	467
350	466	272	272	437	423	488	467

(continued)

Table A-22c. Regenerated stand volume estimates for the Fort St. James Forest District (concluded)

Age	Analysis unit 9	Analysis unit 10	Analysis unit 11	Analysis unit 12
10	0	0	0	0
20	0	3	0	0
30	0	60	19	0
40	0	139	65	11
50	0	207	121	35
60	1	270	161	69
70	21	317	203	106
80	59	354	243	135
90	103	383	272	159
100	148	406	296	180
110	188	424	317	203
120	224	440	334	224
130	258	453	348	241
140	296	464	359	255
150	328	464	369	267
160	353	464	377	277
170	374	464	384	286
180	390	464	390	294
190	404	464	395	301
200	414	464	399	307
210	424	464	403	312
220	432	464	406	317
230	438	464	408	321
240	444	464	410	324
250	449	464	412	327
260	449	464	412	327
270	449	464	412	327
280	449	464	412	327
290	449	464	412	327
300	449	464	412	327
310	449	464	412	327
320	449	464	412	327
330	449	464	412	327
340	449	464	412	327
350	449	464	412	327